> The volumetric structure of visual consciousness and perceptual invariance to rotation, translation, and scale offer direct and concrete evidence for an explicit volumetric spatial representation in the brain, which is at least functionally isomorphic with the corresponding spatial experience. (sect. 5.1)

Lehar is right that functional isomorphism between phenomenal experience and its implementation is required to avoid "nomological danglers," but once again, "explicit volumetric spatial representation" is in no way entailed – for "rotation, translation, and scale" substitute "hue, saturation, and brightness," and the fallacy will be apparent. Nor does Lehar's claim that phenomenal spatiality preserves the relational structure of spatial objects entail an internal replica, because (once again) a three-dimensional relational structure defines "color space" without in the least implying that the color solid appears somewhere in our brain. Functional isomorphism, meanwhile, is readily preserved between spatial objects/scenes and their representations without invoking replicas. For example, the World Wide Web is well stocked with virtual worlds that preserve functional isomorphism with spatial scenes, each of them encoded in some nonspatial computational idiom such as VRML.

In sum, the conceptual arguments in the target article do not support the author's main conclusion. Nonetheless, the brain does have properties, and some of its properties do determine the contents of conscious experience. Lehar's arguments do not establish that the brain must use space to represent space. Does phenomenality license any inferences at all about the neural medium? There are two ways to approach this question, beginning either with contingent generalities about perception or with its essential structures. The first approach begins with features of phenomenality (as revealed by perceptual psychology, including the Gestalt demonstrations of our perceptual capacities). The second analysis isolates essential or necessary structures of phenomenality. The second approach accords with classical phenomenology, as exemplified in the works of Husserl (e.g., Husserl 1974). In either case, the hope is that the analysis of phenomena will constrain the search for computational architectures sufficient to generate some or all of the features of phenomenality.

On neither approach is there compelling reason to posit the spatial virtual world proposed by Lehar. I do not doubt that I live in a spatial world, but my visual field – that is, what I see before me right now – conveys far less spatial information than Lehar's Gestalt Bubble encodes. At the focus of attention I am aware of surfaces, distance from my eyes, and edges, but outside of focal attention I experience only a very indefinite spatiality, which seems to me to be inconsistent with the continuously present three-dimensional models constructed in the Gestalt Bubble. The supposition that my experience specifies a full 360-degree diorama in my head arises from the "just-in-time" availability of spatial information with every attentional focus. The information is there when and where I need it, and experience presents an ordered sequence of focally attended presentations rather than a single wraparound replica of the spatial world. This seems to be phenomenologically "given" but it is also amply confirmed in psychological studies of "inattentional blindness" (Mack & Rock 1998) and "change blindness" (Simons 2000). (Sect. 8.8 briefly acknowledges the effect of successive gaze fixations in different directions, suggesting that parts of the replica fade while outside the visual field. This suggests either that the replica has an absolute spatial orientation and does not turn with the head or, if the replica does turn with the eyes, that only a small focal part of it has the spatial detail Lehar describes.)

This disagreement can be made more rigorous and more properly phenomenological. One essential property of the phenomenal world is expressed in our ability to distinguish properties by location. That is, I can be aware of a red circle and a green square at the same time without confusing the pairings of colors and shapes. Austen Clark refers to the problem posed by this pervasive perceptual ability as the "Many Properties" problem, and he argues that it can be solved only by coding places along with other perceptual properties (Clark 2000). So "red" and "circle" must be assigned a location, and "green" and "square," a second location. Experience, of course, solves the Many Properties problem easily, and arguably it is essential to the very concept of phenomenality that consciousness solve it. This argument so far provides support for Lehar's position but immediately raises the question: How many spatial dimensions are required? Lehar advocates three, Clark suggests two, but the argument necessitates just one, a linear dimension along which one point is tagged "red" and "circular," and another "green" and "square." The basic dimension, then, would be temporal, and experience would be an orderly ensemble of phenomenal leaps and bounds, a time line. Spatiality emerges from trajectories encoded in proprioception that orient each momentary percept to those before and after. This proposal conforms well with classical phenomenology (Husserl 1966; 1974), and in other work, I present evidence for its implementation in the brain (Lloyd 2002; 2003). This alternative cannot be defended here, but it does suggest that the Gestalt Bubble is not entailed by phenomenology.

It is important that theories of perception accommodate the Gestalt observations; Lehar brings forward an essential array of examples to consider, and exhibits the care and detail required to translate spatial perception into a computational model. But more evidence to support the model – from philosophy, phenomenology, psychology, and neuroscience – will be needed.

## Isomorphism and representationalism

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**Abstract:** Lehar tries to build a computational theory that succeeds in offering the same computational model for both phenomenal experience and visual processing. However, the vision that Lehar has about isomorphism in *Gestalttheorie* as representational, is not adequate. The main limit of Lehar's model derives from this misunderstanding of the relation between phenomenal and physiological levels.

Gestalt psychology has been fundamentally misunderstood in the United States (though the field too has to bear some responsibility; see Kanizsa 1995). After World War II, it had a meager destiny, cultivated only marginally in Germany and America though more intensively in peripheral countries such as Italy and Japan. However, mainly in the last few decades, some concepts of Gestalt psychology have appeared frequently in psychological debate, such as *prägnanz,* isomorphism, minimum principle, and so forth. The continuing debate demonstrates the inability of cognitive psychology to accept some highly significant aspects of our way of picking up the reality that is around us. Lehar's paper does not confine itself to stressing the importance of some classic Gestaltist ideas taken in isolation, as other scholars in the past have done, in an attempt, never completely successful, to integrate part of the *Gestalttheorie* into cognitive psychology. Instead, Lehar tries to build a computational theory that succeeds in offering the same computational model to both phenomenal experience and visual processing.

This highly interesting attempt deserves some comment, however. In my opinion, Lehar's vision of *Gestalttheorie* is not fully adequate, and this has some consequences for his theorizing. The point on which I disagree almost completely with Lehar is the following: He claims that there is a central philosophical issue that underlies discussions of phenomenal experience, as seen, for example, in the distinction between the Gestaltist and the Gibsonian view of perception. Is the world we see around us the real world itself or merely an internal perceptual copy of that world generated by neural processes in our brain? In other words, this


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is the question of *direct realism,* also known as *naïve realism,* as opposed to *indirect realism,* or *representationalism.* I note parenthetically that although Gibson (1966; 1979) called himself a naïve realist, this was only a provocation. The theory of direct perception is neither naïve nor realistic. As Michaels and Carello (1981, p. 90) clearly put it, "the test of the veridicality of perception concerns the mutual compatibility of the action of the actor/perceiver with the affordances of the situation." Here we are very far from the veridicality requested by genuine naïve realism.

More important is the picture of Gestalt psychology that Lehar offers to us. It is well known that in *Gestalttheorie* there was a strong Spinozian attitude. For example, Wertheimer (greatly impressed by Spinoza's *Ethica* from childhood on: see Luchins & Luchins 1982) remained in this orientation all his life. So we can speak in terms of an indifference or "indifferentism" about the problem of representation. In general, Gestaltist isomorphism has to be considered as a variant of psychophysical parallelism (see Boring 1942; 1950, mainly Ch. 13; for a recent survey of this issue, see Luchins & Luchins 1999). But the same could be said about almost all other Gestalt psychologists. Lehar quotes Köhler extensively. But Köhler never said that "the world we see around us . . . (is) . . . generated by neural processes in our brain" (target article, sect. 2, para. 1). Köhler, indeed, was in some instances a little ambiguous on this topic (e.g., Köhler 1969). But he was absolutely clear when he had to address the mind-body problem directly. He conceived the Gestalt position as a variant of parallelism (Köhler 1960, pp. 20–21), and said: "The thesis of isomorphism as introduced by the Gestalt psychologists *modifies* the parallelists' view by saying that the *structural* characteristics of brain processes and of related phenomenal events are likely to be the same" (emphasis added).

Lehar, quoting Köhler (1969), insists that the isomorphism required by Gestalt theory is not a strict *structural* isomorphism but merely a *functional* isomorphism. But Köhler always spoke of structural isomorphism. He was very clear in stating (Köhler 1940, Chs. 2 and 3) that the processes that run in our brain do not have any necessary correlate in our phenomenal experience. What is *structurally* identical is their interaction with what happens in bordering areas of the brain and the interaction that there is in the phenomenal field: Their dynamics and the dynamics of the phenomenal field.

The structural identity between the phenomenal world and physiological processes does not imply any causal relationship between the two levels. It means only that we are made up of one, and only one matter. The physical laws that rule matter lead to structurally identical outcomes when we consider the phenomenal level as well as the physiological one. In this sense, Gestalt psychology is neither representationalist nor antirepresentationalist; it is indeed indifferentist.

The main limit of Lehar's model derives, in my opinion, from this misunderstanding. His computational model, as I can assess it, works perfectly for a world that is organized in terms of soap bubbles (Koffka's metaphor [Koffka 1935], used too by Attneave 1982). A soap bubbles world is, in Gestalt terms, a world in which the forces of the perceptual field tend to dispose themselves to make an outcome that is maximally *good,* pregnant in the sense of *ausgezeichnet.* In Lehar's model, this happens at the phenomenological as well as the neurophysiological level. The fact is that – as I believe Kanizsa and I have demonstrated (Kanizsa & Luccio 1986; 1990) – a tendency of this kind does not exist in perception. These tendencies are instead well present in thinking, in memory, in all that Kanizsa (1979, Ch. 1) called "secondary processes," to distinguish them from primary processes of perception. But they are beyond the scope for which the concept of isomorphism is interesting – and relevant.

In recent years, a few other computational models have been presented to account for some typically Gestaltist phenomena, from information theory, to coding theory, to group algebra. However, Lehar is right when he says that they cannot account for both the phenomenal level and the neuropsychological level. I should stress that there is at least one exception: nonlinear dynamic systems, and, in particular, the synergetic approach. Apparently, we have not yet at our disposal a fully comprehensive theory; it should be interesting to test if the model proposed by Lehar could be integrated with other approaches.

## The unified electrical field

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**Abstract:** The electrophysiological perspective presents an electrical field that is continuous throughout the body, with an intense focus of dynamically structured patterns at the cephalic end. That there is indeed an isomorphic mapping between the detailed holistic patterns in this field and in perception (at some level) seems certain. Temporal binding, however, may be a greater challenge than spatial binding.

The independent processor model of individual neurons has given rise to the widespread impression, echoed by Lehar, that neurophysiology fails to deliver a unified basis for the holistic properties of perception. If there is any "illusion," it is not in the unity of perceptual awareness but in the portrayal of physical separation by techniques such as extracellular recording and fMRI. Overlooked is the axis of continuous activity stretching from the spinal cord to the cerebrum. The tonic activity in the brain stem activating systems (cholinergic, serotonergic, and noradrenergic), plus the histaminergic activating system of the hypothalamus, is responsible for our state of (un)consciousness (Pace-Schott & Hobson 2002). All sensory and motor activity feeds into this axis and influences the general distribution of activity. Also, the activating systems can directly trigger synchronization of activity within the cerebral cortex (Munk et al. 1996).

Furthermore, it is extremely doubtful that action potentials are of much significance in the direct link to perception. They are far too fleeting. It is the more sustained membrane potentials that are likely to correlate the best. Discrete neuronal activity in the brain, however isolated it may appear, is simply a local distortion in an unbroken continuum of electrical flux. All cells produce membrane potentials, even if static, such that an electrical field encompasses the entire body. The "panexperientialism" view would also suggest that perceptual awareness is linked to something like an electrical field. This is the only obvious property that is shared by both the atom and the organism, and it is increasingly elaborated as one ascends to the organism. One might postulate that the higher the degree of complexity in the electrical field, the higher the level of consciousness experienced. Using fMRI, it can be seen that the same cortical areas are active whether a stimulus is perceived or not. The difference in the case of perception is that the level of activation is greater (Moutoussis & Zeki 2002). This could mean either that more neurons are depolarized within the given area, or that the same synapses are active, but at a higher frequency, or both.

Neurons and their attendant glial cells manipulate membrane potentials like no other part of the body. This is their "game." Many attributes of neuronal electrical activity extend the range of information coding. No single one of them is the essence of conscious perception, but collectively they can raise (or lower) the level of consciousness. Spike synchrony is unquestionably relevant. For example, Riehle et al. (2000) have shown that unit pairs in the motor cortex synchronize activity to a very significant degree exactly at the moment of an expected signal. However, synchrony is not essential for "binding." In area MT, Thiele and Stoner (2003) recorded from pairs of units, one pair preferring the direction of motion of one visual grating, and the other preferring another grating direction. The units did not usually synchronize activity when the gratings were perceived as moving together in a



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