Gestalt bubble and the genesis of space

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Abstract: Lehar (rightly) insists on the volumetric character of our experience of space. He claims that three-dimensional space stems from the functional three-dimensional topology of the brain. But his "Gestalt Bubble" model of volumetric space bears an intrinsically static structure—a kind of theater, or "diorama," bound to the visual modality. We call attention to the ambivalence of Gestalt legacy and question the status and precise import of Lehar's model and the phenomenology that motivates it.

Lehar should be applauded for making a strong case for the fundamental character of volume and depth in our experience of space. The originality of his proposal resides *inter alia* in the radical claim that three-dimensional experience of space stems from the functional three-dimensional topology sustained by the human brain (not to be naïvely equated with brain topography). He posits that subjective spatial experience criterially requires a three-dimensional topological substratum—a device lacking three-dimensional topological-dynamical structure could never account for volumetric experience of space. In other words, the only viable option for a functionalist indifferent to brain physiology is three-dimensional topological-dynamical functionalism.

Lehar depicts his model as an outgrowth of Gestalt tradition. Indeed, one can easily recognize two essential features of Gestalt theory: its phenomenological approach to subjective experience, and the postulate of psychophysical isomorphism. Phenomenological space, its emergence, and its scientific explanation as a brain process are, according to Lehar, grounded in pregiven, continuous, and coherent topology, specifically a three-dimensional functional topology.

Lehar may not be aware that the way Gestalt psychologists treated space was in reality quite equivocal. Although they were in principle cognizant of the fundamental status of volumetric space, they granted it low priority in their scientific agenda and tended "provisionally" to treat space as a series of transparent/opaque surfaces, if not as ambient ground against which to set a figure. On the other hand, it is true that Köhler's theory of psychophysical isomorphism explicitly referred to three-dimensional functional brain topology to construe not only three-dimensional geometrical static structures but also two-dimensional structures evolving in time (see Koffka 1935). The theory combined empirical and phenomenological constraints with speculative brain physics (e.g., the theory of cortical fields) so as to represent both brain process and phenomenological experience in a single dynamical scheme (see Rosenthal & Visetti 2003).

Several attempts have been made to model Gestalt principles of perception in accordance with neurophysiology and in particular with the doctrine of *neural coding* (e.g., of perceptual

microfeatures). For example, models of *neural fields* or *neural repertoires* feature a two-dimensional functional topology that corresponds to a topographic two-dimensional arrangement of units in primary areas (e.g., retinotopy) (e.g., Hoffman 1989; Koenderinck 1990; see Petitot 1999 for a review). Less discrete models, unconstrained by brain physiology, developed in the context of image processing and sometimes resorted to fairly complex mathematics but maintained set to a bidimensionality of their input (retinal or pictorial; see Morel & Solimini 1995). The very idea of three-dimensional functional topology was hardly taken into consideration in the few attempts to account for depth (e.g., Grossberg 1994), which hence had to resort to hosts of specialized coding units: a patently implausible solution, as Lehar rightly noted.

The solution advocated by Lehar is original and certainly deserves attention. He defines a three-dimensional topological *milieu* where any local element can be in one of four states (corresponding to local surface elements). Each individual element (or point in a perceptual matrix) exerts a field influence on adjacent elements for them to take on a similar state (or to be prevented from this by inhibition). Reciprocal determination between surface elements is assumed to generate equilibrium in which the relevant features are stabilized. The input to the model is an image set in the frontal plane (much like a retinal image). The output (actually the first step in "geometrization" of space) is a distribution of geometrical surface microfeatures in a three-dimensional space. Although Lehar does not mention this issue, one can readily deduce that unit formation or individuation is assumed to take place in this three-dimensional visual matrix. The originality of this proposal should be highlighted: Whereas the majority of rival models first individuate two-dimensional units (from two-dimensional image input), then categorize them as faces of three-dimensional units, Lehar sets his three-dimensional structure *ab initio,* and whatever is to populate this three-dimensional distribution of geometrical microfeatures supposedly comes next.

It is not clear, however, which scientific question Lehar has set out to answer. He does not seem to attempt another *perspectival* reconstruction of the visual field, for his model, in contrast to its alleged purely phenomenological motivation, builds on a physicalist metaphor. Although Lehar dismisses neurophysiological concerns, the analogy between his model and neural net models jumps to the eye: Traditional "neurons" with their receptor fields are replaced by elements or points in perceptual matrix, and neural connections are supplanted by fields of influence. Moreover, Lehar alludes to the possibility that the model may take a discrete or granular form (see Lehar, Fig. 7A). Why, then, does he hammer so loudly his physicalist credo? It seems that Lehar believes that the process by which space is *constituted* necessarily sheds light on the way we perceive space. Then why does he not try to motivate his model *genetically?* Clearly, Lehar needs to tell us the rules of the scientific game he plays more explicitly (does he want to model the constitution of space from a purely phenomenological viewpoint or does he attempt a free mathematical reconstruction of subjective experience?).

Lehar could have mentioned that during the past century other theorists put forth elaborate proposals concerning the constitution of space experience (e.g., Gibson 1950; Husserl 1907/1997; Poincaré 1905/2001). Instead of sticking to neurophysiology, they referred to the structure of the organism or the *lived body.* These were strongly dynamic, sensorimotor "models" of constitution of phenomenological space that assumed a multimodal origin of volumetric space and explicitly related its dimensionality to repertoires of self-generated movements. Although none of these "models" can be regarded as fully effective, they account for the ontogenesis of space in a *dynamic* fashion and for a variety of phenomena of adaptation (e.g., to distorting or inverting goggles). We suggest that considering the dynamics of genetic, multimodal, and sensorimotor character of the

constitution of space is as important in modeling perceived space as neurophysiology and the kind of static geometry on which Lehar elaborates. What comes along with such dynamics is the constitutive relationship between *external* and *bodily space.* Lehar appears to be aware that perception of space involves one's own body, but instead of taking this as a constitutive relation, he treats the body as just another object in space.

Finally, we have strong reservations with respect to Lehar's phenomenology. The field of vision he refers to neglects readiness for prospective action, and the phenomenological subject is not immersed in the *practical field* of ongoing activity with its qualitative, praxeological, and prospective dimensions (see Rosenthal & Visetti 2003). What about the nonisotropy of perceived space and the resulting potential heterogeneity in the constitution of regions of space? Is it advisable to consider phenomenological space as a mere deployment (be it three-dimensional) independent of the engaged or prospective actions to which it gives stage?

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