TOWARDS AN INTERDISCIPLINARY SCIENCE OF VISUAL GESTALTEN

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1. Introduction

The study of visual Gestalten, in a broad sense, encompasses all activities that seek an answer to Koffka's (1935) famous question: "Why do things look as they do?" And so it considers itself open to intuitions of artists, designers and architects as well as to the musings of philosophers, art historians and others who theorize about these disciplines; to theorists of our culture and self, and generally to the great disciplines of continental philosophy, in particular phenomenology and ontology.

Here I would like to express my commitment to a project more modest in scope, and yet ambitious enough it its own right. Especially in the Berlin school, the study of Visual Gestalten has been conceived as a science in the sense of physics. Science raises the issue of the laws that guide our experience. Nowadays, the notion of laws is often considered too restrictive, in particular for the biological sciences (Bechtel & Richardson, 1991). Instead, these sciences promote the notion of mechanisms. As a consequence, the emphasis shifts from the "why" in Koffka's question to the issue of "how"; in other words, "How do things look as they do?" What are the mechanisms that produce our experience?

The sciences have often been placed in opposition to the humanities. I wish to oppose to that opposition; the project I committed myself to should offer a much-needed interface between the humanities and the sciences. It has to be an active interface, though, as our research should critically reflect aspects of both the sciences and the humanities. We must, then, convince mainstream science of the importance of emergent properties as sensible qualities; to the humanities we must hold up that, rather than being the product of historical contingency and social construction, our experience has been shaped in natural evolution. Thus, with our scientific project, we are embarking on a double historical mission.

2. Missioning Amongst the Humanities

First I would like to comment on how a science of visual Gestalten should critically reflect on the humanities. We take experience serious. This, however, shouldn't mean that we can take it for granted. The way we experience things is a product of history; consider the development of perspective in Renaissance art

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(Kubovy, 1986). Some have gone as far as to consider our reflexive self-awareness as a product of relatively recent history, preceded by what famously dubbed the bicameral mind (Jaynes, 1990/1976; Sleutels, 2006). Even for basic phenomena with which we are all familiar, such as perceptual switching in the Necker cube, we must concede that these have once emerged in a cultural context; switching rarely happens to those who are not familiar with it (Rock, Hall, & Davis, 1994).

Historical development and cultural evolution may lead us to think of Gestalten as social or cultural constructions. The science of visual Gestalten, however, tells us that at the basis of our experiences there is invariance, which is firmly rooted in biological evolution. We have no difficulty, today, to appreciate the artistic products of cave dwellers, such as the famous drawings of Lascaux. The science of visual Gestalten can point to the eternal appeal of symmetry, balance, dynamicism, and conciseness of expression in important works of art. The biological foundation of our experiences is manifest in these enduring preference for certain structure.

Much can be learned from the creations of artists, designers and architects, even more from the way these are produced: When we look at the process of creation, we observe that artists, designers, and architects frequently engage in cycles of sketching, reading off the sketch perceptually and renewed sketching. We may say that designers benefit from sketching by extracting the surplus structure that was hidden in the mental image prior to its externalization (Goldschmidt 1991). Thus, by inspecting the product of externalization, they are able to introduce new, unanticipated features into the design (Verstijnen et al., 1998). At every stage of the process, the new depictions are being subject to evaluation (Berlyne, 1971). What is this norm against which provisional designs are evaluated? We find the artists' abiding structural preferences playing the normative role all these stages of the creative process.

We carried out a study of the work by the Dutch artist Paul Kleyne (van Leeuwen et al. 1999), and were able to specify the norm that prevailed in it. The artist reports he was looking for "tension" in his art, but showed little eagerness to elaborate on this notion. Surely, such intuitions are not easy to express in words. "Creation myths", by artists or designers, therefore, tend to be notoriously uninformative. However, by analyzing a series of sketches, we were able to show that "tension" meant, in the context of Kleyne's work, a visual ambiguity between mosaic and occlusion interpretations for the geometrical figures used in his paintings. This may illustrate, against social constructivism, that there are regulative norms in artistic production, which are based in perceptual organization, and therefore of biological origin.

3. Missioning Amongst the Sciences

How might a science of Gestalten engage with the sciences? Scientists tend to think in terms of laws (physics) or mechanisms (biology). Some such laws, as in classical psychophysics, directly refer to the contents of our experience. Laws of sensation uniquely map sensory quantities into a physical scale. Take for instance the experience of the physical duration of a time interval. It is a misunderstanding, however, to think that laws only pertain to sensory qualities. True, only these are projectable into a physical scale. However, the pre-conception that we should always have such 'projectability' is a form of dogmatism. Clearly, projectability is not a defining characteristic of Gestalten. We have visual ambiguity and occlusion, to name a few items that prevent it. Nevertheless, we have some of the most reliable laws: the Gestalt law of proximity, for instance, is a universal, quantitative law that allows for and even predicts ambiguity (Kubovy et al., 1998; Buffart, 1983); measures of figural Goodness allow us to predict how the occluded figure is perceptually completed (Buffart, Leeuwenberg, & Restle, 1981).

The restriction of psychophysics to sensory qualities is based, in my opinion, on a historical misunderstanding of Fechner's psychophysics. Fechner distinguished internal and external psychophysics. Internal psychophysis, in his understanding, was concerned with lawful mind-brain relationships; external psychophysics is what we know as psychophysics today. To Fechner, internal psychophysics was the more fundamental of these sciences, and was supposed to deliver the most reliable laws. The science of visual Gestalten can side with Fechner, in that mind-mind and mind-brain relationships have primacy over mind-world relationships. Only in this way can we ever expect a shift in science from sensory to perceptual awareness; from parts to wholes.

The laws that govern our perception of wholes can only be discovered if we take time into account: the dimensions of space and time are interdependent in perceptual grouping (Gepshtein & Kubovy, 2000); in perceptual switching and multi-stability we observe that percepts are limited in their duration. Structure as experienced is created dynamically in time, through a process of self-organization. Structures experienced, once created, have a restricted life cycle. Invariance or continuity of transformation can only be experienced as situated in time, as an extended presence. Dynamical systems theory can account for this, as I have been trying to do by specifying the psychological present in terms of coherence intervals in an otherwise un-stable, or meta-stable, neuro-dynamics (van Leeuwen, 2007[1]).

Mechanistic approaches traditionally prefer linear systems, mainly for the sake of convenience. With linear systems it is easy to predict their future course and to control their behavior. Linear systems can only approach a nonlinear reality piecewise. To achieve this, it is necessary to carve up de world: as the slogan goes, "to carve nature at its joints." But how can you do this if in order to know where the joints are you need the very theory that you are trying to construe? Having no escape from this circle, traditional research methods are doomed to focus on making ever finer distinctions (e.g. Van Orden, Pennington, & Stone, 2001). This leads to decadence; typically, experimental psychology is poised to focus on ever smaller detail studies that are increasingly relevant to the other members of the scientific family. Rather than going on along this path, experimentalists should tackle nonlinearity of our brains and minds head-on. For a science of visual Gestalten, it is a major task, and a major challenge, to supply working dynamic models of perception and mechanisms for control of nonlinearity in non-equilibrium situations (Tyukin, et al. 2007).

[1] To this paper the Metzger award was given.

4. An Example from Research

After having complemented my view on the mission of a science of visual Gestalten in the humanities with a perspective on how it should engage the sciences, I will proceed to demonstrate with an example, how some of this can sometimes be accomplished, albeit on a small scale, in everyday science. Everyday science is a rather un-heroic activity, and we should not expect too much in the way of battles, charges, or revolutions. Science is a trench war. So what, if unspectacular, are the victories we should be able to carry from the trenches? To illustrate this part I turn to the subject of developmental dyslexia. More than 100 years of scientific research have failed to provide a consistent account of developmental dyslexia (Miles & Miles 1999). Controversies are rife, such as whether the deficit in reading ability mainly resides in visual processing (Hulme 1988; Lovegrove, Bowling, Badcock & Blackwood 1980; Skottun 2001; Slaghuis & Ryan 1999; Stanley & Hall 2005; Stein 2001; Willows 1998) or is phonological in nature (Rack & Olson 1993; Siegel 1993; Snowling 2991; Vellutino 1987; Vellutino, Steger, Moyer, Harding & Niles 1977). In particular, it has been observed that dyslexics perform similar to unimpaired readers in many visual tasks (see Willows, 1998 for a review). Some researchers, therefore, concluded that visual processing deficits are not involved in the syndrome (Vellutino 1987; Vellutino, et al. 1977). However, as I will argue, this conclusion is premature.

The conclusion is premature, because visual Gestalten, are left out of the equation. The perceptual organization of letters and shapes differ, as Koffka had already noted. As shapes, b and d are similar; as letters they are not. Their symmetry is usually not noticed, at least not in normal adult readers, in letters. We propose that normal readers suppress the symmetry in individual letters, as it is not helpful in reading. This may be part of an overall strategy to process letters more analytically in the early processing stage of reading, than comparable figures. With anomalous readers, i.e. dyslexics, we might expect anomalies in their processing strategy.

My colleague, Thomas Lachmann, and I recently published a number of studies involving the perception of symmetry in letters and shapes, several of which involves dyslexics. One of these (Lachmann & van Leeuwen, 2007) I will review here for its potential "missionary" implications. This requires me to discuss the results of this study in some detail. Previously we had published a series of studies using Garner patterns (Garner, 1962) in a same-different task. Garner patterns (Figure 1) are five-dot patterns construed on a 3x3 grid leaving no row or column empty. These patterns differ in their perceived Goodness (Garner & Clement, 1963). Garner showed that this could be predicted by the notion of equivalence set size (ESS). Some patterns can be transformed into each other by combinations of 90^{o} rotation or mirror image transformations. The ones thus linked by combinations of one or more transformations constitute an equivalence class. The number of members in the class constitutes its ESS. The more reflectional or rotational symmetry of a pattern, the smaller is its ESS.

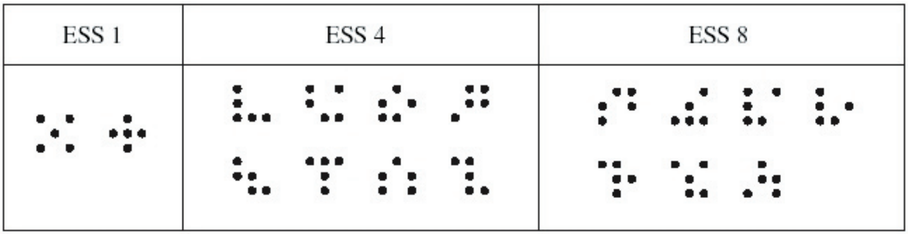


Figure 1: From Lachmann & van Leeuwen (2005a): Examples of Garner patterns used in a Goodness rating task (Garner & Clement, 1963).

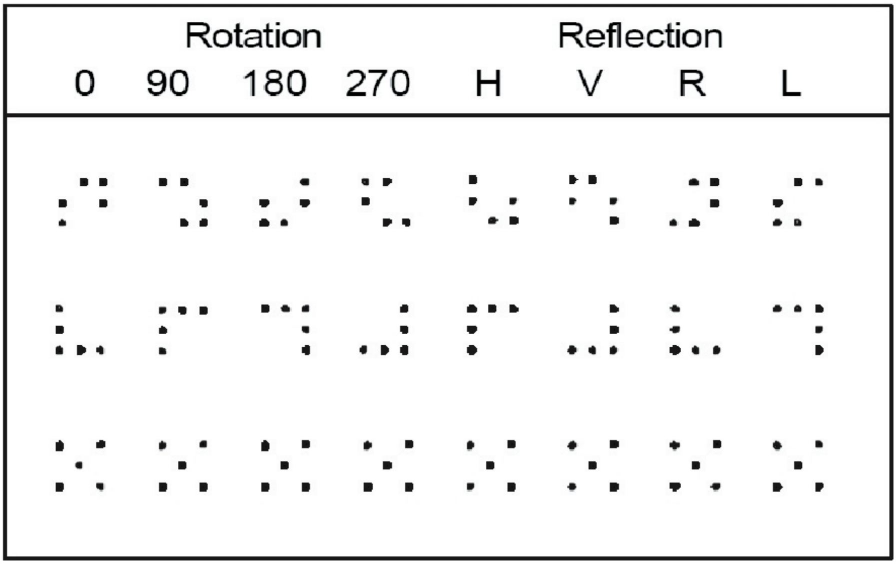


Figure 2: From Lachmann & van Leeuwen (2005a): Illustration of identity under rotation and reflection transformation. The figure in the top row lacks any symmetry. Each transformation produces a different version of the figure. Hence its equivalence set size (ESS) equals 8. The figure in the middle row has one symmetry, which means half of the transformations produce the same figure, and so it has ESS = 4. The figure in the bottom row has several symmetries, such that it remains identical under all transformations; ESS = 1.

Lachmann & van Leeuwen (2005ab) presented Garner patterns in a same-different task. Participants are to judge these patterns as "same" if they are an identical pair, if one is the mirror images of the other when presented in a different orientation. For this task, we showed that more than 90 % of the variance in reaction times between conditions can be explained, based on a model (Lachmann & Geissler, 2002) that assumes that both patterns are searched, sequentially, in their respective equivalence sets (Figure 3). With this assumption it is possible to calculate the number of search steps, which provides a predictor for response times. This predictor explains, on average, 90 % of the variance with adult participants in this task.

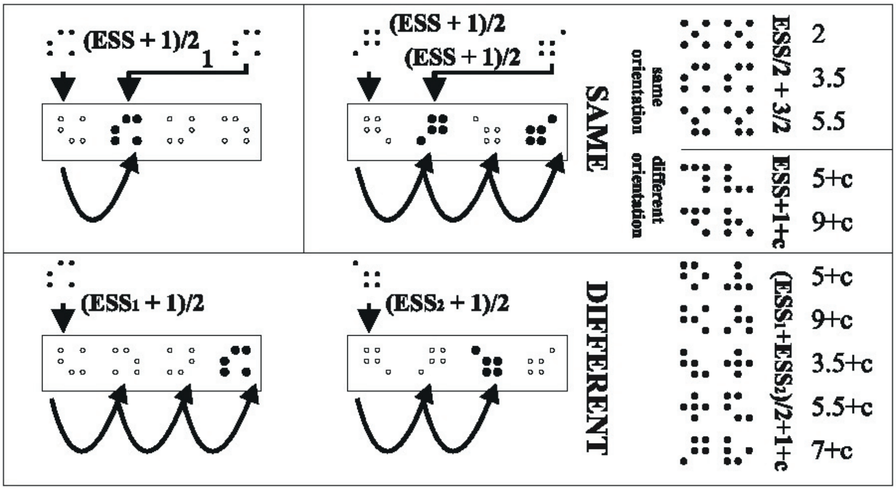


Figure 3: From Lachmann & van Leeuwen (2004). Model assumptions for making RT predictions based on search of the Equivalence Set. ESS_1 and ESS_2 = equivalence set sizes elicited by the first and the stimulus, respectively. See the reference text for details.

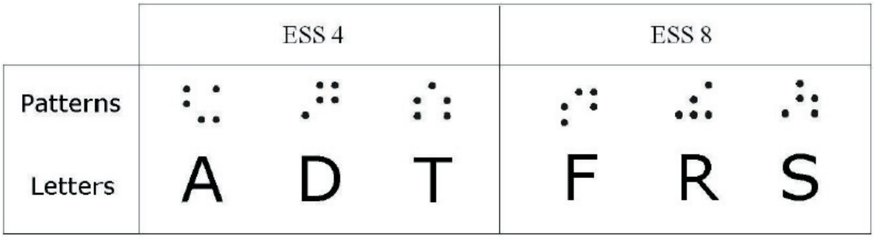


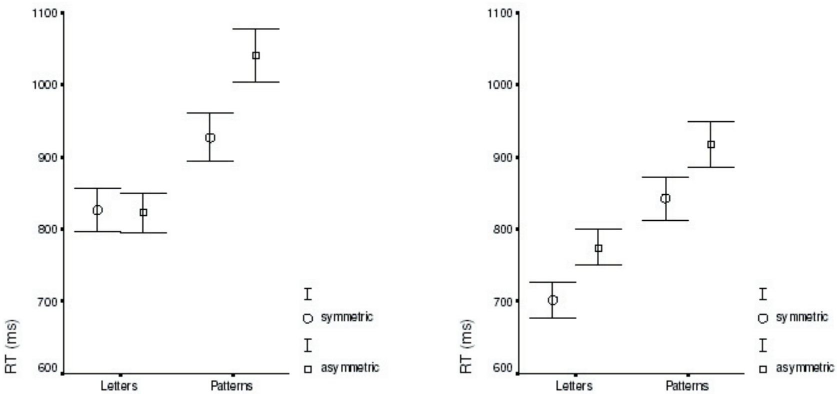
Figure 4: From Lachmann & van Leeuwen (2007): Example stimuli used in a same-different experiment, together with their ESS value used as predictor to RT in this task. Symmetrical patterns and letters have ESS =4; asymmetrical patterns receive ESS = 8. Note that the “S”, despite having rotational symmetry, is given ESS = 8 based on the assumption that this symmetry is perceived neither in normal readers nor in dyslexics.

In Lachmann & van Leeuwen (2007), we presented this task to normal reading and dyslexic children. We included in the task also conditions with letters. Both Garner patterns and letters could be symmetrical (ESS = 4) or asymmetrical (ESS = 8), see Figure 4. Participants responded same to identical pairs or pairs which are mirror images of each other, and different otherwise. The results, shown in Figure 5, are quite unusual: first of all, dyslexic children perform this task much better than normal reading children. Most unusually, they are better, in particular, with letters. With patterns they do better as a practice effect: only those dyslexics who started with the letters condition perform better on patterns than normal readers. Normal readers do not show such a transfer between letters and patterns blocks. Letters, for dyslexics, are more similar to Garner patterns than for normal readers.

Dyslexics outperform normal readers overall with letters. In Figure 5, both normal readers and dyslexics have a symmetry advantage for Garner patterns. Dyslexics, however, are also faster for symmetrical than for asymmetrical letters; normal readers do not have such a symmetry advantage. Dyslexics benefit from the symmetry they see in letters but normal readers do not. Where normal readers use different perceptual organization strategy for letters and shapes; dyslexics, it seems therefore, use the same one. Figure 6 confirms this hypothesis. Here we used ESS for letters and shapes as predictors in our model for reaction times. Note, however, that we predicted that normal readers do not perceive the symmetry in letters. Thus, for normal readers (but not for dyslexics), symmetrical letters were assigned an ESS = 8 instead of 4. This significantly improves the fit, which is consistent with the assumption that dyslexics use the symmetry in letters, whereas normal readers have learned to suppress it.

Based on this result, what can we say to the humanities? We can say this: Letters and shapes are normally perceived in different ways, as our research has shown; yet there is nothing intrinsic to a pattern configuration that distinguishes a letter from a non-letter shape; the phenomenology of letters and shapes is embedded in a context of cultural convention. This may all be true, but still it doesn't have to lead to cultural constructivism. The more basic reality is that of shapes. Their Gestalten contain symmetries that readers suppress in letters. But this suppression is something you need to learn to do; anomalous readers fail to do so. The symmetry immanent in visual Gestalten has an objective, biological foundation. It is only based on this that you may expect to learn special-purpose strategies as the cultural context requires.

To the sciences we may say: It is possible to observe that normal readers and dyslexics differ in perception, but only if you are willing to focus on how they perceptually organize the world. You will also be able to observe that dyslexics are not helplessly deficient. They are flexibly compensating for their deficit, whatever its nature, by falling back on biologically more primitive perceptual organization strategies that are normally applied only outside the reading context. This might suffice to reach normal scores in standard visual processing tasks, and sometimes even better than normal scores in specific tasks, in which their strategy happens to be optimal.



Normaly reading children Dyslexic children

Figure 5: From Lachmann & van Leeuwen (2007): Reaction times for normally reading and dyslexic children on the same-different task using Letters and Garner Patterns with or without symmetry. Dyslexic children are faster on the task than normally reading children, in particular with letters, and show an advantage for symmetric letters not found in normal readers.

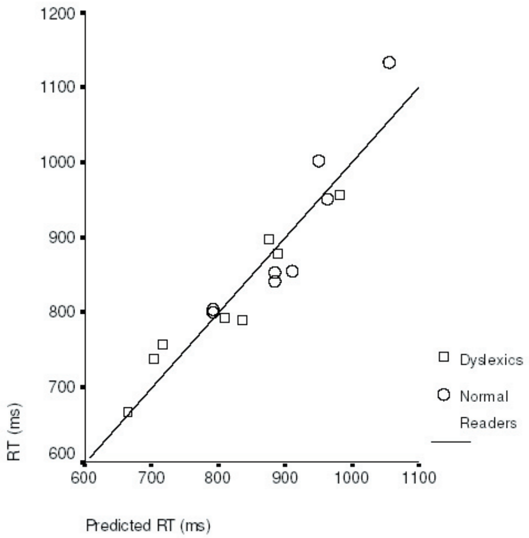


Figure 6: From Lachmann & van Leeuwen (2007): Reaction times on the same-different task for normal readers and dyslexics, for letters and Garner patterns plotted against predictions from the model shown in Figure 3. Model predictions were based on the extra assumption that normal readers to do not perceive the symmetry in letters, i.e. for all normal readers, letters receive ESS = 8.

5. Concluding Comments

I have argued for a science devoted to *how* things look the way they do, a science that aims to explain the mechanisms that produce our visual experience. I describe its role within the wider field of the Gestalt movement and I have shown an example of how this sometimes works in practice. We do not need orthodoxy with respect to theories by the likes of Koffka, Köhler, and Wertheimer. But I realize it is, in a sense, quite orthodox to propose biological mechanisms as foundational for visual experience. What is the relationship with the other modalities, with cross-modal experience, or with experience tout-court? Surely I do not want to claim that visual experience has a privileged status, or that people without vision are less capable of experience. To the contrary, proclaiming, as I did, the primacy of mind-brain over mind-world relationships implies that experience originates within the system. Without vision, our experience would therefore not necessarily be less rich, not even always less informed. Humans have remarkable capacities for auditory localization of an object in space, and for learning to read through touch (and, most likely, even for being dyslexic in Braille). Despite what could be said about the importance of vision, making it the unique basis for a theory would be hopelessly parochial. May the next development, therefore, be a science of multi, cross, and amodal Gestalten.

Zusammenfassung

Unter der Untersuchung visueller Gestalten kann man im weitesten Sinn jede Aktivität verstehen, die eine Antwort auf Koffkas berühmte Frage sucht: „Warum sehen die Dinge so aus, wie sie aussehen?“ Innerhalb dieses weiteren Rahmens ist ein etwas enger gefasstes wissenschaftliches Projekt möglich, das sich auf die Mechanismen der visuellen Erfahrung richtet und daher die Frage so stellt: „*Wie* sehen die Dinge so aus, wie sie aussehen?“ Ein solches Projekt kann eine Schnittstelle zwischen Phänomenologie und Neurowissenschaft zur Verfügung stellen und aus dieser Position die Möglichkeit bieten, mehr oder weniger naiven Missverständnissen über unsere Phänomenologie empirische Befunde entgegen zu setzen und sowohl die Psychologie als auch die Neurowissenschaften mit dem Primat der Ganzheitlichkeit im Wahrnehmungsgeschehen zu konfrontieren. Die Implikationen, die ein solches Projekt hat, werden in diesem Beitrag mit einer bereits früher publizierten empirischen Untersuchung von Wahrnehmungsaspekten der Primärlegasthenie illustriert.

Summary

The study of visual Gestalten can be defined broadly as all activity that seeks an answer to Koffka’s famous question: “Why do things look as they do?” Within this larger framework a more narrowly defined scientific project is possible, aimed at the mechanisms of visual experience, and thus asking the question: “How do the things look as they do?” This project is providing an interface between phenomenology and neuroscience, which renders it uniquely positioned to counter more or less naïve misconceptions about our phenomenology with empirical evidence, and confront psychology and the neurosciences with the primacy of holistic features in perceptual awareness. The implications of this project are illustrated with an earlier-published experimental study, involving the perceptual aspects of developmental dyslexia.

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