ted, its *evolutionary* value can be brought out, which is precisely what Roy Wood Sellars and Durant Drake – the very philosophers that Lehar calls to his aid – insisted upon (target article, sect. 2.3; Drake 1925; Sellars 1922). Sellars particularly stressed the feedback nature of the perceptual engagement, which allows for the continual updating of entity selection from the fields (altering spatiotemporal boundaries, qualitative criteria, etc.), a claim that renders stances such as Gibson's which take the object as given (amusingly termed "afforded"; Gibson 1977), not so much as "spiritual," the term favoured by Lehar (sect. 2.3), but as literally *superstitious.*

What weakens the direct realist case is its unthinking reliance on the pre-existing *singularity* of "external things." If the feedback argument of Sellars *père* is correct (Sellars 1970, p. 125), then the perfectly *singular* "object" or "entity" is but a feature of the mode of perceiving and not ontological in its nature. The behaving *as if* it is singular, the trusting *assumption* that it is, is a necessary feature of the intersubjective cooperation, for we could not even roughly coordinate our differing percepts unless we did project a strictly imaginary perfectly common focus of them; but it is fatal to take the convergence as without residue, for that would cancel the possibility of feedback and hence of mutual correction.

Lehar adverts to the uncertainty of the object (sect. 6.1). The only basic ontology required under the theory above is of the material continuum: When human social perceiving is in operation, with its incessant *intersubjective* correction in action, then a very modest ontological further claim can be made, namely, that a community of correctors exists, and hence of selves and their sensory fields, but *not as fixed entities,* only as current tentative selections from sensory and motivational experience. The direct realist, by contrast, is committed to an indefinite number of separable singular entities (objects and persons), a superstition that is disconcertingly all too common in recent books on the philosophy of perception (from Millar 1991 to Thau 2002; there are very few exceptions, e.g., Maund 1995). The act of faith in singularity which is necessary to bring our differing percepts into some kind of working overlap, is taken by the direct realist as actual, which represents an insidious and dangerous move to the conviction that his own percept is the standard for all.

Author's Response

Alternative paradigmatic hypotheses cannot be fairly evaluated from within one's own paradigmatic assumptions

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Abstract: To avoid endless and futile debate, critics of an alternative paradigmatic hypothesis cannot simply state their own paradigmatic assumptions as if they were plain fact while dismissing those of the opposition as self-evidently absurd, because it is exactly those initial assumptions that are brought into question by the paradigmatic proposal. Perceived incredibility is no valid ground for rejection of a paradigm whose alternatives are at least equally incredible, and arguably more so.

The energetic responses of the open peer commentaries indicate that the target article has touched a raw nerve; this is perhaps a harbinger of an interesting direction of investigation. The epistemological issue at the core of the debate is a paradigmatic question that challenges some of the foundational assumptions of psychology and neuroscience, which have remained so long unchallenged that they are generally held to be established fact. As is frequently the case in paradigm debates, the opposing camps often cite the selfsame evidence to support their opposite conclusions, because they are arguing from different foundational assumptions. To avoid endless debate, it is therefore essential for commentators to recognize the paradigmatic issue at the core of the debate, and not just state their own paradigmatic assumptions as if they were established fact – while dismissing those of the opposition as self-evidently absurd – because it is exactly those initial assumptions that are brought into question by the target article. If alternative paradigms are to be fairly evaluated, it is necessary to temporarily and provisionally suspend one's own paradigmatic assumptions, and accept the assumptions of the alternative paradigm as if they could actually be true. Only then can the competing paradigms be fairly compared, not on the basis of the perceived incredibility of their initial assumptions, but on the overall coherence and self-consistency of the world view they implicate in total.

R1. Rigor paradigmatis

Unfortunately, many of the commentators failed to grasp the paradigmatic nature of the proposal and restated their own paradigmatic assumptions as if they were plain fact, thus committing the error of *petitio principii,* assuming from the outset that which is to be proven.

Booth complains that it is "foolish" to look for consciousness among the brain cells. I contend that it is foolish to look for it anywhere else but in the brain! As in most paradigmatic debates, one man's "foolish" is another man's "obvious." But Booth says not a word about the epistemological difficulties, which were discussed at length in the target article, of the view that he defends. If the experience of a red surface, for example, is located anywhere else but in the brain, then it is a spatial structure that exists, but it does not exist in any space known to science. This makes Booth's hypothesis a religious or spiritual theory, because the experienced surface is in principle beyond detection by scientific means, and therefore it is a theory that is impossible to disprove. It's no good trying to dismiss the structure of consciousness in a trick of grammar, as Booth proposes, by claiming that the spatial structure of experience is a "seeming" rather than something real. That objection was addressed in the target article with the observation that visual consciousness has an *information content,* and information cannot exist independent of an actual physical mechanism or substrate in which it is registered. Booth seems to think that simply stating his own paradigmatic hypothesis as if it were plain fact ("We are not looking at a world inside our minds; we are . . . seeing the colour of the patch out there.") is an adequate response to the hypothesis that what we are seeing really is in our brain.

Dresp complains that I fail to make clear the link between the Gestalt Bubble model and general theories of consciousness.

> What the model has to do with consciousness . . . remains totally unclear. Neither the fact that we are able to consciously experience and describe three-dimensional shapes as entities and wholes, nor the fact that we can find laws or codes describing how these emerge perceptually, implies or proves that con-

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sciousness is necessary to see and move around in three-dimensional space.

The link to general theories of consciousness is through the philosophy of *identity theory* (Feigl 1958; Russell 1927), as explained in the target article, whereby mind and brain are not separate and distinct but are ontologically one and the same. The presence of spatial structures in the perceptual representation is identically equal to a conscious experience of those structures.

Dresp simply assumes as if it were plain fact, that the experiential component of consciousness is separate and distinct from the physical mechanism by which it is instantiated, and that, therefore, a model of the mechanism cannot possibly be a model of the experience, because the experience cannot be modeled in principle. But it is at least equally likely prima facie that experience is *not* separate and distinct from the mechanism that carries it, but that experience is a physical process taking place in the physical brain, so a model of the mechanism would automatically also be a model of the experience. In fact, this is *by far* the more parsimonious explanation because it employs a single *explanans,* the brain, to account for the properties of mind and brain. Identity theory is an equally valid paradigmatic alternative that cannot be dismissed without demonstrating why it is less credible than a mystical, nonphysical theory of experience beyond science. Furthermore, the Gestalt Bubble model is explicitly defined as a model of experience, rather than its neurophysiological correlate, so it is inconceivable how Dresp fails to see the connection between a model of experience and the experience it models.

Dresp objects to my exhortation to discover the real truth behind visual processing. "Who said that science has to bother with metaphors such as 'truth'?" she asks. But science is all about modeling *objective external reality,* a truth that science presupposes to exist. Either there are "pictures in the head," as explicit spatial structures, or there are not. And whether there are pictures in the brain is of primary importance for psychology, philosophy, and neuroscience. Simply defining those pictures as a mystical nonphysical entity brings us no closer to understanding how consciousness arises in brains.

Duch asks: "How can the physical skull encompass nonphysical, inner world? 'The world inside the head' is a metaphor, and it does not make much sense to invert it, unless one believes that there is some kind of physical world squeezed inside the skull." That is precisely the hypothesis I presented, although it is a perceptual world, expressed in physical form, which is squeezed inside the skull. This notion seems to Duch so absurd from the outset that he cannot believe that is what I am proposing. Duch states, as if it was plain fact, that "interpretation of the spatial structure of the states of the visual system has nothing to do with their physical location." This is exactly the issue brought into contention by the target article. If he is to contest this assumption, he must explain which incredible alternative he wishes to defend in its place. Does he claim that consciousness does not exist at all, as Dennett (1981) would have us believe? Or does he allow that it exists but in some hidden dimension inaccessible to scientific scrutiny, as **Velmans** proposes? If so, how does he address my critique that his view of consciousness is a religious rather than a scientific hypothesis?

In his conclusion, **Duch** says "It is doubtful that the Gestalt Bubble model can explain observations that have not been hidden in its premises." That is the nature of paradigmatic hypotheses, and is just as true of the hypothesis that Duch defends. If you begin from the outset with the assumption that consciousness has no location, then you are guaranteed never to find it located anywhere!

Fox begins his commentary with the complaint that "[Lehar] ignores much of what is known in perceptual and brain science." The truth is that Lehar *challenges* much of what is "known" in perceptual science. Far from ignoring, I have taken pains to point out the errors of what is known in perceptual and brain science. If Fox begins with the assumption that those supposed "facts" are indisputable, then he is bound to have trouble coming to grips with a hypothesis that they may perhaps be mistaken.

There is much in **Fox**'s commentary that is deeply mysterious. **Fox** accuses me of maintaining the "Cartesian mind-body distinction." But the central hypothesis of the target article is an identity theory whereby *mind* is nothing other than the functioning of the physical brain. This monistic view is diametrically opposed to Cartesian dualism. Furthermore, in section 2.3, I explicitly *refute* Cartesian dualism as a spiritual rather than a scientific hypothesis.

Laming also fails to grasp the paradigmatic nature of the proposed model, presenting as counterarguments the axioms of his own paradigmatic alternative as if they were plain facts, rather than unsubstantiated initial assumptions. Laming insists that some parts of visual experience can be shared with others while the remainder are private, and therefore there cannot be a natural science of perception. So a psychophysical report that, for example, a subject can or cannot see an extended red object, is a valid subjective report. But the redness and spatial extendedness of that perceived object are not validly reportable because they are private. Curiously, the very aspects of experience that Laming considers illegitimate, including all of the Gestalt properties surveyed in sections 5 and 7 of the target article, are exactly the aspects of experience that reveal the spatial structure that Laming insists have no physical reality. Laming must explain *why* the spatial aspect of perception is so private that it cannot be reported, when the Gestalt Bubble model clearly demonstrates how the spatial aspects of perception *can* be reported and quantified in a spatial model. If he contests my phenomenology and claims not to see the sky as a dome, and the sides of a road converge to a point, then he should tell us what he sees instead. It is a paradigmatic choice of Laming's, not a statement of incontestable fact, to call the spatial extendedness of perception unreportable. And if Laming chooses to believe that phenomenal consciousness is not a physical entity in the brain, he should address the clear objections to that paradigm outlined in the target article. In particular, conscious experience, according to Laming, is a spatial structure; it is a structure that exists, and yet it does not exist in any space known to science, and it is in principle undetectable by scientific means. This is a religious or spiritual hypothesis because it is impossible in principle to disprove. To accept Laming's view of consciousness is to declare *consciousness* in principle forever beyond explanation in scientific terms – which would then become a self-fulfilling prophecy.

R2. Perceived incredibility

Some commentators reject the representationalist thesis because they find it to be frankly incredible. **Velmans** complains

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> Stick your hands on your head. Is that the real physical skull that you feel or is that just a phenomenal skull inside your brain? . . . If we live in an inside-out world, as Lehar suggests, the skull that we feel outside our brain is actually inside our brain, and the real skull is outside the farthest reaches of the phenomenal world, beyond the dome of the sky . . . Our real skulls are bigger than the experienced universe. Lehar admits that this possibility is "incredible." I think it is absurd.

And with this, I believe, Velmans touches on the principal reason this alternative has been given so little consideration.

I am viscerally sympathetic with this objection, so much so that for years I too refused to accept the conclusion toward which all of the evidence points. It is indeed incredible to think that your physical head is larger than the dome of the sky. But science has discovered many things which were initially considered to be at least equally incredible; like the vastness of the universe, and its cataclysmic genesis from a singularity in space and time, and the bizarre nature of black holes and of quantum phenomena. All of these theories were initially held to be incredible but have since been accepted as established fact. And the reason they were accepted is not that they became any less incredible. Scientific fact is accepted on the basis of the evidence, regardless of the incredible truth to which that evidence points. In fact, that is exactly what gives science the power to discover unexpected or incredible truth: When the obvious explanation is blocked by chronic paradoxes, it is time to give the seemingly incredible alternative a serious look.

In his conclusion, **McLoughlin** invokes Occam's razor against the notion of the world of experience being a picture inside the head. I believe McLoughlin reflects the consensus view in neuroscience: that the hypothesis seems frankly too incredible to deserve serious consideration. But before deploying Occam's razor we must first balance the scales and take a full accounting of the alternatives under consideration. For the alternative is that experience is a spatial structure; it is a structure that exists, but it exists in a separate space that is inaccessible to scientific scrutiny: It is a structure with a vast information content, but with neither mass nor energy nor spatial presence in the physical universe known to science, and the brain conducts a continuous two-way exchange of information with this phenomenal, semiexistent nothing. Alternatively, McLoughlin might prefer Dennett's (1981) eliminative alternative, that conscious experience, the spatial structure under discussion, simply does not exist – and that's the end of the problem of consciousness. If McLoughlin finds the idea of the world-in-your-head incredible, he must balance his rejection of it by telling us which of the other two incredible hypotheses he finds more credible, otherwise it is *his* bubble that bursts, not mine.

R3. Paradigmatic alternatives

Not every challenge to alternative paradigmatic hypotheses is a case of rigor paradigmatis. It is perfectly valid to challenge a paradigm based on the overall coherence or self-consistency of the world view that it implicates in total. In fact that is the only way that paradigms can be fairly compared, as seen in the commentaries discussed in this section.

Revonsuo accepts the representationalist view of the target article but challenges panexperientialism. Revonsuo cites phenomena, such as neglect and blindsight, that suggest perceptual information can be processed without necessarily entering consciousness. But, as in the case of most paradigm debates, both camps can usually muster an explanation for almost any phenomenon raised, although each explanation is consistent only within its own paradigm and sounds patently absurd from the point of view of the other.

For example, *blindsight,* the apparently unconscious processing of visual information, can be explained as a case of amodal perception. When the blindsight patient reports a vague suspicion of motion in the absence of an experience of a moving object, he is reporting a conscious experience of a vague suspicion of motion without actually seeing anything in motion. Even people with normal vision commonly have such experiences in peripheral vision, and many psychophysical experiments measure vague perceptual experiences at the threshold of detection which are not so much *seen* as suspected to have possibly appeared. Many philosophers deny that amodal percepts, or other forms of nonsensory knowledge, can be validly considered as conscious processes, insisting instead that only modal experience is experience. But if we exclude the amodal component of perception from conscious experience, then by definition, amodal perception is always blindsight. It seems more parsimonious to suppose that amodal perception is consciously experienced, even if only amodally, than to suppose that something experienced can be unconscious.

Other examples of apparently unconscious processing can be explained in the panexperiential view as separate, parallel, and largely independent conscious processes in the brain. The part of the brain that performs the processing is indeed conscious of its own performance, but it is not in touch with the part of the brain that reports on that processing, so no processing is reported. Similarly, unconscious processing in dichotic listening can be explained by separate, parallel streams of consciousness, one of which overwrites the other, which is therefore never recalled. This is not to say the evidence of neglect and blindsight favors panexperientialism, merely that it does not refute it. The motivation for panexperientialism lies elsewhere.

It is true, as **Revonsuo** suggests, that the protoconsciousness hypothesis probably cannot make testable predictions, but that is not why I invoked it in the target article. It was raised to plug up some otherwise serious holes in a purely monistic or physicalist explanation of conscious experience. This paradigmatic choice avoids a most subtle residual dualism hidden in Revonsuo's alternative.

As long as a sharp step or abrupt discontinuity is allowed between conscious and unconscious processes, there will always be an explanatory gap, because physically, the brain *can* be disassembled into ever-smaller pieces, all the way to atoms and molecules; whereas in **Revonsuo**'s view, consciousness does not have this ability to be disassembled but disappears abruptly as soon as the minimal conditions for it are no longer met. To be clear, I do not dispute that consciousness may exhibit, and indeed appears to exhibit, an abrupt cut-off – for example, when falling asleep or waking up – although intermediate semiconscious states are also known. If consciousness appears abruptly at some level of organization, then something else physically observable must come into existence at that point also.

For example, consciousness might be identified with a holistic process such as spatial standing waves of electro-

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chemical resonance in the brain (Lehar 2003). Resonance shares with consciousness the property of coming abruptly into being when the conditions for its formation are just right, as when blowing a note in a musical instrument. And yet, standing waves are not some supervenient spiritual entity but a real, physically measurable phenomenon that emerges holistically in a physical system. But if standing waves were indeed the physical substrate of consciousness, then that would suggest that musical instruments also necessarily possess some form of primal spatial consciousness. And when global consciousness breaks down in the brain, whether as a result of sleep or of anesthesia, the global synchrony does not disappear so much as it breaks up into a million fragments of locally isolated coherence. Would these fragments not each experience an isolated fragmentary consciousness? If not, then we have again an abrupt discontinuity that suggests a dualism between experience and its physical correlate. The more likely alternative is that parallel fragmented states of consciousness are indeed experienced during periods of unconsciousness but they never register in memory and are therefore quickly forgotten, as are many dreams.

A further problem with the abrupt discontinuity of consciousness is that it opens the problem of the "bridge locus" in the brain; that is, the question of why some very special parts of the brain become conscious, while other parts do not. It also leads to problems with partial or fragmented consciousness, as in split-brain patients, and in cases of multiple personality syndrome, and hypnotic or trance states, which all seem to indicate multiple parallel or alternating consciousnesses in a single brain. Whether the disassembled pieces of consciousness can be usefully considered conscious in any real sense is admittedly a semantic question. But what is *not* semantic is the question of whether consciousness can be disassembled into component pieces, as the matter and energy in the brain can be, or whether the mind operates by different laws than the matter that is sometimes its physical correlate. The only self-consistent physicalist explanation is that complex consciousness in a complex brain occurs by the same principle as simple consciousness in simpler brains; and the same argument propagates all the way down to the root of the phylogenic tree and beyond. Consciousness is what it feels like for matter to exist, and complex human consciousness is what it feels like to be the waves of energy resonating in a human brain.

Revonsuo complains that the panexperientialist position brings us no closer to explaining the radical empirical differences that we want to understand. Quite to the contrary: Until we bring consciousness fully into the realm of the physical world, one small corner of it will remain permanently trapped in a supervenient dimension forever, in principle, beyond scientific scrutiny. That is the modern "ether" theory that must be shown to be pure vacuum.

Gunderson observes that visual experience consists of more than just a spatial structure – it is a spatial structure that is experienced as being viewed from a particular point – and that this aspect of viewing from a point is not captured in the Gestalt Bubble model. In the first place, whether experience is viewed from a point or not, the fact remains: Visual experience is a spatial structure, and the spatial structure of experience is captured in the Gestalt Bubble model.

But in fact, the Gestalt Bubble model goes further, suggesting that the experience as if viewing from a point is itself an illusion. Once we recognize the world of experience for the internal model that it is, it becomes evident that our objective nouminal "self" is not the body-image homunculus observed at the center of our phenomenal world, but that in fact, the whole world of experience is part of our real self. The blue of the sky is not observed "from" the egocentric point, but it is experienced to exist out there where it lies at the surface of our perceptual sphere. The blueness of that azure dome is experienced to exist at a location relative to the egocentric point, but it is in no sense transposed or projected back to the egocentric point. In fact, phenomenally speaking, there is nothing special at all at the location of the egocentric point, which is experienced as an empty void of phenomenal space inside the phenomenal head, just like any other empty space in the phenomenal world.

Three factors contribute to the vivid illusion of viewing the world from a point. The first is the body-image homunculus, which we take to be our real "self" because that particular piece of the phenomenal world is under our direct volitional control. Under large doses of hallucinogenic drugs such as LSD the perceptual distinction between self and nonself tends to disappear, as the body image merges with the background, leaving the entire sphere of perceptual experience to be identified as "self," a common theme also of Buddhist phenomenology. The second contributory factor is the warped geometry of phenomenal space that is organized around a center, the point of highest perceptual resolution, marking that center of symmetry as a special location in phenomenal space. Finally, the illusion is bolstered by perceived surfaces being perceived modally only when they are exposed to the egocentric point, as if they were indeed being viewed from or by the egocentric point. Objects not exposed to the egocentric point are invisible to direct modal experience, and are therefore experienced in amodal fashion.

A similar phenomenon is observed on a radar scope, where radar "echoes" are registered only from those surfaces exposed to the central radar dish, for example, from the exposed front faces of nearby mountains. No echoes are registered from the hidden rear face of the mountains, nor from more remote surfaces occluded by the nearer mountains. As in perception, the center of a radar scope is not the "observer" of the rest of the image on the scope, and appears to be special only because the image on the scope is a veridical manifestation of the external, "nouminal" situation, where the radar echoes are indeed received or "viewed" from the location of the radar dish – which is why no echoes are received from surfaces that are not exposed to that point. Similarly, the phenomenal experience of viewing from a point is a veridical manifestation of the external nouminal situation where physical light from the external world is indeed received by the nouminal eye, no light being received from hidden or occluded surfaces, creating the illusion that the phenomenal world is being viewed from the location of the phenomenal eye.

R4. Reliability of phenomenology

A number of commentators challenged the reliability of phenomenological observation. **McLoughlin** pointed out that naïve observers are surprised to discover that they have a fovea and amazed that they have a blind spot in each eye. True enough, but the same naïve observers can be easily

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educated by the most convincing demonstration of all, phenomenological observation of their own loss of resolution in peripheral vision and of their own blind spots. Like any tool, phenomenology is useful only if employed with intelligence.

Booth complains that I commit the epistemological fallacy of trying to build public knowledge on the basis of private impressions. Booth objects that phenomenological observations are private, and so "they cannot be wrong – but then neither can they be right." But then he objects that my observations on phenomenal perspective are wrong! If phenomenological observation cannot be wrong, then how can Booth claim that my observations of phenomenal perspective are wrong? Booth complains that it is impossible to look one way down a road and at the very same moment be looking the other way, So it cannot be correct to write that the two sides of the road must be bowed, as in Figure 2 of the target article. In the first place, it is not necessary to be looking in opposite directions at the same time to see the curvature of the phenomenal world, all one needs to do is to look in one direction and observe that the parallel sides of a road meet at a point at a distance which is less than infinite, and that those parallel sides appear straight and parallel throughout their length. And in the opposite direction one sees exactly the same thing, and in between one sees a spatial continuum exactly as depicted in Figure 2. Phenomenological observation can indeed be right and it can be wrong, and Booth's phenomenology is just plain wrong if he can't see perspective foreshortening in the three-dimensional world around him!

Hochberg suggests an alternative, less holistic model – a stage set rather than an all-encompassing bubble, with an abrupt discontinuity at a certain depth, where a proximal percept of a full three-dimensional road with perfectly parallel sides changes abruptly to a flat two-dimensional experience at right angles to the view direction, in which the sides of the road converge to a point in the plane of the backdrop. No matter how hard I try, I cannot see the world this way; I always see the two extremes of near and far perception seamlessly connected through a continuous intermediate zone, wherein the sides of the road are perceived in full three dimensions, and yet they are also perceived to converge, and they are perceived to be parallel even as they converge.

I acknowledge that perception is somewhat more fragmented than the Gestalt Bubble model suggests. For example, every visual saccade presents a momentary experience perhaps somewhat like a stage set. But the most salient and immediate aspect of conscious experience is the way these individual theater sets are welded together into a unified sphere of spatial experience. Whatever direction we gaze, we are constantly aware of where that gaze is directed in the global sphere of surrounding space, and the objects perceived in that direction are perceived to be located in that part of global space. The experience is more that of a stable, structured surrounding space than a series of theater sets showing successively on the same stage.

As evidence to disqualify the Gestalt Bubble model, **Hochberg** cites visual illusions that vary as a function of where they are attended, because the same Gestalt is in view wherever it is attended. There are two aspects of spatial experience that must be carefully distinguished, we might call them *global* and *focal.* In the global experience our view is of a perfectly stable surrounding world, as suggested in the target article's Figure 2, whose entire surface is painted in modal colors, because whichever direction we look, that is the way it appears. The other aspect of experience is focal, the immediate experience of looking in a particular direction. The world appears at higher resolution in the direction of gaze than in the periphery, and the rear hemisphere behind our head is blank, as suggested in Figure 15. Both global and focal aspects are observed in our experience, so they should both be represented in a model of that experience. The combined experience is modal and focal in the direction of sight, but amodal in the hidden rear portion of the field, as indicated by the dashed lines in Figure 15, although successive saccades in different directions create an illusion of the complete modal sphere suggested in Figure 2.

The point of the Gestalt Bubble model is not to deny that there are localized focal processes active in perception, but merely to add that there is also a single, globally unified perceptual experience, and the localized focal experiences are perceived to be embedded at specific locations in this larger global framework of spatial experience.

Hochberg also cites examples of ambiguous or unstable percepts attributable to figures such as Adelson's (Adelson 2000) Impossible Staircase (Figure 2C of Hochberg's commentary). Hochberg argues that since these percepts are observed to be unstable and/or ambiguous, they would disqualify a Gestalt Bubble model of a globally unified perceptual world. But Hochberg need not have gone farther than Figures 3, 5, 6C, 11D, 12A, and 16A (porthole illusion variant) of the target article for examples of unstable, semistable, or ambiguous figures. The perceptual tendency towards a unified, globally consistent percept is a goal that the perceptual mechanism seeks, but does not always achieve, so unstable and multistable percepts are not counterexamples to the principle of emergence as described in the Gestalt Bubble model; they provide a more detailed look at the mechanism of that emergence.

Hoffman argues that the perceived world of the Gestalt Bubble model is not a veridical replica of the external world, but merely a useful "user interface" to the external world, with no more need to resemble that world than a Windows interface needs to resemble the diodes, resistors, and software of a computer. Therefore, there may be no real resemblance at all between the structure of our phenomenal world and the real external world that it represents. Hoffman proposes to replace indirect realism with this species-specific "user-interface" theory of perception. But that is exactly what I have proposed in the Gestalt Bubble model. Nowhere was it stated that the phenomenal world is in any sense identical to the external world. Phenomenal colors are very much more impoverished than the chromaticity of physical light, and phenomenal perspective shrinks the infinite external world into a finite bounded bubble. These are clearly species-specific "user-interface" simplifications of external reality. The "realism" in "indirect realism" is already modulated by the word "indirect," that is, the phenomenal world is a very real and direct view of processes taking place within our own brain, and those processes in turn represent indirectly the structures and surfaces presumed to be present in the more remote external world.

Immanuel Kant (1781/1991) anticipated **Hoffman**'s observation that the phenomenal world need not show any resemblance to the external physical world. We do not even

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know if it has three spatial dimensions and time; all we know is that those are the dimensions of the internal phenomenal world. It should also be noted, however, that in every other realm of human activity, from hunting and gathering, to business and finance, to politics and engineering, the assumption that the world of experience is an accurate representation of objective reality is so successful that the indirectness of perception can be readily ignored. And that in turn suggests that experience must accurately reflect some essential aspects of the external, although **Hoffman** is right that we cannot determine phenomenologically which aspects of the world are veridically replicated and which are not.

Lloyd presents a very clever argument by analogy that appears to punch a hole through the central premise of isomorphism. Consider the statement from the target article: "The fact that the world around us appears as a volumetric spatial structure is direct and concrete evidence for a spatial representation in the brain" (sect. 5.2, para. 6). Lloyd suggests that the absurdity of this statement can be revealed by substituting "colored" for "spatial" in this passage. Phenomenal color experience defines a three-dimensional relational structure of phenomenal color space. But, Lloyd correctly objects, the fact that we experience phenomenal color does not mean that the color solid appears anywhere in our brain, and by the same token, spatial experience does not imply a spatial structure in the brain.

This objection is already addressed in the target article by the specification of *information content* as the one quantity which is necessarily preserved across the mind/brain barrier. A color experience is indeed a three-dimensional relational structure, not so different in principle from the color phosphor dots on a television monitor. It takes three values of three phosphor dots to encode a single point of color on your screen, and those three values define a single point in Red-Green-Blue [RGB] space. However, a single point on a television screen does not define an entire color solid, but merely one point in that three-dimensional color space, representing the color currently represented at that point. The color solid is not explicitly present anywhere, but the relational structure that it encodes is implicitly present in the range of possible values of the three phosphor dots.

Spatial perception is different from color perception in this one significant aspect, that every point in perceived space can be perceived with a distinct color. That means that there are as many separate and potentially distinct color values in a perceived surface as there are resolvable points across that surface. The points in a perceived surface are perceived simultaneously and in parallel, and together they define a relational structure in which every point bears a specific spatial relation to every other point in that perceived surface. This is quite different from the implicit structure of color space that encodes only one color at a time, because spatial perception encodes a whole spatial array of color values, all of which are simultaneously present in experience.

Regarding the value and prospects for phenomenology, **Marković** says that "without the precise specification of the extraphenomenological aspects of perception, such as the stimulus and neural domains, it is difficult to answer the question related to why the percept looks as it does." This, however, is difficult only if one employs phenomenology merely to confirm theories of vision based on neurophysiology. Once we realize that what we are seeing in experience *is* the representation in our own brain, there is a *great deal* that can be learned about why things look the way they do, and how things are represented in the brain. Marković is right that scientific explanation must go beyond mere description. In Marković's example, the Earth's motion becomes comprehensible only when considering the influence of the Sun. But before science can propose explanations it must begin with description. The influence of the Sun on the Earth's motion would have never become clear had we not first observed and described that motion. Psychology too must begin with a description of experience before it can attempt a plausible explanation for it.

R5. Explicit volumetric representation

McLoughlin points out that a volumetric space can be expressed in a sparse, more symbolic code, without recourse to an explicit spatial array, with objects represented as tokens, with *x*, *y*, and *z*, location, and so forth. There are many aspects of mental function, such as verbal and logical thought, that are clearly experienced in this abstract manner. But visual consciousness has an information content, and that content is equal to the information of a volumetric scene in an explicit volumetric representation. Every point in the volume of perceived space is experienced simultaneously and in parallel. To propose that the representation underlying that experience is a sparse symbolic code is to say that the information content of our phenomenal experience is greater than that explicitly expressed in the neurophysiological mechanism of our brains.

Velmans' holographic analogy is very apt. There is indeed no "picture" as such on a holographic plate, just a fine-grained pattern of interference lines. But for the picture to be experienced by a viewer, or to be available for data access in an artificial brain, that picture must first be reified out of that pattern of interference lines into an actual image again; that is, the holograph must be illuminated by a beam of coherent light. After passing through the holographic plate, that beam of light generates a volumetric array of patterned light, every point of which is determined by the sum of all of the light rays passing through that point, and it is that volumetric pattern of light in space that is observed when viewing a hologram.

So if holography is to serve as a metaphor for consciousness, the key question is whether the metaphorical hologram is illuminated by coherent light to produce a volumetric spatial pattern of light or whether the hologram in experience is like a holographic plate in the dark. If it is the former, then conscious experience in this metaphor is the pattern of light waves interfering in three-dimensional space. It is a spatial image that occupies a very specific portion of physical space, and it requires energy to maintain it in that space. This is exactly the kind of mechanism we should be looking for in the brain. If it were the latter, as **Velmans** suggests, then why would the shape of our experience not be that of the interference patterns etched on the holographic plate, rather than the volumetric image they encode? What magical substance or process in conscious experience performs the volumetric reconstruction that in the real universe requires an actual light beam and some complicated interference process to reconstruct? If it is a spatial structure that we observe in consciousness, then it is a spatial structure that we must seek out in the brain, not a

potentially spatial structure that remains stillborn in a non-spatial form. Otherwise, the spatial image-like nature that is so salient a property of subjective experience must remain a magical mystical entity forever in principle beyond the reach of science.

In the target article, I commended **Grossberg** for advocating explicit filling-in to account for Gestalt illusions, but chided him for not extending that same reasoning into the third dimension. To this, Grossberg responds that I have not kept up with the modeling literature; he cites the FACADE and LAMINART as models that explain many three-dimensional figure-ground, grouping, and filling-in percepts, including transparency, and that use an explicit surface filling-in process. This I do not doubt. But in both FACADE and LAMINART, depth is handled in a disparity based representation with left and right eye image pairs and disparity images to represent depth information. In neither of those models is there a three-dimensional volumetric spatial matrix with receptive fields at every location and every orientation in three dimensions, as would be required for a neural network model of spatial experience. While FACADE and LAMINART do perform explicit filling-in of both contours and surfaces, the filling-in itself does not propagate in the third dimension by diffusion as it does in the other two. The third dimension is handled very differently than the other two, and the result is a 2-D sketch rather than a full volumetric spatial matrix. Whatever their merits as neurophysiologically plausible models, these models leave something to be desired as *perceptual* models, because perceptual experience *is* fully volumetric and three-dimensional, and multiple depth values can be experienced in any direction.

If **Grossberg**'s argument that explicit filling-in is required to account for two-dimensional illusions has any validity at all, then it should apply just as well to three-dimensional perception as it does to two, at least for a *perceptual* model that models the experience rather than its neurophysiological correlate.

R6. World as external memory

McLoughlin endorses O'Regan's (1992) concept of seeing as an active process of probing the environment as though it were a continuously available external memory. But probing the world with visual saccades, especially in the monocular case, is nothing like accessing a memory, internal or external, because every saccade retrieves only a two-dimensional pattern of light. The three-dimensional spatial information of the external world is by no means immediately available from glimpses of the world but requires the most sophisticated and as yet undiscovered algorithm to decipher that spatial information from the retinal input. Furthermore, in the absence of a global framework to register the information from each saccade in its proper place, vision as described by O'Regan would be indistinguishable from apperceptive agnosia, a visual integration failure. In other words, the condition of apperceptive agnosia is the absence of a visual function whose existence O'Regan effectively denies. McLoughlin is right that the brain need not explicitly represent more than it requires at any particular time, and it can make do with a sparse or abbreviated representation of the world. But he misses the paradigmatic point that the world we observe in experience is already that sparse representation, the real world beyond experience being infinitely more complex than our experience of it. So the brain must explicitly encode exactly as much detail as we observe in experience, no less, and unbiased phenomenological observation clearly reveals a spatially structured world.

Fox complains that I refute direct perception on the grounds that no plausible mechanism has ever been identified neurophysiologically that accounts for the external nature of perception. "Yet," says Fox, "there is growing physiological evidence to the contrary," and he cites neurophysiological findings *in the brain.* But the kind of physical evidence required to support *direct perception* would have to be energy or information located *outside* the physical brain, out in external space where perception is supposed by direct realism to occur. Fox chides me that "Using the term 'perceptual processing' or 'computation' is a serious misrepresentation of direct perception." He is quite correct. But that is exactly what is wrong with Gibson's theory of direct perception, and that is exactly why modern proponents of Gibson's theories usually take care to disclaim his most radical views. For if perception is *not* a computation in the brain based on sensory input, then why does Fox cite evidence from the brain to explain that perception? Fox suggests "A more fruitful heuristic for understanding perception is a physiology that has evolved a sensitivity to meaningful environmental relational information or . . . action-oriented systems." And how would one build an artificial system with a "sensitivity to meaningful environmental relational information" that is *not* attained by way of input through sensory systems and internal representations? This "explanation" is every bit as mysterious as the property of consciousness it is supposed to explain.

Lloyd disputes the phenomenological basis of the Gestalt Bubble model and insists that outside of focal attention he experiences only a very indefinite spatiality, which seems to him inconsistent with the continuously present three-dimensional model constructed in the Gestalt Bubble. Instead, he proposes that the natural supposition that our experience specifies a full 360-degree diorama arises from the "just-in-time" availability of spatial information with every attentional focus. But the availability of spatial information is not only "just in time," but, more significantly, it is also "just in place," that is, the spatial percept appears at the point in the global experience of three-dimensional space that the percept is perceived to occupy in that space. Lloyd's Gibsonian view also fails to account for dreams and hallucinations, where the world as an external memory is no longer available for data access, and yet a structured world is experienced nonetheless. There is no question that there is a loss of resolution in peripheral vision – that too is easily confirmed phenomenologically. But if Lloyd's experience of each individual saccade appears separate and disconnected from any global whole, like a series of scenes on a television screen, then either he is suffering a form of apperceptive agnosia, or more likely, his theory of vision suffers from apperceptive agnosia, which in turn handicaps his phenomenological observations. This suspicion is supported by Lloyd's own analysis of the dimensions of conscious experience. The basic dimension, according to Lloyd, is temporal, and experience is an orderly ensemble of phenomenal leaps and bounds along a time line. Spatiality emerges from trajectories encoded in proprioception, which orient each momentary percept to

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those before and after. This is the consequence of designing a phenomenology based on one's theory of perception, rather than a theory of perception based on one's phenomenology!

R7. Neurophysiological issues

McLoughlin argues that the fragmented architecture of the visual cortex into separate retinotopic maps requires a fragmented model of vision. But that is true only for a purely neurophysiological model that cares nothing about phenomenology, where the unity of visual experience is its most salient feature. But a neuroscience that explains everything about the brain except how it generates consciousness, is a neuroscience that explains nothing, because it is consciousness that makes the brain interesting in the first place. To declare from the outset that the unity of consciousness requires no explanation is to guarantee that no explanation will ever be found.

Ross agrees that a simple neuron doctrine cannot account adequately for size constancy in perception, but contends that more complex neurological models show promise. She then cites a number of neurophysiological models that account for some aspect or other of size constancy. But curiously, none of the models that Ross cites accounts for the one aspect of size constancy that is the central focus of the target article; that is, the fact that objects in space appear as solid volumetric objects embedded in a volumetric surrounding space, and that space has the peculiar property that its size scale shrinks progressively in nonlinear fashion with distance from the egocentric point. Both Gibson and the Gestaltists complained about the trend in psychophysics of breaking the complex phenomenon of visual experience into very simple visual tasks that are then recorded as keypress data points in psychophysical studies. Neural network or other models are then devised to replicate those data points, and those models are then considered to be models of vision. Lost in the shuffle is the rich and complex volumetric spatially extended experience of visual consciousness, which never finds its way into those models of vision.

Grossberg is quite right when he says that the Gestalt Bubble model "makes no contact with neurophysiological and anatomical data about vision." This means either that the model is wrong, or that neuroscience is in a state of serious crisis because it offers no hint of an explanation for the observed properties of conscious experience. If the latter should happen to be the case, as the target article suggests, then limiting our observations of our phenomenal experience to that which is allowed by contemporary theories of neural representation will turn out to have been an exercise in futility.

Duch also complains that I misrepresent the neuron doctrine by omitting discussion of dynamic recurrent neural networks. He must have missed my discussion of the dynamic recurrent neural network models of Grossberg, and their fundamental difficulties with modeling spatial experience (sect. 3 of the target article).

MacKay bolsters the evidence for Gestalt processes in the brain by considering the web of continuous electrical activity stretching from the spinal cord to the cerebrum. MacKay proposes that the "panexperientialist" view suggests that awareness is linked to something like an electrical field of this sort. Indeed, that is exactly why Köhler was so interested in electrical fields. My own preference is for a *harmonic resonance* theory (Lehar 2003) involving patterns of electrochemical standing waves in the neural substrate. Standing waves inherit all the properties of static electric fields, and add to them an extraordinarily rich repertoire of spatiotemporal behaviors that are very Gestalt-like in nature. This hypothesis also resolves the issue of integration raised by MacKay, because it is in the very nature of different resonances in a mechanism to couple to each other and thereby produce a single larger integrated resonance, of which the original resonances become higher harmonics (Lehar 2003b).

R8. Various and sundry issues

Laming raises the homunculus objection, that if there were picture-like processes active in perception, then there would have to be an internal viewer of those picture-like processes. I refuted this objection in the target article with the argument that information encoded in the brain needs to be available only to other internal processes rather than to a miniature copy of the whole brain. Laming rejects this explanation with the statement "The fact that Lehar has a mathematical model to replace the neurophysiological observations does not alter this requirement." But the requirement for an internal observer of any spatial data is itself a paradigmatic assumption on Laming's part. He has not shown that it is necessary in the first place, and it is at least equally likely prima facie that it is not. Furthermore, we know for a fact that our experience is expressed in the form of a spatial structure, regardless of whether that structure requires an observer, and that experienced structure can be expressed in a perceptual model. There is no reason a model of perceptual experience should be invalid.

Luccio takes issue with my characterization of Gestalt theory as a representationalist theory; he claims that it is neither representationalist nor antirepresentationalist but is merely "indifferentist" to the epistemological question. There have been different schools of Gestalt, not all of which have shared the same philosophy. But at least Koffka and Köhler, and therefore by implication presumably Wertheimer, were definitely representationalists. Koffka makes the most clear representationalist case with his distinction between the "geographical environment" (the objective external world) and the "behavioral environment" (the phenomenal world), and he clearly stated that the behavioral environment is located inside the geographical body in the geographical environment (see Koffka 1935, p. 40, Fig. 2). Köhler expressed his representationalist views most clearly in Köhler 1971, p. 125.

That is not to say that one can't be a Gestaltist and a direct realist. One can profess, like Gibson, that illusions are not illusory at all, and that perceived illusory surfaces have a real objective existence out in the physical world, although that existence cannot be verified by scientific means, and the function of the sense organs becomes highly ambiguous. In my view, the message of Gestalt has been representationalist from the very beginning, with its focus on objects experienced vividly in phenomenal space that are known to have no objective existence.

Marković is puzzled that I can claim at one point "the internal perceptual representation encodes properties of

the distal object rather than of the proximal stimulus" (sect. 9, last para.) while at another I state "the direct realist view is incredible because it suggests that we can have experience of objects out in the world directly, beyond the sensory surface, as if bypassing the chain of sensory processing" (sect. 2.1, first para.). Why, asks Marković, would the thesis that distal objects are mapping onto the phenomenological domain without neural intervention be incredible and mysterious, while the idea about the projection of internal representation onto the external perceptual world not be incredible and mysterious? How is it possible that perception is partially indirect (representational), and partially direct (distally oriented)?

Perception is entirely indirect; what we experience is in every sense inside our physical head. The "distal orientation" of perception is seen in the form or dimensions in which perceptual information is expressed. The perceived world is expressed not in terms of the proximal image on the sensory surface, that is, a two-dimensional pattern of brightnesses, but in terms of actual three-dimensional objects and surfaces in a world that we take to be reality. We do not see visual patterns and infer them to be a table, we experience a table, expressed in terms of volumes of perceived wood embedded in a volume of perceived space. But that world information does not enter experience directly in some magical mystical manner, but indirectly by the conventional route of sensory input, and that input is expanded out or reified in the brain to become the spatial percept that we experience.

Randrup complains that my position is not really materialist, because I say in the target article that "there remains a vivid subjective quality (or *quale*), to the experience of red" for example, which "is not in any way identical to any externally observable physical variable" (sect. 3, para. 6) in the brain. This quoted passage however represents not my own view, but my summary characterization of Chalmers' "hard problem" of consciousness, and why it is considered by some to imply a fundamental dualism. According to identity theory, the difference between subjective experience and its objective physical realization is a difference in viewpoint or perspective, rather than an ontological dualism, and that makes the Gestalt Bubble a materialist position.

Randrup himself favors an idealist position, and goes on to conclude that the Gestalt Bubble model is most readily understood within the idealist world view, whereby the troubles of direct or indirect perception are significantly reduced. It is true that the Gestalt Bubble model is useful even as a structural description of pure mind. But to deny the existence of an independent objective material world, of which that mind is a copy, strains my credulity beyond its elastic limit.

Rosenthal & Visetti are generally supportive of the perceptual modeling approach proposed in the target article. However, they are puzzled about whether the proposed mechanism of emergence in the model is motivated primarily by the emergent properties of perception, or whether it is a physicalist model, whose spatial matrix and fieldlike interactions represent physical space and physical forces in the brain.

In the first place, the model is explicitly defined as a model of experience, and the local elements in the model are defined as local perceptual experiences. The dynamic fieldlike forces are therefore defined as perceptual tendencies observed phenomenologically, for example, the tendency for perceived surfaces to fill in like a milky soap bubble, and the tendency for corner or occlusion percepts to link up to produce globally coherent edges. Although the dynamics of these experiences are usually so fleeting as to be impossible to observe, it is the configuration of the end result, or final stable percept, that implicates an emergent spatial filling-in, because no other mechanism could plausibly produce that result. So the Gestalt Bubble model is not a physicalist model of the brain, but a mathematical model of experience, although it is committed to an emergent spatial computational strategy as offering the best explanation for spatial experience, and that in turn sets constraints on the corresponding neurophysiological mechanism in the brain.

Schirillo proposes to extend the Gestalt Bubble model by adding the perception of illumination to that of spatial structure. Schirillo is an astute phenomenological observer; the perception of brightness, lightness, and illumination are indeed intimately coupled to the perception of visual structure. I have explored the interaction of spatial perception to the perception of illumination in Chapter 5 of my book (Lehar 2003b).

Tse is generally supportive of the Gestalt Bubble model, and offers a more general analysis of the why the visual system operates as it does. Tse identifies two general principles by which the visual system attempts to correct errors. One involves completing missing information on the basis of knowledge about what most likely exists in the scene, that is, perceptual "filling-in"; and the other involves exploiting the physical stability of the environment as a reference frame with respect to which the eyes and body can move. An interesting aspect of this view is that the visual system implicitly understands its own limitations, and attempts perceptual filling-in only when it "knows" that it has failed to detect something that it believes must be present.

I take issue, however, with **Tse**'s contention that in amodal completion there is no perceptual filling-in. It is true that there is no *modal* filling-in of explicit surfaces, as in the Kanizsa figure, which is what Tse probably intended. But there is filling-in nonetheless, although of a nonsensory, *amodal* manner. When we see an occluded object, like a horizontal branch, part of which is occluded by a nearer vertical tree trunk, we can reach back behind the tree trunk and grab exactly that point in space that we "know" to be occupied by the occluded branch, based exclusively on the configuration of its visible portions. Although it is a semantic issue whether such experience is really "seeing" at all, there is no question that a three-dimensional volumetric *experience* is involved, and that experience is produced by filling-in processes very much like those seen in the modal surfaces of the Gestalt illusions.

Wright supports the representational stance in the target article, and provides further arguments to defeat the alternative direct realist view. Wright objects, however, to the use of the term "subjective" when applied to the sensory field, saying the sensory representation of colored volumes embedded in perceived space is thoroughly nonconceptual, and therefore no kind of subjective judgment is involved at that low level of experience. If television is an apt analogy for the televisual function of vision, Wright suggests I acknowledge the nonconceptual nature of the pattern of glowing phosphor dots on the television screen.

The semantic distinction that **Wright** draws between nonconceptual sensory processes and subjective judgment

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based on that sensory data may serve him well for his own purposes, but it is at odds with a prominent theme in Gestalt theory: that there is no difference in essential principles between the lower-level functions of sensation and perception, and the higher-level functions of recognition and cognition, except for a difference in complexity (cf. Lehar 2003b, Ch. 6). The higher-level recognition of a table as a whole is not different in principle from the recognition of its edges and surfaces as edges and surfaces. In the television analogy, the individual pixels of a photosensor array can be seen as very simple "feature detectors" tuned to respond to their feature, the brightness and color of light from a narrow angle of the visual field. Similarly, the local spatial fields proposed in the Gestalt Bubble model can be seen as three-dimensional surface-element, edge-element, and corner-element "feature detectors" that, in cooperation and competition with their neighbors, make a collective "subjective judgment" about the presence or absence of edge or corner features in particular parts of space. What is missing in the Gestalt Bubble model is the strict input/output function normally ascribed to feature detectors, because the "output," or final state of a particular "detector," depends not only on the input from the retina, or only on local interactions in perceived space, but on the total configuration of all of the other local elements across the whole of phenomenal space simultaneously. Even the highest-level global recognition has an influence on the state of the lowest-level edges and surface brightnesses of a scene, as seen in the subjective reversals of Figure 11D of the target article. That perceived corners and surfaces are observed to change their configuration with the perceptual shift, clearly indicates the "subjective" nature of these low-level components of experience, which are not strictly invariant with the input, as Wright suggests.

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Letters "a" and "r" appearing before authors' initials refer to target article and response, respectively.

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