The Complementarity of Singularity and Stability

A Comment on Kanizsa & Luccio's „Analysis of the Concept of 'Prägnanz"' (1986)

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The main results of KANIZSA & LUCCIO's (1986) analysis are that (i) the concept of 'Prägnanz' in Gestalt psychology is ambiguous, namely the aspect of singularity versus the aspect of stability, and that (ii) this ambiguity may have resulted from a lack of distinguishing between early (pre-categorical) and subsequent (categorical) processes in visual and - perhaps - auditory perception. In the following analysis it is shown that the aspects of singularity and stability are neither contradictory nor independent but complementary in the sense of SHEPARD (1981) and that this complementary has induced the seemingly inconsistent results of experiments and phenomenological analyses which are invoked as being in favor of different levels in perception.

KANIZSA & LUCCIO (1986) point out the apparently contradictory definitions of what is meant with the concept of Prägnanz in citing - among others - WERTHEIMER who was the first to introduce this term into gestalt psychology (1912) and KÖHLER who integrated it into a general theory of forms (1920).

When in his article on the thinking of aboriginal peoples (1912) WERTHEIMER introduces the term 'Prägnanz' in the discussion of numerical systems he talks about 'distinct domains' (e.g. 10, 20, 30 in the decadic systems) which are easily comprehended and memorized without the guessing typical for numbers lying between these distinct domains. GOLDMEIER (1937) precisiates this notion of 'Prägnanz' as singularity further by claiming that these 'distinct domains' mark discontinuities in qualitative change, illustrating it with the metaphor of the gravitational field. Consequently, in 1982 he writes "The word singularity is my translation of the German word Prägnanz, the two words are intended as synonyms" (p. 44). However, already 1914 when talking about his 'law towards the Prägnanz of forms (Gestalt)' WERTHEIMER stresses the point that it describes a tendency towards simplicity in form. That this conception identifies Prägnanz with stability is shown by KÖHLER (1920), p. 250): "In all processes which develop towards time independent final states there is a tendency towards the minimum of structural energy". KOFFKA, finally (1935, p. 107), coined the term "maximum-minimum" property for phenomena in stationary processes, this already hints at a complementary relationship between *singularity* or *distinctness* aiming at maximization and *stability* denoting the minimal point in a potential landscape (see Figure 1).

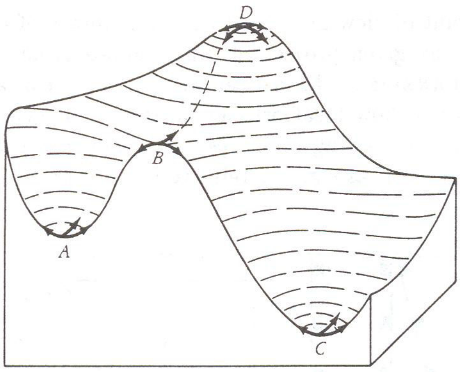

Figure 1. A potential landscape with maxima and minima.

The complementary relation between singularity and stability has two aspects: (i) What is a *singular* object in a purely perceptual task (e.g. if even minor perturbations of an equilateral triangle are detected without effort) might turn out to be *stable* in an identification task making operations in memory necessary (e.g. if triangles are shown tachistoscopically and have to be identified immediately afterwards, there is a strong tendency or bias toward identifiying the shown object with an equilateral triangle). Paradigmatic experiments among many others for this aspect of complementarity have been conducted by STADLER, STEGAGNO, TROMBINI (1979) showing the sensitivity of highly regular objects to perturbations ('prägnant' as estimated from RAUSCH's dimensional model of Prägnanz 'Prägnanzaspekt') and by ZIMMER (1982) expanding GOLDMEIER's gravitational model of 'Prägnanz' which can account for the fact that in the mental representation the distances to and from objects exhibiting Prägnanz are not symmetric (see Figure 2).

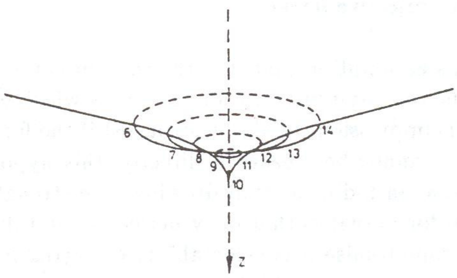

Figure 2. The distances to and from the equilateral triangle in the graviational model; 10 is the equilateral triangle and denotes the bias.

(ii) The second aspect of the complementarity, namely that of interaction between local vs. global optimization, can best be exemplified in the field of spatial perception where the forked effect of local optimization (*stability* leading to the transformation of ellipses into circles, of arbitrary rectangles into squares etc.) and the uniqueness (*singularity*) of the point of view give rise to a stable image of the surrounding world despite the fact that any given projection can originate from a multitude of spatial arrangements. LaGournerie in the last century (see Figure 3) and Ames since about 1935 have shown this and how local orthogonalizations or symmetrizations together with the singularity of the viewing point result in unique spatial impressions even if they contradict 'known facts' as e.g. the relative height of people in the Ames-room.

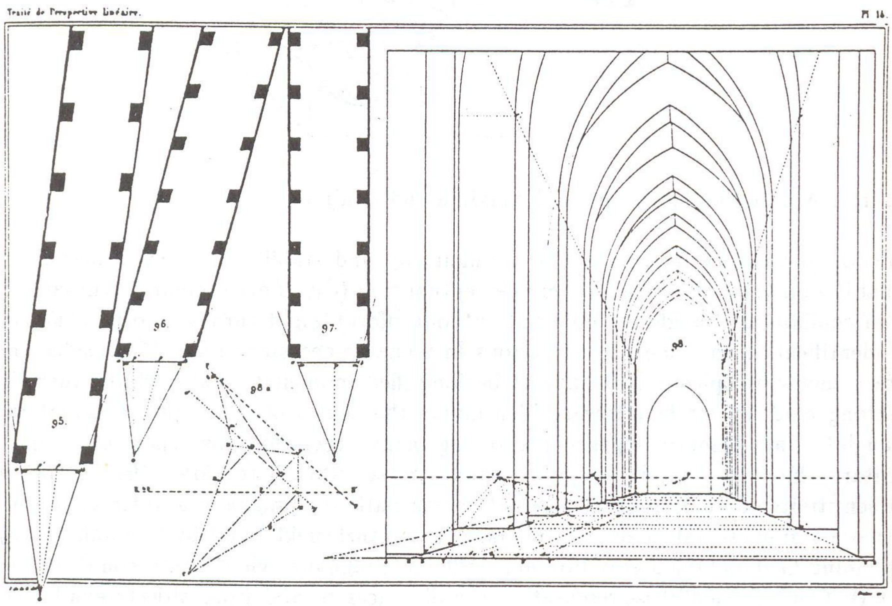

Figure 3. La Gournerie's demonstration that various spatial arrangements can result in an identical projective image.

One prediction from this assumption that it is the tension between a global tendency towards stability and the sensitivity to local disturbances which generates the impression of space, is that this impression should be strongest if the forked effects are about equal. Since the effects cannot be measured directly, this hypothesis can be tested indirectly by showing that in 2-dimensional drawings the strength of the spatial impression is not maximal for drawings that obey perfectly the rules of perspective but for those which form a compromise between stability of partial forms and perspective distortions. Experiments by Zimmer (1990) with drawings of wire cubes have shown this to be the case (Figure 4).

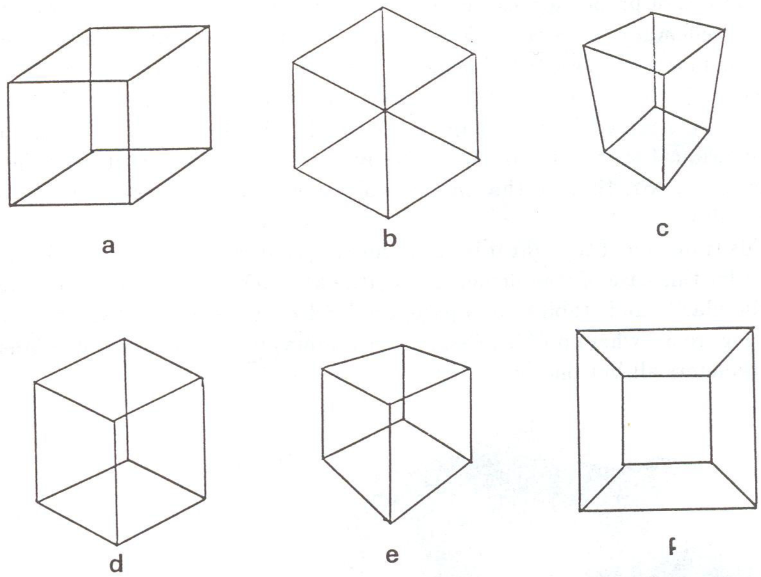

Figure 4. Line drawings of wire cubes.

If one presents subjects different cube drawings (Figure 1 a-f), it turns out that the impression of 3-dimensionality is strongest in d, a, e, and c (in decreasing order) and that only rarely any depth effect at all can be found with b and f. This is in line with the hypothesis because d is an orthogonal projection without a vanishing point, implying that it is seen from infinite distance, and a is an impossible cube from the point of view of projective geometry. That is, the two drawings producing the fastest impression of 3-dimensionality do not comply with any real world projections people have been able to observe. In contrast, the drawings with 2 or 3 vanishing points (e;c) need more time to induce a comparable effect. However, the line of puzzling results does not stop here: Drawing b is entirely equivalent to d but does not induce depth and drawing f is a possible cube projection with a central vanishing point but is seen as a flat picture frame. The last part is in line with KOPFERMANN's (1930) results.

These results draw attention to GOMBRICH's (1973) observation that in the development of art there is always the tension between what is seen and what is known - in our terminology: between singularity and stability. Further results supporting this hypothesis for its role in spatial orientation are given in ZIMMER (1986).

However, also in the foundation of classical physics NEWTON utilizes a formally similar approach to bridge the gap between unique observations and the postulated stable order of the world which is regarded as independent of an observer.

In his scholium on the definitions in his Principia Mathematica (1687), NEWTON differentiates between the concrete observation which is always relative (Sic vice locorum & motuum absolutorum relativis utimur) and theoretical physics (in philosophicis autem abstrahendium est á sensibus). The distinction between what is unique for the specific observation and what is true in an absolute sense is possible by analyzing the interactions of properties, causes and effects (...ab invicem per proprietates suas & causas & effectus). This scientific strategy is more than reminiscent of the forked effect of stability and singularity in spatial orientation: At the same time it is processed (perceived) what is seen from a unique viewing point and as what it is seen the latter being determined by the minimum principle, the discrepancies in this percept allow the veridical orientation in space relative to the objects constituting the spatial scene (see CUTTING, 1987 on the similar problem why we can view a movie from the front seat aile).

For this tradition of thought it is not surprising that modern physics offers a formal treatment for this case of complementarity. HAKEN (1991) in his theory of synergetics models singularity and stability in a potential landscape defined by two order parameters (see Figure 5); where points of stability (minima) result when in a combination of order parameters all but one become zero.

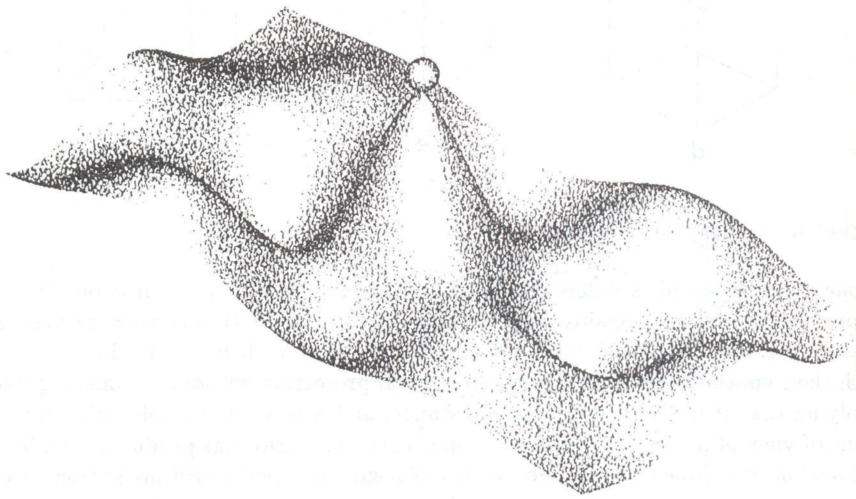

Figure 5. Example of potential landscape in a space of two order parameters (after HAKEN, 1991).

Points of singularity are the result of 'freezing' more than one order parameter at fixed non-zero values considerable larger than the turbulences in the system. This describes perfectly the singularity aspect of 'Prägnanz' as shown in the experiments by STADLER et al. (1979). By switching the signs of the ordinate in Figure 5 one gets the complementary potential landscape (Figure 6), modelling the situation where the stability aspect prevails.

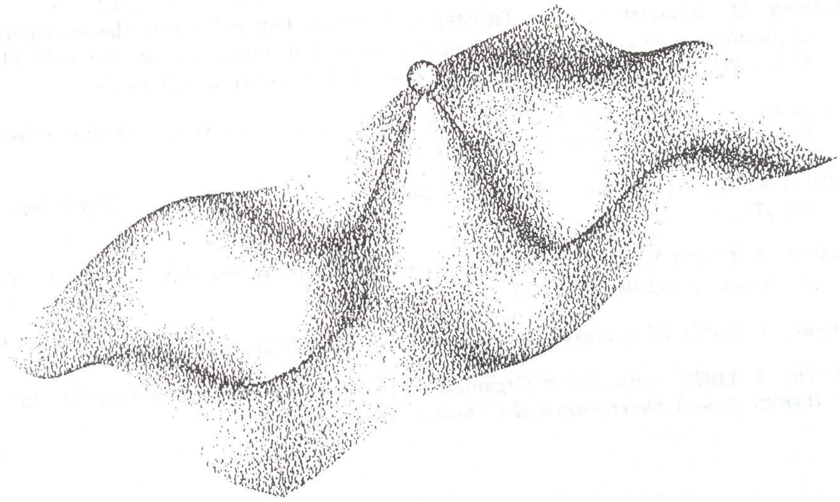

Figure 6. The complementary potential landscape of Fig. 5.

To sum up, in my opinion 'Prägnanz' is modelled best as the complementarity of singularity and stability, this not only is perfectly in line with experimental and phenomenological results, but also can be regarded as a direct consequence of KÖHLER's field theory interpretated in terms of HAKEN's synergetics.

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