ON WERTHEIMER'S PRINCIPLES OF ORGANIZATION

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1. Some unquestioned remarks

More than twenty years ago I presented a paper (VICARIO 1975) where some doubts were risen about the true significance of WERTHEIMER's principles of organization. My arguments were above all grounded on some figures that I reproduce here with some variations.

In figure 1 we see that the character of figure equally pertains to a set of elements rather densely packed (to the left: a dark hexagon on a light ground), and to a set of elements fairly rarefied (to the right: a light hexagon on a dark ground). If we make reference to the principle of *proximity* in order to explain the formation of a perceptual unit on the left, we have to call up the opposite principle of *remoteness* to explain the formation of a perceptual unit on the right.

Figure 1: Unit formation by *proximity* (on the left), but even by *remoteness* (on the right).

In figure 2 we see that the character of figure equally pertains to a set of elements that share the same feature (color, size, orientation or anything else) and to a set of elements by which the same feature (the orientation, in the case) appears in different ways. If we make reference to the principle of *similarity* in order to

explain the formation of a perceptual unit on the left, we have to call up the opposite priciple of *dissimilarity* to explain the formation of a perceptual unit on the right.

Figure 2: Unit formation by *similarity* (on the left), but even by *dissimilarity* (on the right).

In figure 3 we see that the character of figure pertains even to a set of elements that are arranged in *disorder* (by means of unequal distances). We are used to make reference to the principle of good form (symmetry, regularity, evenness, and so on) in order to explain the formation of a perceptual unit in conditions of contrasting principles, but in the case we have to observe that *irregularity* can also be a principle of unification.

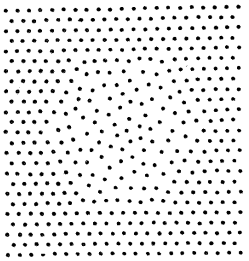

Figure 3: Unit formation even by *disorder* (instead of order, or good form).

I concluded this part of my essay stating that the same effect, like unification, cannot be imputed to opposite principles: there must be something wrong, in WERTHEIMER's laws. To tell the truth, at that time I did my best in order to preserve the usual Gestalt arguments, pointing out that the elements that contribute to the formation of the perceptual unit by remoteness, dissimilarity and disorder, share anyway something in common: that of figure 1 a greater distance in respect to that separating the elements of the ground; that of figure 2 orientations ever different from that of the elements of the ground; that of figure 3 random distances, ever different from the ones that separate the elements of the ground.

At this point, I raised two other questions, illustrated in figure 4.

Figure 4: On the left: similarity is not effective without *contiguity*. On the right: there is unit formation without unification: the case is that of *singularity*

[1] To the left: similarity cannot be a principle of unification if not accompanied by *contiguity*. In the chessboard frame we cannot see a figure generated by white squares and a ground generated by black squares (or *vice versa*), but an even surface lacking in stratification.

[2] To the right: we have unit formation without unification (the case is that of *singularity*). The lonely white element pops out from the ground as a perceptual unit even if it is not the result of the unification of anything. Obviously enough, in this case I do not refer to the actual drawing of figure 4, but to a situation where a source of light, seen in the dark, is sufficiently small to appear as punctiform, that is "having no parts" (and so lacking in elements to be "unified"). In configurations of the same kind, Gestalt psychologists could speak of "segregation" (of the object from the ground), rather than of unification: the problem is whether we refer to two distinct processes (unification and segregation), or to a single unnamed process of which unification and segregation are the two inseparable aspects.

I got no reply to my observations and arguments, either on the Gestalt side, or in the opposite cognitivist field, with the remarkable exception of METZGER (1975, pp. 219-221), who brought back the cases of figure 1 and 2 to the formation of secondary boundaries due to the contrast of divergent principles of distribution of parts (see also WERTHEIMER 1923, pp. 348-349), and the case of figure 3 to similar cases described by WERTHEIMER (1923, but I failed to find them) and RAUSCH (1966).

I offer again my perplexed questions, made worse by further considerations.

2. Plan of the discussion

I learned Gestalt theory mostly by oral tradition, as a pupil of KANIZSA and of other eminent scientists, like METZGER and METELLI. Now, what in Gestalt theory was for me especially discomforting, was the unceasingly turning to concepts like "force" and "field of forces" in order to explain the formation of units on the perceptual scene. This was apparent in some linguistic ambiguities occurring in the statements of some theorists, since unit formation was equally and

indifferently attributed to “principles of unification” or to “factors of unification” (WERTHEIMER calls them *Faktoren*). This sort of ambiguity is to be avoided, since “principles” refers to a generalization of observed states of affairs, and “factors” refers to something active that produces the observed facts. I was also witness of the efforts made by a group of distinguished perceptionists, led by KANIZSA, to mathematize the principles of WERTHEIMER and to quantify their strength in specified conditions. After half a dozen meetings the group was dissolved, because it became clear to everyone that the attempt would not achieve any result.

I will analyze the sources of that unceasing discomfort, supposing that my remarks will be of some use for the theoretical frame in which most of us experimental phenomenologists work. The matter is very intricated, but I hope to come to an end by exploring in succession three problems: [3] the process of unification, [4] the nature of WERTHEIMER’s principles, and [5] the concept of “field of forces”. It will seem that I would like to clear away the Gestalt model for the interpretation of perceptual facts, indirectly supporting other views, like the HELMHOLTZean or the GIBSONean one. Not at all. I will return to the problem of unification, suggesting that [6] the process in question can be interpreted by means of physical phenomena other than field of forces. I will finally quote [7] a paragraph by KOFFKA, who seems to stimulate and inspire the quest for new theoretical frames.

3. On unification

At the cost of being submerged by criticism, I must admit that I cannot see where the problem of unification is. To tell the truth, I otherwise suspect where is it.

I believe that the problem has to do with the juxtaposition of two undisputed axioms: the holistic character of percepts and the fragmentation of their antecedents. In my opinion, however, the problem of unification takes place only after we have fragmented the process that leads from stimuli to percepts. We are used to think of the facts at the origin of percepts as separated and disjointed (at the distal, proximal or central level), and accordingly we face immediately the problem of a succeding unification (or “reunification”) of them, in order to produce perceptual facts, that are “holistic”. Yet things can go otherwise. After all, the numbers that we dial on our phone apparatus have nothing to do with one another, but their successive presentation has as a result the answer of the called person; no one of them activates a specifiable part of the answering apparatus, but all together they do it. That card that we insert in the slit of the room door in some hotels allows the matching between some elements in the door and some other elements on the card: there is no relation between the holes on the card, but when all the holes are simultaneously in the right place, the door opens. This means that a response can be elicited by a mere combination of facts, and not by a computation of them (HELMHOLTZean view) or by an auto-organization of them due to “forces”

(Gestalt view). (Notice that the ringing of the answering apparatus, as the pivoting of the door on its hinges, have nothing to do with the nature of processes that give rise to them. By the way, this is an argument against isomorphism between physiological processes and phenomenal contents.)

This is what I presume I have learned from GIBSON (1966, 1979), the major contribution of which I see in the renewal of the concept of stimulus: not a single point of light (or a single physiological process), but a multiplicity of luminance levels (or retinal responses). That seems to me acceptable, even if I am rather dubious about the "optical array", first because the rectilinear transmission of light is not a description of a fact, but a physical model (some phenomena are better explained by the model of waves motion). I would think rather of motor habits, as described by LORENZ (1973), where a response is elicited only when the proper stimulus is in combination with a neutral stimulus that happened to be beside the proper one, and occurring at the same time. The concept of optical array includes the idea of an organization yet present in the stimulus, in which I do not trust; that idea of GIBSON seems to me just a tool for assuring a link between the state of affairs in the physical world and the *Erscheinungsweise* of the behavioural field, what BISCHOF calls *Korrespondenzannahme* (on this point see GIBSON, 1950, BISCHOF, 1966, VICARIO, 1991).

To sum up, we can easily assume that at the beginning there is a multiplicity of stimuli (or of physiological processes). But from that assumption does not descend that an active process of "unification" is necessary. The mere combination of single stimuli can perhaps elicit any phenomenal "unit" whatsoever, the characteristics of which possibly have nothing to do with the characteristics of the whole stimulation (the phone numbers and the called party, the holes on the card and the pivoting of the door). I cannot forget the lesson given by ethologists, who assure us that behavioural responses in animals are often triggered by unimaginable "stimuli".

4. The nature of WERTHEIMER's principles

The common and major argument against WERTHEIMER's principles is that they could not support predictions about the final outcome of their synergies and conflicts. Humiliating is the admission that we can resort to their presence and intervention in the building up of a percept only *a posteriori*, just once all is done. (For the present, that argument loses the most part of its efficacy, provided that we cannot forecast either the radioactive decay of a single atom, or where or when an ascending thin column of smoke dissolves.)

Yet there are still minor complaints: [1] principles of unification are a collection of heterogeneous fundamentals: similarity and proximity refer to simple elements, where closure, passing-by curve, articulation without rests and so on, refer to already unified wholes; [2] common fate and objective set refer to the perception of events, whereas the other principles refer to the perception of objects; [3] there is

some doubt whether *Prägnanz* is a principle at the same hierarchical level of the others, or is in some way superimposed on them, or even the resulting characteristic of the already formed percept; [4] past experience is a very sensible tool of explanation, but there is a major difference between it and the other principles: while we can *see* the source of "action" for every other principle (we can put our finger on the elements that are supposed to share proximity, similarity and so on), in the case of past experience the influence seems to come out from nowhere. (In other words: where the elements that share proximity are both observable, the memory trace that exerts its influence on other observable elements is not observable.) The same thing can be said for subjective setting. [5] One could ask oneself why unification principles are varying in number according to different theorists: WERTHEIMER (1923) enumerates seven of them, METZGER (1966) ten. Moreover, other theorists are supposed to have discovered new factors of unification (for instance, BECK, 1966 and BOZZI 1969), and one can ask oneself whether there are other factors to be discovered.

In addition to, there is another problem that I cannot solve. We begin with the plain (I hope) assumption that in an act of perception the whole and the parts are discernible, and that the properties of the whole and of the parts are also observable. We usually state that the properties of the whole influence the parts, and that the properties of the the parts influence the whole. I usually illustrate these *principia* with Sander's illusion (after LUCKIESH 1922; the diagonal in the greater parallelogram seems longer that the equal diagonal in the smaller one: the whole influences the part) and EHRENSTEIN's illusion (1954; the small tilted lines make their column to appear tilted: the parts influence the whole): see figure 5.

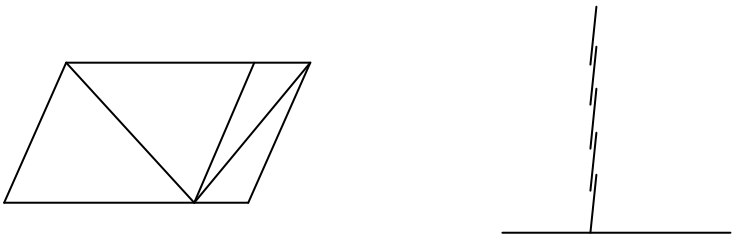

Figure 5: On the left: SANDER's illusion: the length of the parts is influenced by the size of the whole (from LUCKIESH, 1922/1965). On the right: EHRENSTEIN's illusion: the verticality of the whole is influenced by the obliquity of the parts (from EHRENSTEIN, 1954).

That means that wholes and parts have no characteristics of their own, since these characteristics are the outcome of a sort of bargaining between the whole and the parts. My problem can now be so formulated: "How can we speak of unification

of parts because of *their* proximity, similarity and so on, if parts owe to the whole their proximity, similarity *etc*.?" This is particulary evident in the picture we use for demonstrating that "proximity" does not mean a fixed geometrical distance, but a "relational property" (see figure 6).

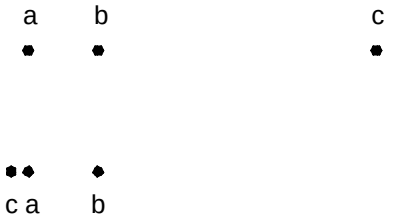

Figure 6: Proximity as relational property (see the text).

I surely agree on recognizing that proximity is a relational property: the same millimetric distance that makes *a* and *b* be unified and *c* left apart, in the upper row, in lower row makes *a* be unified with *c* and *b* left apart. But all that happens because the upper row is big, and the lower one is small: what can be said "near"in one frame, can appear "apart" in the other.

At this point, I see the problem in the following way. There is some difference in stating [A] that some parts (elements) come upon some other parts (elements) by virtue of properties of their own, in so giving rise to the whole, or in stating [B] that the whole is only what it is, and that the parts recognizable in it exhibit proximity, similarity, common fate and so on. In the first case WERTHEIMER's principles are also *factors of unification*, that is real agents of some processes of which we see the outcome; in the second case WERTHEIMER's principles are just *categories of description* of the parts and of the relations between the parts and the whole.

In my opinion the statement [A] is untenable, mostly because of the facts illustrated in figures 5 and 6: parts have no properties of their own, but those that appear when they are parts of a certain whole; if parts have no properties of their own, they cannot share similarity, proximity or any other "factor" of unification; in addition, there are other reasons set forth in the next paragraph, about the "field of forces". I prefer the statement [B], considering that at the root of WERTHEIMER's effort there is the problem of the proper level of analysis of perceptual facts. Let us hear KOFFKA (1931, quoted in KOFFKA 1962, p. 22): "… to apply the Gestalt category means to find out which parts of nature belong as parts to functional wholes, to discover their position in these wholes, their degree of relative independence, and the articulation of larger wholes into subwholes". As anyone can see, the main task is that of describing the facts of concern for the psychologist, in

order to apply the usual tools of scientific research, like analysis, measurement, and so on.

Where is then the novelty and the strength of WERTHEIMER's work? In having reduced the countless ways of describing perceptual facts in a few categories, reasonably suitable to evidence functional connections of the parts in which analysis decomposes such wholes like perceived objects. Why do we call them "principles"? Because there are no better criteria to gain the same end by means of other sort of descriptions. This is the reason why I prefer to think of WERTHEIMER's laws in terms of *principles of description*, rather than in terms of *Faktoren* of unification.

5. On the "field of forces"

The concept of "field of forces" is consubstantial with the principles of WERTHEIMER, I think, as they are considered as *Faktoren* of unification. Against that concept some objections can be risen.

In the first place, there is to say that its assimilation to gravitational or electrostatic fields is dubious. I made an experiment, surely perfectible (VICARIO & TOMAT, 1991), where the phenomenon of "perceptual shrinkage" (KANIZSA, 1975) served as test stand of the hypothesis. As you can see in figure 7, a thick black bar was placed across a row of points, making them replace themselves in a way that shows central points coming nearer to the bar (shrinkage) and subsequent points moving farther: the deviations from real positions have been measured for all the points.

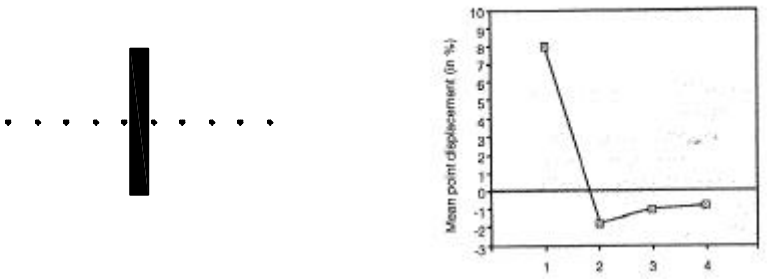

Figure 7: On the left: phenomenal shrinkage of space (showed by the displacement of points) in the nearness of a perturbation (the vertical bar). On the right: Displacements of points in terms of deviations from the real position (1 = the nearest, 4 = the farthest): positive values mean toward the bar, negative ones away from the bar (from VICARIO and TOMAT, 1991).

The hypothesis of the field (a gravitational-like one) of forces would be confirmed in the case that the deviations were highest in the nearness of the bar (where phenomenal shrinkage takes place), and then proportionally lesser as the points are further away from the bar. On the contrary, plotting the real positions of the points against the deviations from them, we obtain a curve that does by no means fit with that of known physical forces. It is rather assimilable to the one hypothesized by ERIKSSON (1970) for other visual illusions.

In the second place, it is well known (see KÖHLER, 1947) that the concept of field of forces has been put forth by Gestalt theorists in order to escape the deterministic machinery of the HELMHOLTZean view (or its today's version, cognitivism) in favour of a more free and autonomic kind of processes. Well, we cannot see a more deterministic result than that of field forces (*e.g.*, in gravitation): the absence of material constraints does not make bodies and processes more free.

In the third place, as far as for perceptual phenomena we have to seek for analogous phenomena in natural sciences, at the times of Gestalt theorists at least one instance of actual autoorganization was known in physics: BÉNARD's rolls (see later); in chemistry the BELOUSOV-ZHABOTINSKI reaction had been recognized at the end of the thirties (for what I know), and KÖHLER could have been informed about it.

Finally, there is a point of crucial importance. It is well known that Gestalt theorists are used to feed their arguments with examples borrowed from auditory and even musical domains (especially WERTHEIMER, METZGER and KOFFKA). Here it is rather easy to speak of similarity, proximity, and especially of good continuation: everyone understands the examples, and finds that they make quite clear the meaning of the principles of unification. BOZZI and I (1960) even theorized about the principle of *temporal proximity*, giving many instances in tonal perception, of which I found amazing correspondents in stroboscopic movements (VICARIO, 1965). But the applicability of such instances to the problem of unification is illusory: we cannot go on speaking of similarity, proximity and so on, as conditions that allow synergies and conflicts among "forces", without explaining *how* these forces stretch forth themselves over time. What kind of process does establish that there is similarity between an element in the present, and an element that is gone away, or at worst with an element that has even to come in? What does "field of forces" mean in temporal domain? Gestalt psychologists seem to have made no allowances for theoretical and experimental enquiries of STERN (1897, 1898) or of HUSSERL (1980, 1985).

6. Toward a new form of Gestalt theory

In his *Psychologie*, METZGER (1963) outlines with deep penetration the course of the problem of unification, from theories that claim for the intervention of external factors (association, past experience, attitudes, thoughts, and so on)

through theories that begin to distinguish between extrinsic and intrinsic properties of the parts (WUNDT), to come to Gestalt Psychology and to WERTHEIMER's principles, for which unification is the outcome of the interaction among intrinsic properties only (even if any theorist is led to the feet of the enormous problem of the principles of interaction between subwholes, see WERTHEIMER 1923, pp. 347-350, or METZGER 1963 *passim*). To sum up, in treating the problem of unification, we have a progressive walk from the representation of forces that act from outside the elements (like attention or memory traces), toward forces that act from inside the elements (on the ground of proximity, similarity, *etc.*). What I suggest, is to take another step forward on the path designed by those scientists: a form of Gestalt theory that has no need of forces, either from outside, or from inside.

Now, let us look at figure 8, that reproduces the state of affairs in a thin film of oil, heated from below.

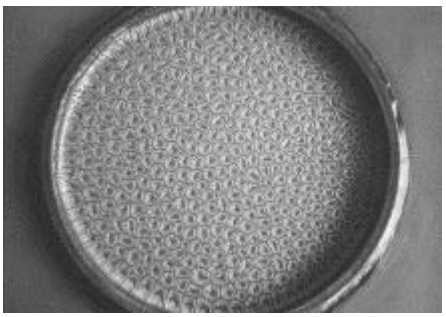

Figure 8: Bénard's rolls: spontaneous forming of structures in a heated thin film of oil (from COVENEY and HIGHFIELD, 1990).

At the beginning the surface of the film is uniform, but after a while pseudo-hexagonal cells come into being in the mass of oil, so that the surface appears articulated in many subwholes that give to the whole the appearance of a honeycomb. The phenomenon is well known from the beginning of this century, under the name of "BÉNARD's rolls". It is clear that the phenomenon is linked to convective motions of molecules in the film of oil, but the deep reason of the rising of the structure is, as far as I know, still unknown. In front of this case of "spontaneous organization", the grounds of which are not recognizable in the elements forming the mass of oil and in the physical laws governing collisions between molecules, one cannot but think of perceptual units, whose grounds cannot be found in the elements preceding the perceptual fact, that is physical stimuli and neural processes.

Figure 9 reproduces two diagrams that we find in a paper of MARESCHAL and KESTEMONT (1987) concerning order and fluctuations in heated fluids.

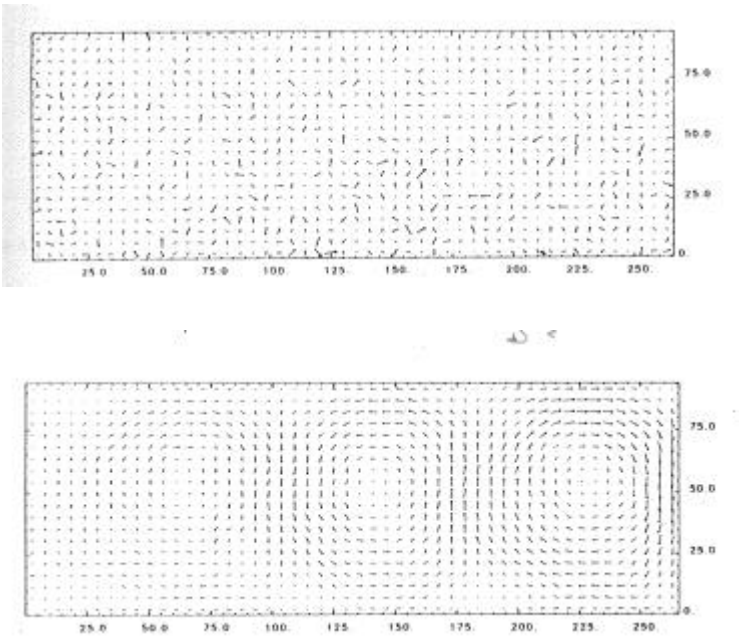

Figure 9: Spontaneous forming of units (vortices) in a computer simulation of molecular motions (from MARESCHAL and KESTEMONT, 1987). On top: intitial state; below: after 2.720 time units.

These authors simulated on a computer the behaviour of 5.000 or more "particles" in a two-dimensional field (the rectangle) divided in 20 by 50 cells. At the beginning the particles have the same velocity, but when they encounter the lower side of the rectangle they are speeded up, in so simulating contact with a higher temperature level (for more details see the original paper). The small arrows that you see represent the mean velocity of particles for each of the 1.000 cells. The upper diagram shows the initial velocity field, the lower one the velocity field after 2.720 time units. (In the original paper the diagrams are ten, and one can notice how these vortices come in to being, dissolve and then reform again, exchanging their elements.) In the lower diagram you see that three vortices have been formed, and that they are characterized by an inner core in practice still, surrounded by strata of increasing velocities.

My point is that in these cases there is unit formation without "forces" generated by the elements or among the elements: the "heating" of the lower side of the field is indifferently applied to all particles, and has no "direction". It is far from me to think that unification processes in perceptual field can be directly connected with the Bénard rolls, or the vortices simulated by Mareschal and Kestemont, at least for the enormous difference in complexity level of phenomena. But WERTHEIMER (1923, p. 305, footnote) and KÖHLER (1947) appealed to electrostatics, and

KOFFKA (1962) to gravitation, in order to explain unit formation in perceptual field without any intervention of external forces, making use of concepts that are much further from vision (*e.g.*) than vortices, and we accepted their arguments as quite reasonable.

7. Conclusion: let us hear KOFFKA

"I am convinced as any reader that each one of the many special hypotheses advanced in this book is in need of further verification; I am doubtful about the future of many of them. But this attitude towards particular hypotheses must be not confused with the general principle, which is independent of special applications. Gestalt theory would be not refuted if its hypotheses of perceived motion were proved to be false. The truth of the Gestalt principle will have to be tested by the course that science takes in the future. But I should not have written this book upon a non-positivistic theory, were it not my deep scientific conviction that truth demands such a philosophy" (KOFFKA, 1962, p. 685).

While I stress the supreme sacrifice of the Gestalt theorist KOFFKA, who declares himself "doubtful" about the explanation of perceived motion, that is about the major achievement of the Gestalt theory, I ask the reader to interpret the term "positivistic" as a synonym of the adjectives "atomistic" or "realistic", or "physiologistic", with which METZGER (1963) defines the present attitude toward mental facts characterized by elementarism or reductionism, with a particular *penchant* for physicalistic explanations. KOFFKA's "philosophy" is poles apart, in the sense that he is convinced that truth rests on the side of global phenomena, where the characteristics and the behaviour of the whole cannot be described or explained by means of the characteristics and the behaviour of the recognizable or constituting elements.

In this sense, my perplexities about WERTHEIMER's *Faktoren* may not be confused with an attack on the "general principle", that remains untouched. The admission that WERTHEIMER's laws are in difficulties, because their traditional formulation does not account for observable facts, does not delete the Gestalt theory, but promotes a deeper insight into phenomena. When I suggest the study of chaotic phenomena, in order to see whether they can offer a model of processes underlying the fact of unification in perceptual field, I see both an escape from obscurities of WERTHEIMER's principles and an opportunity for testing such a model. The general principle to which KOFFKA refers is still valid: the behaviour of a cloud of particles is something "real" that cannot be resolved in the behavior of the constituting parts.

One could point out that I am substituting the physicalism of Gestalt founders, supported by comparability with gravitational or electrostatic forces, with another form of physicalism more subtle and sophisticated (that of chaotic phenomena); in addition to, there seems to be no use in swapping the few assured laws for

undetermined or unknown ones. But KOFFKA seems to say that the truth of the Gestalt principle will have to be tested by the course that science takes in the future, and the future is here.

Summary

The very nature of WERTHEIMER's principles is discussed, since they are often interpreted as actual forces acting in perceptual field. Special figures (VICARIO, 1975) show that in some cases unification should be credited to remoteness instead of proximity, to dissimilarity instead of similarity, and to disorder instead of good form. Some doubts are set forth about the necessity of the concept of unification itself, since in some cases well structured responses may depend on unrelated stimuli. Other doubts are set forth about the necessity of the concept of field of forces, showing that in physical world there is unit formation without the exertion of any specific force. On the ground of that all arguments, it is recommended to think at WERTHEIMER's "laws" in terms of principles of *description*, rather than in terms of *Faktoren* of unification. This interpretation seems to be consistent with KOFFKA's (1962) statements on the nature of Gestalt theory and on the future developments of it.

Zusammenfassung

Diskutiert wird der tiefere Kern von WERTHEIMERs Prinzipien (Gestaltfaktoren), da diese oft als Kräfte, die im Wahrnehmungsfeld wirken, interpretiert werden. Bereits in einer früheren Arbeit verwendete spezifisch konstruierte Darstellungen zeigen, daß in manchen Fällen die Vereinigung von teilen zum Ganzen aufgrund von Entfernung statt von Nähe, oder aufgrund von Unähnlichkeit statt von Ähnlichkeit und von Unordnung statt von „guter Gestalt" erfolgt. Zweifel werden auch an der grundsätzlichen Notwendigkeit des Konzepts der Vereinigung (unification) geäußert, da in einigen Fällen gut strukturierte Reaktionen auf unverbundenen Reizkonfigurationen beruhen. Darüber hinaus wird die Notwendigkeit des Konzepts eines Kraftfeldes problematisiert, indem gezeigt wird, daß in der physischen Welt formative Tendenzen gefunden werden ohne daß spezifische Kräfte wirksam werden. Das Kernargument ist, WERTHEIMERs „Gesetze" eher als Prinzipien der *Beschreibung* anstatt als „Faktoren" der Vereinigung aufzufassen. Eine solche Interpretation erscheint konsistent zu KOFFKAs (1962) Aussagen über das Wesen der Gestaltpsychologie zu sein und könnte deren zukünftiger Weiterentwicklung dienen.

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