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The Nature of Visual Perception: Could a Longstanding Debate Be Resolved Empirically?

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There is a deep divide between people's direct experiences and the standard understanding of vision as taught in biology and psychology. When the looker cannot be seen and other sensory cues are excluded, the sense of being stared at, also called *scopaesthesia*, is impossible from the conventional point of view. Yet it seems to happen. Here, we suggest that thinking again about this puzzle, instead of ignoring or denying it, could deepen our understanding of vision and stimulate fruitful research in the life and mind sciences. The evolution of brain processes that imply a movement of influences out of the eyes would make more sense if such influences actually occur than if they are an illusion. Could scopaesthesia actually happen? No, not if minds are inside heads. But what if minds are not confined to brains?

Two decades ago, the psychologist Gerald Winer and his colleagues at Ohio State University published an article in the *American Psychologist* called "Fundamentally Misunderstanding Visual Perception. Adults' Belief in Visual Emissions" in which they summarized a series of studies on beliefs about vision (Winer et al., 2002). They were shocked to discover that most people, including a majority of their own students, believed that in vision an influence was leaving the eyes, as well as light coming in, namely, "that the process of vision includes emanations from the eyes, an idea that is consistent with the extramission theory of perception, which was originally professed by early Greek philosophers and which

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persisted in scholarly circles for centuries" (p. 417). The students persisted in their belief in extramission ("sending out") even after taking introductory psychology courses on perception (Gregg et al., 2001). Winer and his colleagues then sought to "eradicate" this "unscientific" belief by re-educating their students, emphatically insisting that nothing could go out of the eyes. The researchers were gratified to find a reduction in extramission answers when the students were tested immediately after this "refutational" teaching, but, to the teachers' disappointment, when tested three to five months later, most students had reverted to their previous beliefs (Winer et al., 2002).

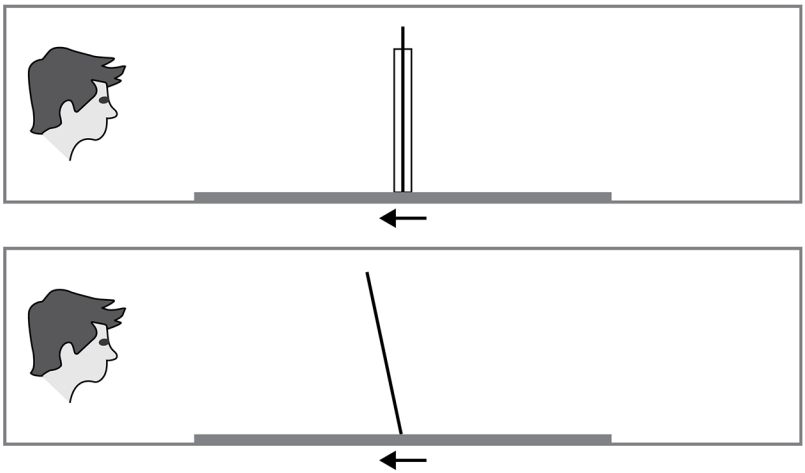

Figure 1: An example of the display in the experimental task in which participants judged at what angle a paper cylinder would topple over when tilted. Once the test began, the cylinder was represented by a single line. The arrow indicates the direction in which the cylinder was tilted. The participants' responses implied a belief that the gaze exerted a gentle force on the cylinder (figure adapted from Guterstam et al., 2019, their Figure 1).

In an ingenious study, the cognitive neuroscientist Arvid Guterstam and his colleagues in the psychology department at Princeton University found that even among people who claimed they did not believe in visual extramission, there was an implicit belief that the gaze involves force-carrying beams projecting from the eyes (Guterstam et al., 2019). In their experiments, conducted on computers, participants had to gauge what angle an upright paper cylinder would topple over when tilted. Their judgements depended on whether or not they thought someone was looking at the cylinder. When shown an image of the cylinder with a human face in profile looking at it (Figure 1), the angle at which they judged the cylinder would fall was significantly different when the face's eyes were open, compared with faces shown blindfolded or facing away, implying that looking at the tube was exerting a mechanical force upon it. When the cylinder was tilted

towards the gaze, the angle at which it was judged to fall was further from the vertical, as if the gaze were supporting it. When tilted away from the gaze, the cylinder was judged to fall at a shallower angle, as if the gaze were helping to topple it. These angles implied a gentle influence "similar in magnitude to a barely detectable breeze" on the order of one hundredth of a newton. Questionnaires filled in after the tests revealed that all the participants were completely unaware that the experiment was designed to test for implicit beliefs about emissions from the eyes, and only 9% thought that the image of the face might have influenced their responses, mainly through distraction (Guterstam et al., 2019).

In a follow-up study, Guterstam and his colleagues showed by using fMRI scans that brains processed the gaze of others as a kind of visual flow, using brain areas known to be specialized for visual motion perception and for tasks requiring theory of mind (the MT+ subregion of the extrastriate visual cortex and the temporo–parietal junction [TPJ] respectively). This effect was primarily in the right hemisphere. They concluded that these results "strongly suggest that, when people view a face looking at an object, the brain treats that gaze as though a movement were present, passing from the face to the object" (p. 13164). They suggested that in the course of evolution, the brain's motion system may have been adapted to keep track of the sources and targets of visual attention, which is particularly important in social contexts (Guterstam et al., 2020). Further studies showed that the imputation of visual flow to the gaze resulted in a motion after-effect (Randall and Guterstam, 2020).

Consistent with implicit or explicit beliefs concerning influences projecting from the eyes, most adults and children claim that they have felt the looks of others and turned around to find someone looking at them. Most people also say that they have had the converse experience of looking at others from behind and finding that these people turn around and look back at them. Surveys on this sense of being stared at, or *scopaesthesia*, were first conducted more than a hundred years ago (Coover, 1913; Titchener, 1898) and these beliefs have not diminished over time. In Winer's surveys, up to 95% of the respondents, both schoolchildren and adults, affirmed that they had felt the looks of unseen others (Cottrell et al., 1996).

Two Theories of Vision

There is a long historical background to present-day discussions about visual perception (Gross, 1999; Lindberg, 1981). For more than 2,500 years, since the time of ancient Greece, inward or intromission ("sending in") theories have tended to regard vision as passive, emphasizing the entry of light into the eye. Outward or extramission theories have emphasized that vision is active. The geometer Euclid, active around 300 BC, was a principal exponent of this view. He recognized that light played a part in vision, but his primary concern was the geometry of visual rays projecting outwards from the eyes. He assumed that these rays travelled in straight lines; through them, the eyes projected the images we see

outside ourselves. He elucidated the principles by which mirrors work, recognizing the equality of the angles of incidence and reflection, and he explained the images we see in plane mirrors in terms of the movement of visual rays outwards from the eyes, passing through the surfaces of mirrors and forming virtual images behind them (Takahashi, 1992).

However, in 1604, the debate seemed to have been settled by Johannes Kepler with his theory of retinal images: small and inverted images of the outside world are produced on retinas through the inward movement of light and the optical effects of lenses. However, Kepler himself admitted that he could not explain how we actually see three-dimensional images apparently outside ourselves, rather than two small and inverted images on our retinas (Lindberg, 1981). This question is still unresolved, as we discuss below. Nevertheless, since Kepler's discovery, most theorists have assumed that representations are somehow produced inside the brain in response to the retinal images, and that there is no extramission of images from the eyes.

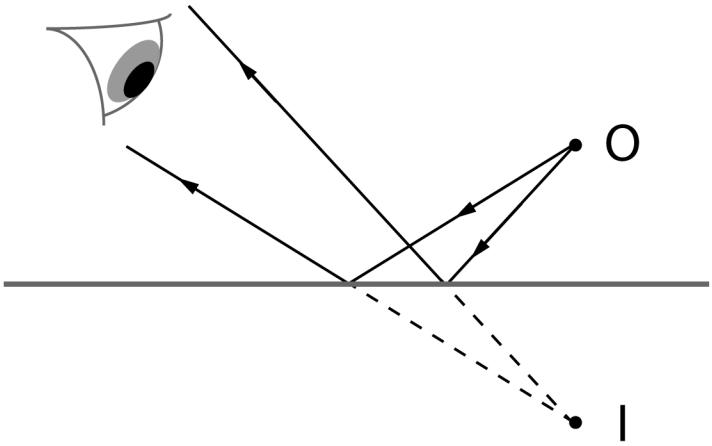

Figure 2: A typical textbook representation of the formation of a virtual image (I) of an object (O) behind a mirror by virtual rays produced outwards, in the opposite direction to the incoming rays of light indicated by arrows (adapted from Duncan and Kennett, 2001).

Yet, ironically, although students of biology and psychology are taught the intromission theory of vision, students of physics are still taught the extramission theory in optics. Modern physics textbooks present an account of mirror reflections in which virtual images are produced outside the eye (Figure 2), as in Euclid's theory. The light rays are shown moving into the eye, but the visual rays that give rise to virtual images go in the opposite direction. This process is

described as follows in a typical British textbook for 14 to 16 year olds: "Rays from a point on the object are reflected at the mirror and appear to come from a point behind the mirror where the eye imagines the rays intersect when produced backwards" (Duncan and Kennett, 2001, p. 8). There is no discussion of how the eye "imagines" rays intersecting, or how it "produces" them backwards. Euclid's diagrams showing the location of virtual images behind flat mirrors produced by the extramission of visual rays are essentially identical to those in modern textbooks (Takahashi, 1992).

Thus science students are likely to conclude that vision involves both the inward movement of light (as taught in biology and psychology courses) and the outward projection of virtual images (as taught in physics courses). However, even before they are scientifically educated, most children believe this anyway. In his study of children's intellectual development, Piaget (1973) found that children under the age of 10 or 11 thought vision involved an outward-moving influence from the eyes. Winer and his colleagues confirmed Piaget's finding in their surveys in Ohio. Eighty percent of the children in grade 3 (aged 8–9) agreed that vision involved both the inward movement of light and outward movement of "rays or energy or something else" (Cottrell and Winer, 1994, p. 219). In the same age group, 75% said they could feel the stares of other people and 38% said they could feel the stares of animals. There was a significant correlation between people's belief in the ability to feel stares and their belief that something goes out of the eyes when people are looking (Cottrell et al., 1996).

This is why we feel it is necessary to think again about the nature of visual perception. On the one hand, many psychologists and philosophers believe in an intromission-only theory of vision, which underlies the assumption that scopaesthesia is impossible. On the other hand, most people implicitly or explicitly believe that influences pass outwards from the eyes, claim to have experienced scopaesthesia, and have also been scientifically educated to believe that the images they see in mirrors are projected outwards by visual rays from their eyes — an understanding reinforced every day by seeing images in mirrors. Consequently, psychologists like Winer are continually frustrated to find that most of their students do not believe what they are taught about the nature of visual perception; even forceful denials of the very possibility of scopaesthesia have no lasting effect.

Are Minds Beyond Brains?

The seemingly conflicting views about visual perception in psychology and physics are paralleled by philosophical discussions about the location of images. Are they confined to the insides of our heads, or are they where they seem to be? According to advocates of the representational theory, they are inside our heads. These supposed internal images are variously called representations, copies,

replicas, "virtual reality displays" (Gray, 2004) or "controlled hallucinations" (Seth, 2021). The neuroscientist Stephan Lehar takes this position to its logical conclusion by considering what happens when you look at the sky. When you look at the sky, he argues, the sky you see is inside your brain. Your skull is beyond the sky. As he puts it:

> I propose that out beyond the farthest things you can perceive in all directions, i.e. above the dome of the sky, and below the solid earth under your feet, or beyond the walls and ceiling of the room you see around you, is located the inner surface of your true physical skull, beyond which is an unimaginably immense external world of which the world you see around you is merely a miniature internal replica. In other words, the head you have come to know as your own is not your true physical head, but only a miniature perceptual copy of your head in a perceptual copy of the world, all of which is contained within your real head. (Lehar, 1999, p. 124)

By contrast, as established above, from ancient Greece to the present day, many philosophers have taken the opposite point of view. Minds are extended. The images we see are in our *minds* but not inside our *heads*. Euclid's theory of vision was one example of this way of thinking. The philosopher Plotinus in the third century took this for granted: "[O]bviously it is there [where the visible object is situated] that the apprehension takes place and the soul looks outwards" (Plotinus, 1884). More recent philosophers who have advocated extended mind theories include Bergson, James, and Whitehead.

Bergson emphasized that perception is directed towards action. Through perception, "the objects which surround my body reflect its possible action upon them" (Bergson, 1896/1911, p. 7). He rejected the idea that images are formed inside the brain: "The truth is that the point P, the rays which it emits, the retina and the nervous elements affected, form a single whole; that the luminous point P is a part of this whole; and that it is really in P, and not elsewhere, that the image of P is formed and perceived" (pp. 37–38).

William James likewise rejected the idea of images or representations inside the brain. He took as an example the reader sitting in a room, reading a book: "[T]he whole philosophy of perception from Democritus' time downwards has been just one long wrangle over the paradox that what is evidently one reality should be in two places at once, both in outer space and in a person's mind. 'Representative' theories of perception avoid the logical paradox, but on the other hand they violate the reader's sense of life which knows no intervening mental image but seems to see the room and the book immediately as they physically exist" (James, 1904; quoted in Velmans, 2000, p. 112). As Whitehead expressed it, "sensations are projected by the mind so as to clothe appropriate bodies in external nature" (1925, p. 54). Throughout the twentieth century, a wide range of philosophers, including Bertrand Russell (1948), made similar

points. Rather than perceiving objects in the external world as re-presented in our heads, we are instead present in the world, actively and directly apprehending such images not as copies but as originals.

In 2000, psychologist Max Velmans advocated a theory of this kind as part of his "reflexive" model of consciousness. He discussed the example of a subject S looking at a cat as follows: "According to reductionists there seems to be a phenomenal cat 'in S's mind,' but this is really nothing more than a state of her brain. According to the reflexive model, while S is gazing at the cat, her only visual experience of the cat is the cat she sees out in the world. If she is asked to point to this phenomenal cat (her 'cat experience'), she should point not to her brain but to the cat as perceived, out in space beyond the body surface" (Velmans, 2000, p. 109).

The so-called "enactive approach" to cognition has recently become the most sophisticated account extending the province of the mind inside-out, with nuanced differences amongst proponents (Chemero, 2001; Clark, 2008; Clark and Chalmers, 1998; Di Paolo, Buhrmann, and Barandian, 2017; Gallagher, 2017; Noë, 2009; Varela, Rosch, and Thompson, 1992). Radical externalism is another version of the extended mind paradigm (Honderich, 2006; Manzotti, 2018). By qualifying the noun "mind" with a battery of adjectives ("extended, embodied, embedded, enactive, and ecological"), Descartes' *res cogitans* is made *extensa*. But is such an extension only metaphorical?

Offering radically opposed theoretical interpretations of visual experiences, these views have not yielded radically different empirical consequences from straightforward mind-in-the-brain accounts, such as those of representationalists, for whom minds are locked in. Are extended minds experimentally detectable, apart from generally agreed physical extensions of minds, as through blind people's canes (Merleau–Ponty, 1945) or cellphones (Clark and Chalmers, 1998)? Do minds have an ability to interact with anything outside the skull directly? The phenomenon of scopaesthesia would suggest that they do.

Does Scopaesthesia Really Happen?

From the representationalist point of view, scopesthesia is impossible, and therefore all the evidence for it must be illusory or flawed; it doesn't happen because it can't. It is often dismissed as "paranormal" (Freeman, 2005; Marks, 2000), literally meaning "above or beyond the normal." However, it is *normal* in the sense that most people say they have experienced it; it is paranormal only if normality is defined in terms of the representational theory of visual perception. Likewise, the assertion that scopaesthesia is an "extraordinary claim" that requires extraordinary evidence (e.g., Marks, 2020) is blind to the fact that this is an *ordinary* claim, in that it is made by most people. The dismissal of scopaesthesia as paranormal or extraordinary is not based on empirical facts, but on theoretical assumptions. Some versions of the extended mind paradigm seem to assume that

extended minds are entirely subjective and have no possible effects on anything in the external world; but other versions open the possibility that the mind of the looker can affect the people or animals looked at in such a way that they detect the looker's attention (Sheldrake, 2005a).

Most people believe that it is possible to detect the looks of unseen others because they have experienced it themselves, but rarely pay much attention to such experiences. However, some people watch others professionally, and have much more experience of people's reactions. Interviews of surveillance officers, security personnel, and detectives showed that most of them took scopaesthesia for granted not as a matter of belief but because they regularly observed it. Likewise, most celebrity photographers, wildlife photographers, hunters, and martial arts practitioners were very familiar with scopaesthesia (Sheldrake, 2003). In some martial arts, people are trained to become more sensitive to looks from behind. Are all these people deluding themselves? Are people and animals merely picking up subtle sensory cues, or misinterpreting coincidences? These questions can be answered experimentally.

Since the 1980s, experimental research on scopesthesia have been carried out using two main methods: direct looking tests, and tests involving closed circuit television (CCTV). In direct looking tests, blindfolded participants were asked to report whether they felt they were being stared at from behind or not in a randomized series of looking and not-looking trials. On average 55% of their answers were correct, compared with 50% expected by chance. Tens of thousands of trials have been conducted so far, with many replications of this small but statistically significant effect, which occurs even when staring takes place through one-way mirrors and closed windows (Sheldrake, 2005b).

In experiments using CCTV, lookers and subjects were in separate rooms, removing all possibility of regular sensory cues. The responses of the subjects were monitored physiologically through the galvanic skin response. The looking and not-looking periods were randomized. In most of these tests, there was a statistically significant difference in response when subjects were watched on a CCTV monitor compared with control periods in which they were not watched (Sheldrake, 2005b). A meta-analysis of 15 such studies showed an overall statistically significant positive effect (Schmidt et al., 2004).

How Might Scopaesthesia Work?

No one knows how scopaesthesia works: at present we can only speculate. One possible way forward is to postulate the existence of "perceptual fields" within and around brains, so that the images we experience are projected outside ourselves and accessible within these fields. This would be one way of conceiving of an extramission theory of vision. Technically, fields are constructs for analysis of remote effects, only indirectly observable. We are all familiar with the idea of fields

surrounding objects, from iron magnets to the moon, invisibly stretching within and far beyond them, outside the material bodies. If minds were extended beyond brains through similarly invisible fields, they could have empirical consequences, including the ability to affect people being looked at from behind (Sheldrake, 1994, 2005a). Perhaps the perceptual fields of the looker interact with fields in and around the person looked at; scopaesthesia may depend on field–field interactions.

This concept of perceptual fields resembles other extended-mind proposals in that minds and perceptions are not confined to the inside of heads; but whereas some extended-mind hypotheses treat the extended mind as non-physical within a conscious perceptual space that lines up with physical space but is distinct from it, our concept of perceptual fields sees them as physical, capable of interacting with other fields of a similar nature surrounding other people's and animals' bodies. Despite being considered as physical, these fields are not the same as the established fields of physics, because they are also mental, implying a dual-aspect nature. Also, although they are probably closely linked to the electromagnetic field through which light travels into the eyes of the looker, their causal influence works in the opposite direction, from the eyes outwards.

As Clarke (2005) pointed out, even according to the conventional intromission theory of vision, the perceiver and object of perception are linked together by an electromagnetic interaction and are thus not self-contained systems but need to be considered as a whole. If consciousness is one of the aspects of this combined system, "then the object (or rather, aspects of it) will be part of this consciousness, associated with the place of the object" (p. 79). However, this more holistic approach to understanding vision cannot in itself account for scopaesthesia, because even if the perceiver and the object perceived are considered to be "entangled" (Clarke, 2007), there is still an information flow in only one direction, from the object to the perceiver. The concept of perceptual fields allows for a flow of information in the opposite direction.

Interactions between the perceptual fields of looker and people looked at may also give directional information, and many reports of scopaesthesia suggest that the effect is indeed directional: people stared at often turn and look straight at the person staring (Sheldrake, 2003). An action propagated through perceptual fields would also agree with the implicit assumption that the gaze exerts a kind of outwards-directed force, as shown in the experiments of Guterstam and collaborators (2019, 2020). However, perceptual fields somehow coupled to the electromagnetic field of light entering the eyes cannot by themselves account for scopaesthesia that does not involve direct looking, as in the ability to detect stares through mirrors and through CCTV. The virtual images in mirrors do not coincide with the person being looked at, nor do the images on TV or computer screens. Another kind of explanation is needed in these cases, more to do with the concentration of attention and/or intention on the person looked at, which Braud (2005) called the effects of "remote attention" and "remote intention." The

effects of remote attention are not identical to those of direct looking. The ability of subjects to detect remote attention or intention appears to be weaker than the ability to detect direct stares. The CCTV experiments described above depended on the measurement of unconscious electrophysiological responses, not on explicit conscious responses as in the direct-looking tests. When subjects who were viewed on screens in randomized tests were asked to respond verbally, the results were at chance levels. Likewise, from an analysis of case histories, the ability to detect stares through mirrors seems to be weaker than with direct looking.[1]

The ability to detect attention or intention at a distance may be more akin to telepathy, through which one person's intention to reach out to another seems able to bring about effects at a distance, as in the phenomenon of telephone telepathy. Many people say they have thought about someone for no apparent reason, and soon afterwards that person called on the telephone, or else they knew who was calling when the phone rang before looking at the caller ID or answering the call. In surveys in Europe and the Americas, more than 85% of the respondents said they had had seemingly telepathic experiences with phone calls (Sheldrake, 2003). These experiences cannot all be explained simply as a matter of chance coincidence and/or selective memory.

In randomized tests, which were filmed, in each trial, subjects received a phone call from one of four potential callers that they themselves had nominated. The callers were selected by the experimenters in a randomized sequence. When the phone rang, the subjects had to say who they thought was calling before answering the phone, which was a landline phone with no caller ID. In some cases the callers were thousands of miles away. By chance the subjects' responses would have been right about one time in four, or 25%. In a series of more than 250 trials the hit rate was very significantly above chance, at 45% (Sheldrake and Smart, 2003). Similar experiments in connection with emails and text messages have given similar positive and statistically significant results (Sheldrake, 2014).

However, scopaesthesia is not reducible to telepathy, and differs from it in several respects. First, it occurs with strangers, and even with unfamiliar animals of other species, whereas telepathy typically occurs between people who are closely bonded, like family members and close friends (Sheldrake, 2003) or between people and animals that are closely bonded, as in the case of some dogs that know when their owners are coming home (Sheldrake, 1999). Second, scopaesthesia is often directional, whereas telepathy is typically non-directional: when people anticipate telephone calls, they do not sense where their callers are. Third, scopaesthesia is by definition associated with visual attention, whereas telepathy may result from non-visual emotions, needs, and

[1] Sheldrake, unpublished data.

thoughts. Scopaesthesia as a result of direct looking may well include *both* the effects of perceptual fields and *also* the effects of attention or intention, while scopaesthesia through CCTV may involve only the effects of attention or intention, which may usually have smaller effects.

Concluding Remarks

Attempts to account for scopaesthesia lead into unfamiliar theoretical territory, where much is still unknown. However, this exploration would be easier if there were more empirical data, for example through direct comparisons of people's ability to detect direct staring compared with staring through mirrors or looking at images on screens. More research on the directionality of scopaesthesia would also help. Studies with non-human animals, including invertebrates, would make its biological and evolutionary context clearer.

This is a relatively new field of enquiry, and perhaps more rigorous experiments will reveal that scopaesthesia is illusory, just as representationalists assume. However, if it is real, further research could shed light on how it works, offering constraints on theory-making and even suggesting practical applications. One would need to suspend the circular reasoning that because it does not work in theory it cannot happen in practice and thus it is not worth examining since one already knows that the phenomenon must not exist. Representationalists will go on dismissing people's experiences of feeling stares, along with the experimental evidence for scopaesthesia, because they believe minds are confined to brains, while in optics classes students will continue to be taught that visual rays move outwards from their eyes to produce virtual images behind mirrors. Psychology and biology professors will be frustrated over and over again by many of their students' disbelief in the "correct" scientific theory. Meanwhile, the centuries-old debate between representationalists and extended mind theorists will go on in academic disputations that make no difference to science. Instead, if we rethink this issue, empirical research on scopaesthesia could move this longstanding debate forwards, opening up new lines of enquiry in evolutionary biology, the evolution of brain systems that model the directional nature of gazes as movements, the ecology of predator and prey relationships, the anthropology of beliefs about the power of looks, and the relationships of minds, brains, and perceptual worlds.

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