How Many Senses?

Multisensory Perception Beyond the Five Senses

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This is the English version of an article published in Sabah Ülkesi, *January 2021*

Close your eyes and then touch the end of your nose with your finger. It's easy, right? But how did you do it? Specifically, which of the five senses did you use? Touch comes into it of course, but only once you feel your fingertip making contact with your nose. Before that you were using an additional sense known as *proprioception*. Special sensors inside your muscles enable you to feel the configuration of your body even when you can't see it and are not in contact with any other objects. (You can get a sense of what this feels like by stretching out your arms and moving them around.)

In fact, proprioception is just one of a host of senses beyond the standard five—sight, hearing, touch, taste and smell—that you probably didn't even realise you had. Balance is another. How do we manage to stay upright in the dark or when standing on one leg? The answer is that we can sense the direction of gravity using tiny fluid-filled structured located inside each ear. When we move, the motion of the liquid causes tiny hair cells to send signals to the brain that enable us to keep track of our position and orientation. Together with proprioception and awareness of our bodily movements, or *kinaesthesis*, the sense of balance enables us to constantly adjust and fine-tune our posture so that we don't fall over. And all of this happens effortlessly and

continuously without even having to think about it, which is perhaps why the presence of these additional senses often goes unnoticed—at least until they go wrong.

If the inner ear becomes infected, the hair cells can start to send erroneous signals even when the bodily is at rest. The brain then interprets these signals as indicating motion, resulting in illusory sensations of spinning, or *vertigo*. A similar thing happens if you drink too much alcohol, making it difficult to co-ordinate and control bodily movements. Sensations of motion can cause travel sickness when the movements that you feel during a car journey, for example, don't match the relative stability of the visual environment. And even once the brain has adjusted to constant movement, illusory sensations of motion can persist. After disembarking from a long boat journey it can seem like the ground is moving even though you are on dry land.

As these examples illustrate, our senses are more varied and diverse than the traditional classifications of sight, hearing, touch, taste and smell suggest. But should proprioception, balance and kinaesthesis, amongst others, be considered additional senses? And if so, how do we figure out how many senses we really have?

Senses and Sense-Organs

The idea that there are five senses dates back to Aristotle, who was one of the first philosophers to examine them systematically. Though it has become conventional wisdom, many scientists and philosophers would argue that this idea is outdated and inaccurate. Indeed, they have given many different answers to this question, ranging from just three (the number of different kinds of physical energy we can detect) to 33 or more senses. Perhaps surprisingly, the issue remains controversial, partly because it is not clear exactly what should count as a 'sense'. Should we include hunger, thirst or tiredness, for example? And what about temperature, pressure, texture and pain? These are normally grouped together under the heading of 'touch', but could also be regarded as distinct senses in their own right. After all, we don't need to touch the

surface of an object in order to feel that it is hot. For example, we can feel the warmth of the sun by detecting the infra-red radiation that it gives out.

One way of identifying senses is by means of the organs that they use: the eyes for vision, ears for hearing, nose for smell, and so on. One reason we regard touch to be a single unified sense rather than several different ones is that all of the various kinds of tactile sensations are detected via a single organ: the skin. As we now know, however, sensations of temperature (moderate and extreme), pressure, texture, pain and itch involve the activation of different kinds of receptor in the skin. If we count the senses according to receptor types, then we have considerably more than five. This would also makes sense in the case of balance which, despite the relevant receptors being located within the ear, hardly seems like a part of hearing since it has nothing to do with the detection of sounds. Rather, the vestibular system, which detects orientation and acceleration, employs dedicated receptors that just happen to be located inside the ear.

Human vision, by comparison, involves four different kinds of receptors: three of which detect various colours and a fourth monochromatic receptor that is used in low-light vision, which is why can be difficult to tell colours apart at night. Nevertheless, we are not only sensitive to the colour and brightness of visible objects, but to their shape, distance, texture and orientation. So, like touch, vision involves perception of a range of different features despite lacking a dedicated external organ for each. Instead, visual information processed and synthesised by the nervous system and brain, enabling us to make sense of complex visual scenes on the basis of the patterns of the light that fall upon our retinas. In a similar way, hearing allows us to recognise and discriminate a huge array of sounds on the basis of the tiny vibrations that reach our eardrums. The psychologist Albert Bregman likens this task to being able to detect the kinds, positions and movements of objects floating on the surface of a lake on the basis of just the movement of two small handkerchiefs located at its edge: a seemingly impossible feat!

The Objectivity of Perception

As the above examples suggest, it takes more than mere receptivity to sensory information to make something a sense. Since Aristotle, philosophers have also sought to classify the senses according to the kinds of things in the world that they detect. Vision, for example, detects visible light, which is a form of electromagnetic radiation. Hearing detects vibrations of the air or some other medium, and so on. Some properties, such as shape, are detectible via two or more senses, in this case vision and touch. The resulting experiences, e.g. seeing and feeling a cup, however, are very different, and difficult if not impossible to confuse. Nevertheless, in order to qualify as sense, the resulting sensations must enable the perception of some aspect of the objective world. This differentiates our senses from purely subjective feelings and emotions, like joy or sadness, which are better characterised as responses to things that happen in the world, or our own minds, rather than directly revealing the world to us (although we are somewhat prone to confuse the two).

The objectivity of sensory perception is highlighted by the fact that perceptual experiences can present the same features of an object in many different ways. A coin, for example, looks circular when seen face-on, but appears elliptical when viewed at an angle. Yet, when we rotate it, it doesn't look like *the coin* has changed shape. Rather, it is *our perspective upon it* that seems to have changed. Similarly, a white sheet of paper reflects different wavelengths of light when seen in full daylight than it does at dusk or under artificial light, which has a more yellowish hue. But in both cases, the surface of the paper looks uniformly white despite the changing illumination conditions. That we are able to identify and track the features of an object under different conditions without the thing itself seeming to have changed is what psychologists call *perceptual constancy*, and is thought by many to be a defining characteristic of sensory perception.

Cross-Modal and Multisensory Perception

So, each sense involves (1) a suitable kind of sense-organ or receptor, (2) some kind of thing or feature of the world that is detected, (3) a distinctive form of sensation, and (4) the possibility of perceptual constancy? Almost, but not quite. Consider the following example. You are sitting inside the cabin of a plane just before take-off. You are looking straight and cannot see out the windows because it is foggy. While the plane remains stationary on the tarmac or begins to taxi along the runway, the cabin looks from inside to be perfectly level, which it is. As soon as the engines kick in and plane begins to accelerate, however, the cabin appears to tilt upwards even before the wheels have left the ground. After take-off, during the ascent, the cabin also looks to be at a steeper angle than it really is. The possibility of such *cross-modal illusions* suggests that the senses are not as clearly demarcated as one might think.

The plane illusion occurs because the vestibular system, which is responsible for balance, cannot differentiate between gravity and acceleration, since both affect it in exactly the same way. In the absence of further information—by looking outside the window, for example—the brain misinterprets the plane's acceleration as indicating a change in the direction of gravity, resulting in the apparent change of incline. What's striking about this case, however, and others like it is that an experience in one sensory modality, in this case vision, is affected by information from another 'sense', i.e. balance and acceleration. Even without the illusory element, the interior of the cabin *looks* like it is sloping upwards during take-off, even though the information you are receiving from the eyes hasn't changed (assuming you are sitting motionless and looking straight ahead). So we experience a visual difference as a result of a change in vestibular information. The converse illusion can be experienced when sitting on a stationary train while the train on the adjacent platform pulls away, creating an illusory feeling of movement in the opposite direction. Here, a purely visual change causes an apparent sensation of motion.

The sense of smell, or *olfaction*, is another interesting example. You may be familiar with the idea that olfaction contributes not only to 'smelling', i.e. sniffing odours via the nose, but to 'tasting' food and drink in the mouth, i.e. *flavour perception*. This is why the taste of food and drink is impaired when we have a cold or flu. Strictly speaking, taste, or *gustation*, consists of just a handful of basic tastes: sweet, sour, bitter, salty, savoury, and perhaps fattiness and metallic (the jury is still out on the last two). Each of these basic tastes is detected by dedicated receptors on the surface of the tongue. In fact, when we have a cold, the detection of these basic tastes remains unaffected. It is our ability to smell that is affected by the reduced air flow of air in the nasal passages. Since a substantial component of flavour perception depends upon olfaction, the 'taste', or rather flavour, of foods is very much diminished.

You can try this out yourself by holding your nose closed and then chewing on a fruit flavoured sweet. Without the olfactory component, you can taste sweetness and not much else, just like when you have a cold. But as soon as you allow the air to circulate again you get a burst of flavour that tells you whether the sweet is orange, strawberry, apple, etc. Yet we tend to think of flavour as a product of the sense of taste rather than smell. This is in part because the things that we taste are located in the mouth. The relevant olfactory sensations are then 'referred', or bound, to the location of the food or drink, which we also feel with our sense of touch, rather than where the odours are detected, i.e. in the nose. Gustation and olfaction also combine together in such a way that it is not obvious which component of the resulting flavour comes from which sense-organ. Along with information from other sensory receptors, including the trigeminal system which is responsible for 'hot' and 'cool' flavours, this generates a multisensory flavour experience.

The sense of olfaction, then, has a dual role that affects both smell and flavour perception. This has led some philosophers and psychologists to conclude that we have not one, but two senses of smell: one for sniffing and the other for tasting. However, this conclusion rests upon a confusion. As the plane illusion shows, visual experiences

also depend not only upon information coming from the eyes, the primary organ for touch, but the vestibular system, which regulates balance and orientation. Similarly, flavour experience depends upon information coming from the tongue, nose and trigeminal system, rather than gustation alone. Indeed, what we ordinarily call 'taste' just *is* flavour perception in all its multisensory glory. Our senses, it would seem, are more complex than they first appear.

From Sensing to Experience

The inherently multisensory nature of human sensory reveals an important ambiguity in what we mean by a 'sense'. On the one hand, we can think of the senses in terms of *physiological mechanisms*—the eyes, ears, vestibular system, and so on—that detect various kinds of environmental stimuli; e.g. light, sound, or the forces of gravity and acceleration. On the other hand, we can consider the resulting kinds of *sensory experiences*—seeing, hearing, balance, etc.—that enable us to navigate and interact with our environment. In many cases, there is a one-to-one correspondence between these two different ways of thinking about a sense—we hear with our ears, for example. But, as the cases of vision and flavour show, there is often a more complex relationship between two or more physiological sensory mechanisms and the resulting forms of experience. Vision, and arguably all the other spatial senses, partly depends upon balance, and smell is just one way of using olfactory information. Flavour perception, in conjunction with gustation and trigeminal sensations, is another.

If we take the distinction between physiological mechanisms and sensory experiences seriously, as I think we should, the question of how many senses we have can be split in two. First, how many physiological mechanisms do we have for detecting various kinds of stimuli? As we have seen, modern science and the examples listed above show that there are a lot more than five, and perhaps as many as several dozen. Second, how many fundamentally different kinds of experiences do these generate? Here, the answer aligns more closely with the Aristotelian idea of there being

five senses, though this still seems like an underestimate given the importance of proprioception, balance and other forms of bodily awareness.

Importantly, these two different ways of identifying and thinking about the senses shouldn't be seen as competing with one another. Rather, both form an essential part of an overarching picture of our inherently multisensory experience. Nowhere is this more apparent than our ability to sense spatial location and orientation, which arguably forms the foundation upon which many, if not all, of the other senses rest. In addition to the more obviously spatial senses of vision, hearing and touch, which we use to navigate and explore our physical environment, even the chemical senses of taste and smell enable us to experience how things are here and now, and so make implicit reference to our current location and orientation. So not only are there interesting relationships between different sensory mechanisms, such as olfaction and gustation, which combine to give rise to novel forms of multisensory experience, e.g. flavour perception, but there are important relationships among the senses, such as balance, vision and touch.

It is perhaps unsurprising that human perceptual experience should be multisensory. After all, the world is not divided up according to our ability to sense it. Rather, it is our perceptual access to it that is divided. Nevertheless, we experience the world as a complex and integrated whole, deploying our various senses both individually and in combination to explore and engage with the surrounding environment, and each other. In the end, the question of how many senses we have is perhaps less interesting than how these senses relate to one another, and how they integrate and combine to form the rich, multifaceted experience of the world that we know and enjoy. The senses are not isolated, but work together in complex and fascinating ways that science and philosophy are only now discovering.

So next time you sit down to eat a meal, go on a journey, or attend an event or gathering, take a moment to reflect upon which senses you are using. The answer might just surprise you.