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Gestalt Theory of Cognition and "Solid" Sciences: Physics, Mathematics, and Artificial Intelligence

Shelia Guberman*

Keldysh Institute of Applied Mathematics, Russian Academy of Sciences, USA

***Corresponding author:** Shelia Guberman, Keldysh Institute of Applied Mathematics, Russian Academy of Sciences, Cupertino, California, 95014, USA. Tel: +14082554648; Email: guboil@hotmail.com

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Abstract

As all other "soft" sciences, Gestalt psychology has been under the influence of the outstanding achievements of "hard" sciences - mathematics, physics, and chemistry. The relationship between these two parties has always been complicated. When biology, geology, and sociology started to apply the strong scientific methods to research on their very complicated objects, Gestalt ideas on whole/parts relations came into high demand. Despite the attractiveness of holistic ideas, the benefits were very few, because Gestalt psychology didn't supply the main notions (Gestalt, good Gestalt, and Pragnanz) with clear definitions.

In turn, Gestalt psychology was very active in adapting physical and mathematical models, but it did so very unsuccessfully. From the very powerful theories - field theory, chaos theory, and non-linear dynamic theory - were adapted only scientific terms (isomorphism, chaos, organization, non-linearity, attractors) without indicating the corresponding psychological notions. Some adapted theories were created by professional physicians and mathematicians with the purpose of solving the key problems in biology, linguistics, economics etc, but they failed (cybernetics, general systems theory, synergetics).

Artificial intelligence would have to be the most natural ally of Gestalt psychology in the family of "hard sciences", because it tries to imitate the main psychological functions of human beings - perception and decision making. Unfortunately, these fields developed a mutual distrust.

Keywords: Cognition; Gestalt theory; Human-computer interaction; Artificial intelligence; Soft and hard sciences

Introduction

The century that separates us from the period marked by the birth and rise of Gestalt psychology puts us able to evaluate its contribution to the history of psychology and its place in contemporary psychology. It is generally recognized that the outstanding service of the founders of Gestalt psychology was their questioning of the limitations of the analytic approach to the study of complex systems. They formulated and provided a theoretical basis for the position that the perception of the whole cannot be reduced to the sum of the perception of its parts, and that interpretation of each part depends overall. The mechanisms the Gestalt psychologists incorporated into the explanations of this phenomenon were excessively influenced by physics (particularly field theory) and are now of only historical interest. But the problem of Gestalt itself was further developed, especially in the domain of visual perception.

In the middle of the XX century an event occurred which dramatically influenced the science, technology, and everyday life of mankind - the invention of the computer. The impact was felt even in terms of psychology, with relations between computer land and psychology being complicated and many-sided. The most trivial was the use of computers for calculations, for keeping, renewing and processing databases, for construction of the sophisticated visual and audio stimuli needed in psychological experiments. Sometimes psychology used more sophisticated tools (like pattern recognition) for data mining, i.e. for extracting from experimental results information not visible to the naked human eye.

Human-computer communication. At the same time computer science (Artificial Intelligence) was looking for help in psychology. The general problem was communication between humans and computers. The main channels of communication between people are visual, audio, and tactile. When computers were in their infancy, the communication language between man and computer was poorer than Morse code: the only signs were (1) and (0) embodied in binary switches. Later an 8-symbol alphabet appeared, followed by the whole English alphabet. Though man's communication language and computer communication language are the same, the modalities differ from each other: a computer understands a man's messages only if they are sent in a tactile modality (by pushing the keys), whereas a man understands a computer's reports only in a visual modality (by means of monitor or paper). The mouse enlarged the repertoire of our choices but didn't change the tactile modality of our messages. The color monitor enlarged the variety of images presented to us but didn't change the visual modality of computer reports. So, our partner in the dialogue was blind, deaf, dumb, and paralyzed; he understood tactile information only. We know from Kester's and Skorohodova's books how difficult it is to adjust communication and expose these defects of man (even when the whole brain is intact).

These limitations were soon understood, and programmers started to develop software for establishing mutual communication channels - video and audio. Technically it was easy to deliver to the computer the voice signal (from a telephone line) or the visual signal (from a TV camera), but the question was: would the computer's understanding of the signal be similar to human understanding? That was the beginning of Artificial Intelligence. Two particular problems of human-computer communication attracted most attention: speech recognition and printed and written text recognition. Because the goal was to imitate humans' abilities to perceive and understand written and spoken messages, it would have been natural to refer to the psychology of perception and in particular to Gestalt psychology as the most scientific and experimentally grounded branch of perception psychology. But this was not what happened. All the programmers were former mathematicians or electronic engineers; they had extensive experience in processing speech and TV signals presented as electrical currents. For these kinds of signals powerful mathematical methods and appropriate hardware were developed. Programmers were sure that they needed no help, least of all from psychology (in which they were not well-versed). The landscape has not changed significantly. The result was devastating to AI, and the vast majority of promises offered by the gurus of AI were never fulfilled.

First warning to newborn AI. Gestalt psychology sent a warning to the newborn AI community through the mouth of Max Wertheimer, the founder of Gestalt psychology. In 1943, three years before the first general-purpose electronic computer (ENIAC) was developed (announced on February 14, 1946), Wertheimer finished his last book Productive Thinking (it was published two years later). In this book he investigates the basic principles of thinking. He criticized the most popular psychological theories of thinking: the logic method and the associative method. Concerning the logic method Wertheimer wrote:

"Some psychologists would hold that a person is able to think, is intelligent, when he can carry out operations of traditional logic correctly and easily. Traditional logic is not so much concerned with the process of finding the solution. It focuses rather on the question of correctness of each step in the proof." But AI was deaf to warnings and chose logicality as the main road of progress. That is why the set of problems on which AI focused during the first decades of its existence mainly consists of different kinds of games and proving mathematical theorems, which follow strict logical rules explicitly formulated. The feeling of the almightiness of computers and logic reached its peak with the creation of the General Problems Solver - a computer program created in 1959 by Newell, Shaw, and Simon [1], which was intended to work as a universal problem-solving machine. Of course, it never worked, but because Simon was a Nobel Prize winner in economics (more accurately he won the Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel established in 1969) it was very fashionable. As one critic of the program remarked, "it was much cited, but little used". Simon described "Thought processes in terms of propositions and logical manipulations of propositions" [2] precisely what Wertheimer strongly opposed. The irony is that, according to Simon, this approach "Has generally been preferred by Gestalt psychologists". But it was not only gestaltists who were enthusiastic about the psychological theories of the prominent economist: in 1993 he received an Award for Outstanding Lifetime Contributions to Psychology from the American Psychological Association.

A detailed review of Wertheimer's book and its importance to AI can be found in [3]. First warning to Gestalt Psychology. At about the same time, the first face-to-face meeting occurred between Gestalt psychology and computer elites. In 1946 the inaugural Macy Conference, entitled "Feedback Mechanisms and Circular Causal Systems in Biological and Social Systems", took place[1]. It was the first 'coming together' of the hard scientists and the social scientists, and it was followed by 9 more conferences (before 1950). The Core group included such luminaries in mathematics, computers, psychology and neurology as von Neumann, Wiener, McCulloch (chair), Pits, Lewin, Klüver, Northrop, Rosenblueth, Bateson, and Bigelow.

Heinrich Klüver (psychologist and neuroanatomist) gave a presentation on how object perception appears to use feedback mechanisms to enforce constancy. He declared that psychology lacks a good model for explaining how a brain handles form perception (Gestalten) - thus posing a topic which would be addressed repeatedly in the next few conferences.

A sub-conference was designed to allow social scientists to meet with Wiener and von Neumann, to hear about their ideas, and to discuss how these ideas might be valuable in social science. This sub-conference recommended to the larger group that the concepts of 'field' and 'Gestalt' be clarified, and this recommendation was acted upon. Such concepts have been a point of contention throughout the history of Gestalt psychology, and this was a great chance for Gestalt psychology in front of great minds in mathematics and computers to offer clarification and resolve the problem. Unfortunately, resolution did not happen. The main outcome of the discussion was an illustration of how little the attendees agreed on the definitions and implications of these labels. Soon participants interested in cognitive 'content' (cf. Klüver's persistent allusions to Gestalten) found themselves at a disadvantage in putting such topics before the group. Over the subsequent years the pessimism spread: Bateson became concerned that the multidisciplinary conference was being diverted into intra-disciplinary controversies, Northrop saw Gestalt psychology as a suboptimal theme, and recommended keeping the focus on 'harder' science such as (e.g.) neurophysiology and mathematics.

Gestalt theory missed its great opportunity to move in the direction of "Hard sciences". As a result, over the next 60 years Gestalt theory multiplied its number of basic laws, and its "Definitions" of Gestalt and isomorphism. The definitions continued to be intra-disciplinary controversies, often rendered senseless because they contained undefined terms.

So, the second interaction between Gestalt psychology and the computer world (including mathematics, programming, and information theory) was fruitless. At that time, it was the gestaltists' fault, whereas the first time, when computer scientists ignored Wertheimer's warnings, it was the programmers' fault.

Computer paradigm in psychology. The mainstream of relations between Gestalt theory and AI over the next 50 years was dominated by the computer paradigm. It came after previous paradigms which modeled the brain as a hydro-mechanical machine built from reservoirs, pipes, and liquids, as a telephone station with complicated wiring, or as automata with logical knots included in a complex net. Neurophysiology and psychology were continually looking to "Big brother", to the dominant science of that time (mechanics, electricity, and electronics), hoping to jump on the "bandwagon" and share a part of their "Hard" scientific status. The tragedy of the contemporary situation is that computers were designed according to the amateur ideas of electronic engineers about how the brain functions. Psychology continued to mirror the main path of AI, following it to its dead ends. In the beginning cybernetics was pronounced as an adequate language for describing mental processes emphasizing the importance of feedback. The golden age which cybernetics (as a component of AI) promised in production management and the conduct of daily life turned out to be a mirage. As we know, the life of cybernetics was not long. In the 60s in mathematical circles the word "Cybernetics" had been discredited. Cybernetics changed its name to escape responsibility - now it is called informatics and promises nothing.

Then the imagination of psychologists was captured by the theory of information, and the brain was announced to be a machine for processing symbols. Neuron networks became the common ground for psychological models of perception and thinking - psychologists liked this tool because it was stuffed with mathematics and therefore looked very "Hard", and AI-engineers could claim that their solutions were imitating brain organization.

Foot Note[1]: Admittedly daunted by the length and complexity of the conference title, von Forester recommended Wiener's recently-published label 'cybernetics' be adopted as the conference title. This was enthusiastically approved. Wiener, deeply touched, left the room to hide his tears.

This paradigm is still accepted in Gestalt psychology. In 1999 a prominent gestaltist [4] "How does one describe or define a gestalt beyond just stating that it is the interaction of all its vectors. These descriptions are linear. The neurological configurations seem to be reducible to the linear units. Ultimately, we seem to land at the venerable elements of dendrites and axons, things and ties. These physiological elements of gestalten seem to be like the elements of which Computers are designed. There seems to be no technical limit to what problem solving by Computers can achieve".

The idea that a computer will become a thinking device as soon as it will have such high speeds and extensive memory has no proof to support it. Fifty years ago, when the speed of computers stood at 2000 operations per second, enthusiasts (including Professors of Universities and Members of the Academy of Sciences) promised that if they were to build a computer the size of a skyscraper it would be able to solve any problem. This has not happened, despite speed increases of more than 1,000,000 times. Forty years ago, Japan announced that the 5th generation of computers would be so powerful that problems of handwriting recognition, speech recognition, and language translation would be resolved. This didn't happen either. Closer to the present time, we heard again the same tune but with new words: "One aspect of pattern recognition that was not mentioned in our report (July 1999), is the need for parallel processing. With an estimated average of one thousand connections between each neuron and its neighbors, we have about 100 trillion connections, each capable of a simultaneous calculation. That is massive parallel processing and one key to pattern recognition by humans. Computer neural network systems that are set up for pattern recognition need to use parallel processing". And this too couldn't happen through the increasing power of computers. It is impossible to understand the highest functions of the brain (like perception, generalization, recognition etc) at so low a level of presentation as the neuron level. It is the same as trying to understand how an automobile works by describing it at a molecular level.

Epidemic of childhood diseases. The following decades of the computer era were populated with childhood diseases (field theory, self-organization, synergetics, connectivism, neural networks, systems theory, chaos theory). Some of them are "hard" physical theories but unreasonably applied to psychology. They came to Gestalt psychology and went, but some had long-lived consequences.

How much Gestalt theory could learn from ideas of self-organization, and whether these ideas could help to resolve problems of Gestalt psychology, one can understand from some statements of Stadler, one of the active proponents of cybernetics-synergetic-self-organization in Gestalt psychology: "Gestalt theory is one of the most elaborated theories of self-organization" [5]. Gestalt theory had been instantly sacrificed *on the altar* of the new (temporary) godhood. Then Stadler claimed that "Gestalt theory and self-organization have stressed the significance of non-linear perceptual processes (such as multistability) for the solution of the mind-brain problem".

The meanings of linear and non-linear perceptual psychological processes were never defined. In physics, in linear systems cause and effect are proportional to each other; in other words, if the measure of what is the cause is doubled, the measure of its effect is twice as large. Accordingly, in non-linear systems cause and effect are not proportional to each other. What causes our perception system to function? The stimulus. And what is the effect? It is our percept, the Gestalt. And what is the measure of the stimulus (which has to be a number)? The statement: "If the size of the stimulus is doubled the Gestalt is twice as large" is absolute nonsense. The only reason for applying this term to Gestalt psychology was the strong wish to call our nervous system a self-organized system, and publish a number of papers and books full of "Scientific" terms and formulas, but it has nothing to do with solving the mind-body problem (as it was claimed) or any real psychological problem. It is interesting that much later (in 1999) the perception was declared to linear system: "How does one describe or define a gestalt beyond just stating that it is the interaction of all its vectors. These descriptions are linear. The neurological configurations seem to be reducible to the linear units" [4]. Fortunately, both haven't been proved. In 10 lines of the summary for "Gestalt theory and self-organization", one can find many highly sophisticated terms: dualistic, monistic, epistemological, psychophysical isomorphism, holistic emergentism, macroscopic order, and this is not a sign of high quality.

Every 10-15 years the current banner was changed and promises forgotten. The technology of acclimatizing to a new paradigm is simple: identify the basic terms of Gestalt psychology with terms of currently adopted science. For example, order = good Gestalt, phase transition = process of dynamical perception, chaos = randomness, multistability = ambiguous images or reversible figures. In most cases the identity of terms was simply declared with no argument, but when in rare cases some argumentation was presented it did not always yield good results. Here is the argumentation from the paper "On Chaos and Order' [6]: "Sensory perception is to be regarded as a complex process, in which stimuli are converted into Gestalten". As it was mentioned above, if one is to apply a concept from the "On-linear sciences" (synergetic, chaos theory, systems theory etc) to the perception system, one must define the cause of the process and its effect, and then prove that the measure of effect (Gestalt) is not a linear function of the measure of cause (stimulus). But the way the road from perception to chaos theory was paved was flawed.

The following example was presented. In animated films, when the moving shapes do not possess human or animal forms at all, the way the shapes coordinate their movements and approach one another still creates the overwhelming impression that one is dealing with "Living creatures" or even "human beings" who are interacting. They can produce a vivid impression of typical "Social interactions" or "Causes and effects". In this context, "Causes and effects" refer to "Interaction in living creatures", and as an example one could imagine a cartoon showing a chair kicking a ball. In this scenario the cause is the kick, and the effect is the broken window. But if we are talking about a perception system the cause is the stimulus and the effect is the Gestalt (as stated at the beginning). In our cartoon each frame (the visual stimulus) is perceived and transformed into a Gestalt (the effect) according to Gestalt laws: the chair, the ball, the house with the window, and the broken glass in the final frame. So, the meanings of cause and effect introduced in the example of interaction (the kick and the broken glass) have nothing to do with an interpretation of the perceptual system as a non-linear system.

The word chaos is used by Gestalt psychologists in its regular meaning of disorder and disorganization, but it is also used to refer to chaos theory. In chaos theory there is no such notion as chaos. There are only chaotic systems and chaotic behavior. Koffka used the term chaos in Gestalt psychology in the common sense, and long before the theory of chaos was established: "A pattern of lines if presented for the first time gives rise to the impression of chaos, replaced, as a rule, by a well-organized and articulated pattern only after we make an effort to organize the chaos." [7]. It was incorrect to apply the term chaos to the object described by Koffka, the pattern of lines, because a pattern is an organized entity (synonyms of pattern are arrangement and organization, and antonyms are disorder and disorganization). Koffka also objected to self-organization in our perception system - he claimed that perception demands an effort to organize the chaos.

The same attitude to all these previously fashionable words appeared in the introduction to the application section in the article "Chaos" in Wikipedia: "This section appears to contain unverifiable speculation and unjustified claims". The list of suspicious applications includes psychology (as well as geology, microbiology, biology, computer science, economics, finance, philosophy, and politics).

Most Massive Intrusion

As we have seen, contacts between psychologists and computer scientists were not established at the very beginning of the computer era because "Soft" scientists didn't agree to play by the rules of "Hard" sciences: that is, defining the basic notions before developing a theory. But in the XX century there was strong pressure on all "Soft" sciences to use more mathematics. In response, in all the "Soft" sciences use of mathematics became an objective in itself even though in most cases it didn't solve any problems. Surprisingly, this fashion was helped by many very qualified physicists and mathematicians. In the period after World War II, the scientific community was marked by two phenomena: 1) the extremely high prestige of physicists and mathematicians caused by the invention of the atomic bomb and computers, and 2) a deep sense of guilt felt by physicists and mathematicians for participating in the development of different kinds of arms. In such an environment many turned to human needs and humanitarian problems - to biology, medicine, sociology, economics etc. But most did not doubt that the powerful tools they were wielding were adequate to new problems. This was a mistake - a principle mistake. The reason for this mistake was that sophisticated theories and mathematical techniques were applied to existing basic notions, notions that were ill defined and didn't satisfy scientific criteria. In addition, the implementation of physical and mathematical theories was done in a crude and improper manner. Usually it was done according to the following recipe:

1) Declare Gestalt Psychology to be the first version of the theory, which has to be implemented. For example, von Bertalanfy declared that Gestalt psychology was the main contributor to the whole-parts relations problem - the main concern of General Systems Theory [8]. Haken and Studler wrote: "The earlier ideas on Gestalt theory celebrate a come back and remarkable analogies are being established with modem concepts of self-organization" [9].

2) Express classic statements using irrelevant terms from the promoted theory.

3) Use the new terms not according to their definitions, but in their every-day sense.

This intrusion looks unrespectable to psychology - even mathematical and physics references contain rough mistakes. But despite all that, the "innovations" were accepted by the scientific community without criticism. Here are a couple of examples.

One of the top-level professionals involved was professor Haken (his specialties are laser physics, particle physics, statistical physics and group theory). He developed new mathematical tools and successfully solved many physics problems. Then he invented a new science - synergetic. Prof Haken spread his "Interdisciplinary science" widely over "Soft" sciences such as economics, sociology, biology, medicine, ecology, philosophy, linguistics, neuroscience (according to a list prepared by Haken himself [10]). Here there will be reviewed the application of synergetic to pattern recognition and Gestalt theory.

Haken presented a kind of neuron network and named it synergetic computer. He illustrated the power of this invention through the problem of pattern recognition. The first problem was face recognition. The experiment was described as follows. 10 portraits were stored in the "Synergetic computer", then one of them was used for a test. The chosen image was compared by the "Synergetic computer" to all the portraits in the memory, including itself. Some "Black magic" was used and the result announced: the chosen face perfectly recognized itself! But how would an ordinary programmer resolve the problem? How would he compare two images? He would compare the brightness of each pixel of one image with the brightness of the pixel in the same position in another image. It is obvious that when comparing an image to itself the number of perfect matches will be the maximum and equal to the total number of pixels in the image. When the chosen portrait is compared to any other image the score will be substantially less than the maximum - problem solved! No rocket science, no "Synergetic computers", no order parameters, and no self-organization. The solution is so primitive because the task is primitive and has nothing to do with pattern recognition. From the very beginning the problem of pattern recognition through learning by example had the goal of generalizing empirical data in such a way that new objects (i.e. objects not present in the learning data) will be correctly classified. Haken then wanted to demonstrate more sophisticated abilities of his virtual computer and stated that the synergetic computer could restore the complete portrait from any part of a given portrait. But let us once more refer to the naïve programmer mentioned above: how would he resolve such problem? The answer is the same as when dealing with complete images: compare the chosen fragment of a given portrait pixel-by-pixel with all portraits in the storage. Take into consideration that it was not really a fragment that was used but a fragment in the frame of the complete portrait, and we know where the "Fragment" is located. Therefore, when making comparisons with the image from which the fragment was cut, 100% of matches will be positive, but when comparing with the rest of the images the number of matches would always be less than 100%. This happens because the probability that a randomly chosen image at some predefined place will have a visual pattern 100% identical to that in each fragment is negligible. It is true not only when the fragment is a part of the face, but also when the fragment is a part of the background. The only limitation for the algorithm is the size of the fragment: if it contains at least 100 pixels it will work well because the "Synergetic computer" uses the uniqueness of an image. It has nothing to do with human psychology, associative

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memory, or face recognition.

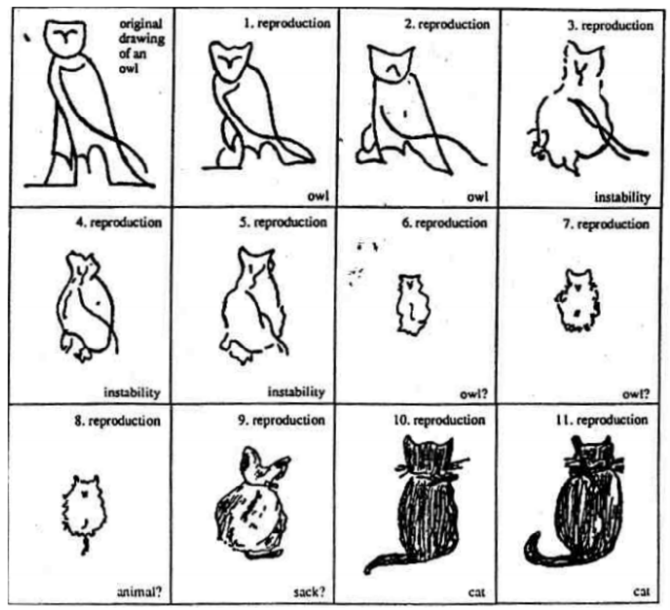
Haken approached Gestalt theory many times in different publications (including in the journal "Gestalt Theory"). As an example, let us take his article "Gestalt Phenomena" [11]: "The Gestalt idea was introduced to science by Ernst Mach and Christian von Ehrenfels. Mach stated that the spontaneous creation of order, that is, order arising without any external control, can be shown in inanimate nature. Von Ehrenfels characterized Gestalt qualities, that is higher order qualities emerging from basic elements". In this passage the words of Mach and Ehrenfels have been substituted by terms used in synergetics, system theory, and other members of the "Non-linear sciences family": spontaneous, order, external control, higher order, emergence. In these three lines the word order appears 3 times, but it is not defined in any of the theories mentioned. In the short article "Synergetics" written by Haken in the internet encyclopedia "Scholarpedia", the word order is encountered 10 times but only in the expression "Order parameter". Another word which is very popular in these sciences is "Spontaneous", but is it not true that the appearance of Gestalt is stimulated from outside by a visual or audio stimulus? The word stimulus speaks for itself. So, these terms were forcedly put in the mouths of classics.

"Wolfgang Köhler in 1920 delivered the earliest formulation of a concept of self-organization of perception [12]. The idea that perception must necessarily be understood as a process of autonomous creation of order runs through all his works." [11]. Once more, it was announced that Gestalt theory is part of self-organization theory. One can see the intrusion of strange terminology in Köhler's writings too: self-organization, autonomous, order. Is our perception autonomous? In the light of the discovery of "Mirror neurons" we understood how much our perception is oriented towards the outside world: one of the final goals of our perception is imitating the outside world.

"The phenomenal organization of the perceptual world is explained as not only stimulus-dependent, but as strongly dependent upon the perceptual system's own inner dynamics". Here Haken admits that stimulus plays a significant (but not exclusive) role in perception. This contradicts his own statement that perception is an autonomous system (see previous quotation). Our perception and the (whole nervous system) couldn't be self-organized; it was organized under the pressure of the environment to present it adequately.

"This principle (self-organization) can easily be demonstrated in cognition by recursive experiments of serial reproduction of complex patterns. These patterns follow the "Principle of pragnanz" towards very simple and stable configurations [13,14]. In perception, this principle states that people will perceive the most orderly or regular thing they can out of the stimuli that are presented to them." This interpretation of serial reproduction is completely misleading.

The serial reproduction cases. The serial reproduction procedure was introduced by Bartlett [15]. A typical Bartlett scenario evolves as follows: a test subject is given a figure and is asked to memorize it. He or she is then asked to externally reproduce it from memory, by redrawing the figure. This externally represented figure is given to another test subject and so on. The usual result of such scenarios is that after several strong fluctuations in the reproduction, the figures stabilize and do not change much from iteration to iteration. Similar experimental results were obtained by Stadler and Kruse (Figure 1) [13]. They reported that serial reproduction of random dot patterns, which were at the beginning rather irregular, tended to patterns of high Pregnanz. These final patterns were declared "Attracters", and "A neo-Gestaltian view of cognition in the context of Haken's synergetics was announced" [16].



Stadler, Kruse & Strüber (2008)

Figure 1: A series of reproductions of initial image (from [13]).

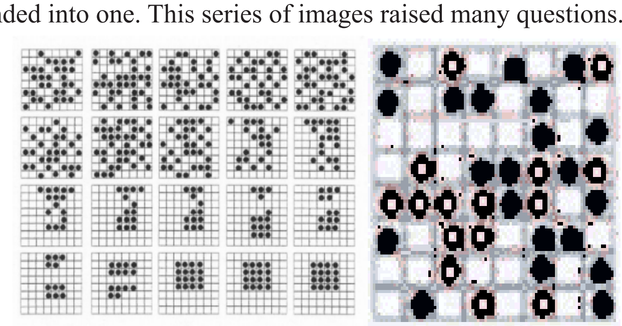
But the interpretation of Stadler and Kruse's results is wrong for many reasons.

As a scientific term attractor is a point in phase space. Because for the perception system phase space was never defined, the word attractor can be used only as a metaphor. This is one more example of an attempt to improve the scientific status of Gestalt psychology - an attempt that only discredited Gestalt psychology.

All Gestalt principles of perception deal with a sole act of perception: stimulus at the input and percept at the output. In the serial reproduction experiment each reproduction is an act of perception. Therefore, the result of the experiment refers to a complicated event consisting of many acts of perception of different stimuli connected through processes of memorizing and recollection. Consequently, this result couldn't be directly applied to the process of Gestalt perception, nor could it transform Gestalt theory into a "Neo-Gestaltian view of cognition in the context of Haken's synergetics".

In contrast to classical experiments, in serial reproduction the stimulus comes not from outside (through receptors) but from inside, through recollection and imagination. What will the subject remember after perceiving a stimulus? First, the Gestalt, and then details. For example, if the stimulus is a drawing of a cat, the Gestalt will be a generalized cat, and some individual features: spots or stripes, an adult or a kitten, color etc. What can the subject recollect after some time has passed? First the details will fade, but the Gestalt ("Cat") will stay the longest.

What could be perceived from the 1st image in (Figure. 2) (experiment of serial reproduction presented by Stadler&Kruse [13]). It is impossible to extract from this image a "good Gestalt", a short and simple description of the image. It looks random, irregular. No regularities were observed by the subject in the first row of images except the density of the dots - about 50% (36 and 32 dots). (Figure, 2) b shows the board #2 with marked positions common to boards #1 and #2. The total number of coincided black dots is 15. If one will randomly distribute 32 black dots, the estimated number of coincidences will be 16, i.e. very close to 15. It means that the configurations on these two boards are not correlated. At the 10th reproduction the density of dots drops by 1/3, and a pattern appears for the first time: three border lines become empty - the dots are concentrated in the central area. This pattern persists to the end. A new pattern appears at the 14th reproduction - two objects appear, which very soon were transformed into two horizontal rectangles (one complete, and one incomplete - enough good Gestalt for remembering). Finally, two rectangles were banded into one. This series of images raised many questions.



#1 & #2

Figure 2: a) Serial reproduction, b) The board #2 with marked positions common to boards #1 and #2 (white circles). (from [13]).

Questions about the serial reproduction case. What will be the final (stable) pattern if the same set of people repeats the procedure (serial reproducing)? Will it be the same image? What will happen if another team repeats this experiment? Will the final image be the same? What will be the final (stable) pattern if the same set of people repeats the procedure (serial reproducing) starting from another but close configuration? Will it be the same image?

There is a reasonable doubt that the answers to all three questions will be "yes". It is reasonable to presume that the authors made the same considerations, but not a single experiment of this kind was reported. Until answers to these questions are found, the proposed explanation of serial reproduction cannot be accepted.

To support the objections to the presented interpretation of the serial reproduction experiment by Stadler and Kruse, let us turn to Bartlett's example (Figure 3). From the very beginning, the subject knows that it is a human face, and that is the Gestalt that every "Reproducer" perceives. This Gestalt, as always, is accompanied by details. At the first couple of reproductions it was angularity, but by the 4th reproduction all details were gone and the restored image was an ordinary human face with no particularities of the initial image. In the next images some extra details were added (hair, ears), and then they were also gone: there is no movement to the "Attractor" - the last image.

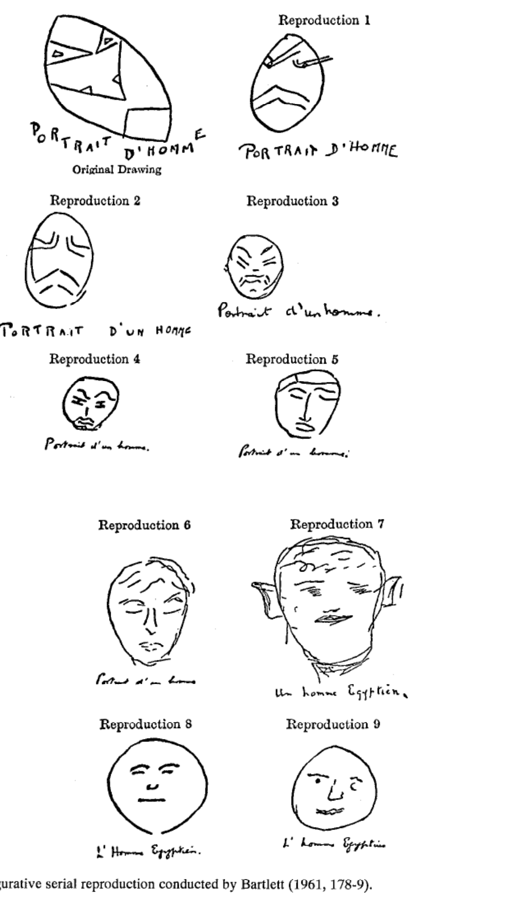


Figure 3: Bartlett's example of serial reproduction (from [15]).

This case demonstrates the same pattern in serial reproduction: as soon as the subject perceives a good Gestalt he expresses it in his drawing with some remembered details. But the Gestalt "Face" is different for different people and this individual pattern dominated at most reproduction steps. As a result, the more complicated is the Gestalt the more varied will be the sequence of reproduced images.

The third example of serial reproduction also belongs to Bartlett (Figure. 4). The initial stimulus is a picture of an owl that means "Mulak" denoting the letter "M". By making a comparison with the original, one can see the difference in the bottom part of the image: at the original there

Fig. 7.4 A Bartlett's (ibid, p 80–81) scenario of serial reproduction: an Egyptian 'Mulak' (owl) transformed into a cat

Figure 4: Another Bartlett's serial reproduction (from [15]).

are easily recognizable legs and short trousers a la Audrey Hepburn in "Breakfast at Tiffany's"? In the image used in the serial reproduction experiment the corresponding part is distorted and not recognizable. The wing is too curved; the shoulder is concaved in the opposite direction (not up but down). As a result, the perception of an "Owl" is weakened. The drawing reminds very much of a cat (see Figure. 5). That perhaps explains the fact that, at the first reproduction, standing ears appear on the drawing. It is remarkable that the ears are present in all subsequent drawings, even in reproduction 7 where nothing else is recognizable. At the next reproduction appears the tail and afterwards in all 11 further reproductions the ears and the tail are present - the crucial details which define the percept as a cat (without these details the rest is senseless).

Figure 5: Similarity in images.

As in the previous examples of serial reproduction, the Gestalt dominates. That is why in the series details sometimes appear which are absent in the stimulus (like a cat's whiskers) but are present in the Gestalt "Cat" of this particular subject. This fact leads to some speculation. When the subject observes the stimulus, he grasps the Gestalt ("Cat") and some details. After some time, he has to reproduce the stimulus. The strongest memory is of the Gestalt "Cat". The traces of the details are weaker, some of them gone. What the subject reproduces is a mix of his personal Gestalt of the "Cat" and details from the percept. At step 5 (Figure. 4) the subject reports that at the stimulus 4 with his inner eye he is seeing hair. This imaginable detail is of the same nature as invisible borders of Kaninza's triangle. In that case the subject perceived the stimulus as a white triangle over three black circles. And as soon as he perceived a triangle he knew that the triangle had definite borders, and he reported them.

All these examples do not prove that gestaltists don't understand what chaos theory is. Here is an excerpt from the book on Gestalt Therapy: "Do you know the idea in chaos theory of an attractor? An example of a chaos-type set-up is cloud formation. Every cloud is different, but there are shapes of clouds that occur. There are attractors towards kinds of ways of being a cloud, depending on atmospheric conditions, depending on the state of winds, sun, moisture in the air, sea underneath or land underneath, you will have different cloud formations, and there are recognizable types of clouds. So, I would like us to see personality expanded beyond the verbal autobiographical, in line with what Damasio is saying, to the non-verbal autobiographical way of seeing things, which is "This is the sort of shape we are, this is how we in our field forces will sort-of look" [17]. The author understands that before talking about chaos theory, phase transition, and attractors one has to define the phase space, and he did it by presenting a set of parameters which define the axes of phase space (winds, sun, moisture in the air, sea underneath or land underneath). Only after that is it possible to define different states of the system, to define phase transition (from one state to another), and to find attractors

- states of local stability of the system. It is remarkable that the author didn't attempt to identify the psychological phenomenon that he was discussing - the personality, with chaos, or attractor, or phase transition; he used the phenomenon of attractor as a metaphor.

Second warning bell. Above was mentioned the first interdisciplinary meeting (196) between top-level representatives of "Soft" sciences (including Gestalt psychology) and "Hard" sciences (mathematics, physics, computers), which was completely unsuccessful - "Soft" scientists rejected the minimal demand of "Hard" scientists to define the basic notions of psychological theories - the supposed matter of discussion. Now the opinion of a brilliant Nobel Prize-winning physicist Richard Feynman would be presented. He was not only a top-level physicist and mathematician, but a wise man as well. Here is (briefly) the story of his participation in the investigation of the explosion of the space shuttle Challenger on 28th of January 1986. He described the story in his book "What Do You Care What Other People Think?" [18].

From the very beginning for Feynman it was clear that the cause of explosion was leaks of liquid oxygen through rubber rings, called O-rings. The shuttle took off when the temperature was 28 or 29 degrees Fahrenheit. The coldest temperature before that was 53 degrees. The cold makes the rubber rings stiff: they lost elasticity. When the engine starts to work deformations appear and the rubber couldn't compensate. That was the cause of disaster found by Feynman. While the rest of the commission investigated the details, Feynman decided to investigate the general climate and culture of NASA. Concerning reliability, Feynman found that NASA management claims it is 1/100,000. An independent engineer consulting for NASA thought 1 or 2 per 100 a reasonable estimate. To the officials this evaluation was not acceptable, and Feynman's findings were excluded from the main report. But the reality proved that he was tragically right: there were 165 flights of shuttles in total and two of them exploded (Challenger in 1986 and Columbia in 2003)!

This story proves that Feynman was a smart man, and that neglecting his advice could have tragic consequences. Now follows the story of Feynman's life concerning matters, which are discussing in this paper: namely, interdisciplinary research. And God forbid us from neglecting his opinion - remember shuttle Columbia! Here is Feynman's story in his words.

"I was invited to a conference in New York. We are going to demonstrate by our efforts a way that we can have a dialogue among people of different fields. I was ready to put my hand up and say, "Would you please define the problem better". I felt that the problem "abc" had nothing to do with the problem "ABC", but "ABC" had never been defined, so there was no way for me to prove that. I was trying to define the problem, and then show how "abc" didn't have anything to do with ABC. And the reason that nobody got anywhere in that conference was that they hadn't clearly defined the subject of "ABC," and therefore no one knew exactly what they were supposed to talk about. "This conference was worse than a Rorschach test: There's a meaningless inkblot, and the others ask you what you think you see, but when you tell them, they start arguing with you! "So, in my opinion," I said, We had no dialogue among people of different disciplines at all. Instead, we had nothing but chaos!" Of course I was attacked, from all around. "Don't you think that order can come from chaos?" I didn't understand what to do with a question like "Can order come from chaos?" Yes, no, what of it? I got very upset. I'm not going to get upset like that again, so I won't participate in interdisciplinary conferences anymore."

As one can see, the symptoms of the disease are the same as in the 1950s: the subject was not clearly defined. Suggestions have been appearing for increasing the scientific status of Gestalt theory by merging the concept of Gestalt with research on system-dynamics, synergetics and chaos theory [19]. The irony is that in the outside world the terms complexity, self-organization, and synergetics lost their value. Forty years ago in Santa Fe (New Mexico, USA) the Complexity Institute was established, dedicated to the investigation of Complex systems in general, and applied in particular to the soft sciences (biology, economics, psychology etc). The main tools chosen were non-linear equations, chaos theory, general systems theory, self-organization theory and some others. They produced many papers like those cited above. Within the Institute there is a growing understanding that this was the wrong choice. Melanie Mitchell (Santa Fe Complexity Institute) wrote in 2008: "I think that, as we increasingly understand complex systems, the concepts and vocabulary we use for describing them will become much more specific, quantifiable, and useful. That is, ill-defined terms such as "Emergence", "self-organization", and "Complexity" itself will be replaced by new, better-defined terms that reflect the increased understanding of the phenomena in question. One danger is that the field of complex systems might go the way of General Systems Theory or Cybernetics. These earlier disciplines were aimed at answering many of the same questions that complex systems address. However, they got a bad name for being, as one Nobel-prize winner described," well-meant, but premature and intellectually lightweight". It's possible that in 50 years' people will similarly criticize early 21st century complexity research." [20].

Conclusion

That is the short story of relations between psychology of perception (Gestalt psychology in particular) and "Hard" sciences (physics. mathematics, and computer sciences). AI completely ignored the psychology of perception, and, to the contrary, the Gestalt community eagerly swallows the terms of new physical theories after another without understanding their meanings and using them as decorations to look scientific. As a result, AI is still in infantile age, and is missing the main characteristic of human perception - the ability to generalize. In turn, Gestalt psychology, despite the criticism from the greatest physicists and mathematicians (Einstein, Wiener, von Neumann, Feynman), today has not a single well-defined notion [21]. It means that the modern version of Gestalt psychology doesn't exist, but it does not mean that the intellectual burst generated by Wertheimer one hundred years ago was an illusion.

In his seminal paper (1923) Wertheimer defined the fundamental notion of the Gestalt theory - the Gestalt - as a short and meaningful description, which was completely ignored by his followers. He introduced (among other basic laws of grouping) the good continuation and closure laws. They reflect the ability of our perception to restore the motor acts that created in the past the present static visual stimulus. This line of investigation started when E. Mach introduced the notion of muscle sensation and Ehrenfels picked the idea up [22]. In 1899 Münsterberg introduced the motor theory of speech perception, in 1905 Stetson presented the motor theory of rhythm perception [23]. In 1918 Gelb and Goldberg published Schneider's case - the medical history of a soldier with brain trauma, which describes a completely new phenomenon: motor perception of static stimulus.

In the computer era Liberman reintroduced the motor theory of speech perception [24] and in 1976 Guberman proposed the motor theory of handwriting perception [25]. In the 1970-th the motor theories of perception were generalized into the imitation principle. At last in 1980-th the mirror neurons phenomena were discovered, which provide the functioning of these psychological phenomena. All this allows presenting the rearranged Gestalt theory [21] on the basis of a single principle, equipped with well-defined notions, and covering all Gestalt phenomena - just as Wertheimer wanted it to be.

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