Do clinicians decide relying primarily on Bayesians principles or on Gestalt perception? Some pearls and pitfalls of Gestalt perception in medicine

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POINTS OF VIEW

Do clinicians decide relying primarily on Bayesians principles or on Gestalt perception? Some pearls and pitfalls of Gestalt perception in medicine

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Abstract Clinical judgment is a foundation of medical practice and lies at the heart of a physician's knowledge, expertise and skill. Although clinical judgment is an active part of all medical fields, thus including diagnosis and therapy, communication and decision making, it is still poorly defined. It can be considered a synthesis of intuition (mainly based on Gestalt principles) and an analytical approach. Gestalt perception finds its rationale in the evidence that perception of any given object or experience exhibits intrinsic qualities that cannot be completely reduced to visual, auditory, tactile, olfactory, or gustatory components. Thus, perceptions are not constructed in a "bottom-up" fashion from such elements, but are instead globally perceived, in a more "top-down" fashion. Gestalt perception, if cautiously and carefully combined with structured (techno)logical tools, would permit one to defoliate the often too-many-branches built diagnostic trees, and help physicians to better develop their competency. On the other hand, the practice of evidence-based medicine lies in the integration of individual clinical expertise and judgment with the best available external clinical evidence from systematic research. This article is aimed at providing some general concepts about Gestalt perception, and to discuss some aspects of clinical practice potentially influenced by this approach.

Keywords Gestalt · Bayes · Clinical judgment · Perception · Electrocardiogram · Imaging

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Introduction

> ***"You never get a second chance to make a first impression"***
> Attributed to both Mark Twain and Oscar Wilde

The medical profession has been defined as "*a vocation in which a doctor's knowledge, clinical skills, and judgement are put in the service of protecting and restoring human well-being*" [1]. Clinical medicine lies within both the fields of science and art, having clinical judgement as one founding basis. Miller [2] writes that clinical judgement is "… *almost as important as the technical ability to carry out the procedure itself*". Belonging to the field of cognition, it is obviously predictable that clinical reasoning should be better developed through methods derived from psychology, neuropsychology and cognitive sciences. However, the application of scientific methods for evaluating clinical reasoning has not necessarily lead to a better understanding of the practice of clinical judgement. Clinical judgement is developed through practice, experience, knowledge and continuous critical analysis. It belongs to all medical areas, thus including diagnosis, therapy, communication and general decision making. However, there are many criticisms of clinical judgment, since many authors consider it notoriously fallacious, irrational and misleading, "… *just a smokescreen for not having read the latest issues of the New England Journal of Medicine or*

Lancet" [3]. As Kienle notes [4]: like many other aspects of medicine, the reputation of clinical judgement has been subjected to a complex metamorphosis during the past century. As such, the clinically skilled and scientifically competent doctors and their judgements were, initially, the milestones for any decision in treatment, therapy assessment and medical progress. With the emergence of modern research methodology, however, some deceptive aspects of clinical judgement were increasingly emphasized. Kienle also presumed that personal judgement would be unable to go beyond a simple post hoc *ergo propter hoc*, and could at best accomplish something like simple, intuitive, low-quality correlation statistics.

It is widely acknowledged that the use of probability in medical decision making has become more and more structured in the past few decades. The main path leading the physician from the concept of probability to the patient's bedside is Bayes' theorem. Thomas Bayes was a Presbyterian minister, but especially an English mathematician, universally known for developing a specific theorem that on simplifying states that the probability of any event is the ratio between the value at which an expectation depending on the happening of the event ought to be computed, and the value of the thing expected upon its happening. The diagnostic performance of each test is dramatically influenced by the pre-test probability, often estimated by disease prevalence. This mathematical and philosophical concept is a way of understanding how the probability of an event (or disease) can change with time and context. Bayesian reasoning first requires an estimation of the baseline (pre-test) probability of a disease before any test is ordered. A "test" could mean a physical finding, an electrocardiogram (ECG), a laboratory assay, or diagnostic imaging. Since no test is inherently perfect, they all produce false-positive and false-negative results. So, the clinician must reach a diagnostic decision based on the pre-test probability, the results of the test, and the magnitude of "skew" introduced by the diagnostic sensitivity of the test (i.e., proportion of diseased patients with a positive test) and specificity (proportion of non-diseased patients with a negative test) [5, 6].

Based on all the aforementioned issues, randomized controlled trials (RCTs) have become the gold standard for evaluation of therapies and—less commonly—laboratory and imaging testing. The principles of RCTs lie on ancient and modern philosophical and scientific statements, such as the concepts of *experiment* (Francis Bacon 1561–1626 and Galileo Galilei 1564–1642), *repetition of observations* (David Hume 1711–1776), *comparison of results* (John Mills 1806–1873), and finally, *randomization* (Ronald Fischer 1890–1962) [4]. Undoubtedly, RCTs have lead medicine to unexplored territories, making it possible to safely treat many diseases, as well as to abandon older concepts and therapies, sometimes based on myths [7]. The main drawback of indiscriminate application of RCTs is that—in daily clinical practice—we deal with a single patient, whose complaints and anthropological, social, psychological and clinical features are peculiar and hardly attributable to the general and often heterogeneous populations included in most RCTs [8–11]. Thus, the clinical approach using RCT as gold standard is currently given priority in clinical research and practice, although these studies seem rather inappropriate for complex and skill-dependent treatments [4, 12]. Unquestionably, RCTs have now reached a position of being the paradigm of mechanistic medicine, although some additional instruments have become available for evidence-based medicine (EBM), which have emerged from non-randomized studies. These are mainly represented by prognostic and diagnostic studies, and also include the use of sophisticated statistical tools for management of complex data and problems [13–16]. Kienle and Kiene observed that the model of technical rationality (i.e., the "RCTs way to Medicine") has been proven to be grossly oversimplified and only applicable to simple, repetitive and novices' situations, but not to the complexity that generally characterizes real-life professionalism [4]. Consequently, in contrast to the positivists' theories that only focus on the outcome of RCTs, the practice of medical profession has often been described as a combination of science and artistry, with its own genuine characteristics [4]. We should always remember that a minority of medical areas are covered by sufficient evidence to make the decision making really "scientific" but—contextually—we should also bear in mind that the absence of evidence is not evidence of absence [17]! Something else does exist, and the next part of this manuscript is oriented around this intriguing discussion.

General concepts on Gestalt theory

Koontz and Gunderman wrote that the Getsalt theory of modern psychology is based on the notion that holistic rather than atomistic approaches are necessary to understand the mind, and that the mental domain is somehow greater than the arithmetic sum of its components [32]. The Gestalt movement emerged in Austria and Germany around the end of the 20th century, largely through the work of Max Wertheimer, Kurt Koffka, and Wolfgang Köhler. From German, Gestalt can be translated as "whole" or "form," an apt summary of this psychological approach [18]. Atomists such as Wilhelm Wundt, one of the fathers of modern psychology, believed that perception could be broken down into discrete units, each playing a finite role in shaping the conscious experience. Gestalt theorists criticized this perspective, and argued for a more

holistic approach [18]. They believed that the perception of any given object or experience exhibits intrinsic qualities that cannot be completely reduced to visual, auditory, tactile, olfactory, or gustatory components. Koontz and Gunderman reported that Gestalt psychologists proposed the notion that perceptions should not be constructed in a "bottom-up" fashion from such elements, but are instead perceived globally, in a more "top-down" fashion [32]. They suggested that we have an innate tendency to organize sensory inputs in a manner that creates the most coherent and seamless possible perception [18]. As such, Gestalt cognition assesses the wholeness of a pattern that is irreducible to its parts, and understandably independent from its particulars [18]. For many physicians, the term "Gestalt theory" evokes several associations, including the familiar aphorism "*the whole is greater than the sum of its parts*", along with images of Necker cubes, Rubin vases, and Escher paintings. However, several principles of Gestalt psychology are ubiquitous in our daily life and work, and have played a crucial role in defining our contemporary understanding of perception. Personal experience can translate into Gestalt cognition, which can be recast into the logic of tacit thought, and can eventually translate into the tacit power of scientific or artistic genius [19]. It is just this capacity for Gestalt cognition that enables the expert's connoisseurship that is the exceptional ability to swiftly interpret situations and to exhibit outstanding performances [18].

Koontz and Gunderman reported that the term "Gestalt" is rather familiar to many physicians, especially during their training period [3, 20, 32]. For example, medical students and residents learn to develop a global impression of a patient's health status within seconds of entering the room [4]. To get to this assessment, there is not sufficient time for "bottom-up" processing, and only a Gestalt perception can explain it.

Koontz and Gunderman [32] also observed that, although Gestalt theory, does not completely explain how perception works, it elucidates several perceptual principles that remain vital to contemporary perceptual psychologists and physicians alike. As summarised by Koontz and Gunderman [32], the main principles of Gestalt theory are: (1) figure-ground relationship, i.e., an automatic feature of the visual system in which the focus of attention becomes the figure and all other visual input becomes the ground; (2) closure, i.e., our minds have a tendency to fill in empty spaces in an apparently incomplete image to create a complete and unified picture; (3) proximity, i.e., image components that are physically close to one another tend to be perceived as belonging to the same group; (4) similarity, i.e., like-appearing objects tend to be perceived as a group; (5) common region, i.e., objects or stimuli that are enclosed in a common region are likely to be perceived as a group, regardless of similarity or nearness of the constituent objects or stimuli; (6) continuity, i.e., smooth, continuous lines can be perceived more effortlessly than interrupted lines; and finally, (7) symmetry, i.e., symmetric objects or stimuli tend to be perceived as a group, regardless of their proximity [18, 21]. The Gestalt theory of perception and its related principles were originally proposed to explain how people organize visual information, so that interpretation of images is overwhelmingly the most studied aspect of Gestalt [32]. Nevertheless, some studies have also focused on auditory and tactile perception in recent years, showing some similar features regarding the Gestalt process of signal interpretation, such as the influence of grouping and shape formation in space as well as in time and, therefore, not only in vision but also in music perception [22, 23].

In the following part of this article we will discuss some aspects of clinical practice potentially influenced by Gestalt perception.

Physical examination

> ***"There is no more difficult art to acquire than the art of observation"***
> Sir William Osler, 1903, Montreal Medical Journal

We have all been trained to perform a thorough ("from hairs to toes") physical examination of our patients, and, undoubtedly, this represents the best way to obtain as much clinical information as possible. However, when approaching a patient, the physician can usually build a strong clinical impression in the initial moments, simply observing and hearing. For example, a patient suffering from pulmonary embolism can trigger a light switch in the physician's brain after a few steps coming into the room, simply because he/she looks dyspnoic. Dyspnea is in fact a potentially misleading symptom, that may be due to a wide range of clinical conditions, both physical and psychical (i.e., anxiety), and that is still poorly defined. In the past few decades, dyspnea has been defined by the American Thoracic society as "*a subjective experience of breathing discomfort that consists of qualitatively distinct sensations that vary in intensity*" [24, 25], thus emphasizing the essentially subjective nature of this important and frequent symptom that is associated with different sensory qualities (e.g., work/effort, tightness, and air hunger/unsatisfied inspiration), also varying in their unpleasantness and in their emotional and behavioral significance. Nevertheless, there are occasions upon which nothing will be found during physical examination, and it could be a case in which Gestalt perception performs better and faster than the analytic approach.

Paradoxically, it may also happen that a malignant melanoma is found on the back of the patient while listening to lung sounds during a routine control visit. In this case, probably no useful information has been perceived according to the Gestalt perspective, whereas the analytic approach has instead been decisive for the diagnosis of a highly malignant condition.

Even considering the strong diagnostic power of the combined use of Gestalt perception and analytical, structured, clinical evaluation, a number of cases remain elusive even for the skilled physician. Some of these paradigmatic cases have been published, like the report of a young and healthy woman with chest pain classified as low risk for pulmonary embolism by clinical gestalt and Wells score, who met all the eight pulmonary embolism rule-out criteria (PERC) criteria, but subsequently was proven to have a large saddle embolus [26]. Most notably, in the field of the challenging diagnostic approach to suspected pulmonary embolism, the values of both Gestalt and clinical rules have been seriously criticized [27, 28].

What clearly emerges in this brief discussion is that physicians should perform at their best both in Gestalt and analytic approaches, tightly combining both components of clinical judgement. It is also noteworthy that it is virtually impossible to diagnose everything based on clinical judgement or laboratory testing, and that sometimes "nothing is as it seems" [29].

Electrocardiogram

The ECG represents an intriguing field of knowledge, in which a highly symbolic and codified language, with its own alphabet, should be translated into useful clinical information. The ECG represents per se an exquisite example of metaphoric language. It is undeniable that when we routinely measure plasma glucose or aortic diameter, although some translational process is obviously included in the instrumentation, we are assessing "real" things (i.e., the amount of a definite analyte, the glucose, in blood or serum, or the width, measured in defined units—cm or mm—of the vessel). Conversely, when we measure Q-wave or QT interval, we are operating a translation. The ECG conventionally represents the average of billions of microscopic electrical signals (the single-cell action potentials), and each mV of difference of potential (recorded on body surface, on conventionally established sites) is represented on the *y*-axis as 1 cm, and each second as 25 mm on the *x*-axis (i.e., conventionally, the paper speed is of 25 mm/s). Thus ECG waves and complexes are nothing but an abstraction, conventionally representing the different phases of electrical activation of the whole heart, so that concluding that there are signs of myocardial infarction on the ECG is anything, but a metaphor.

Then, how can a Gestalt perception of the ECG be gathered? Currently, medical students are trained to read the ECG by teaching a sequenced lecture: frequency, rhythm, conduction, axis, P wave morphology, QRS complexes morphology, ST-T morphology, and, last but not least, analysis of eventually present U waves, J waves and so on. Indeed, when we ask one of our students to read an ECG, we actually pretend to have a sequenced lecture. Otherwise, the risk for the novice is to jump to the diagnosis at the price of missing important features. But, when discussing with skilled internists or cardiologists, the Gestalt perception of ECG is dominating: first the diagnosis, and, eventually, later the comments on single aspects of the tracing. Indeed, all the aforementioned concepts and rules (the whole translational process) need to be firmly impressed in the mind of the expert physician, so that a sort of "automated, fast, flowchart" may suddenly guide its "gestaltic" thought. However, sometimes the Gestalt-based lecture of ECG produces some pitfalls, even for the skilled physician. Two common examples are represented by the Ashman phenomena in atrial fibrillation (AF), often misinterpreted as premature ventricular beats (PVBs), and the misdiagnosis of atrial flutter (Afl) in the presence of AF with relatively high-voltage f waves (particularly when physicians focus on lead V1). Both the aforementioned errors are attributable to the principle of similarity of Gestalt theory, since the Ashman phenomena are morphologically quite identical to PVBs (that can be recognized in the context of long and short cycles of AF), and the relatively high-voltage f waves, if analyzed in only one lead (i.e., V1), can easily be misinterpreted as F waves of Afl.

The lecture and interpretation of the ECG by an expert physician may thoughtfully be considered a heuristic process. Gestalt psychologists define heuristic methods as "looking around" to guide search for information. To put this simply, it may be affirmed that heuristic methods are needed to find a proof, whereas analytic methods are needed for checking a proof. Heuristics can be more accurate than more complex strategies even if they process less information (a sort of "less-is-more" effect). With sufficient experience, people (and physicians, obviously) learn to select and use the proper heuristics from their adaptive toolbox. It is noteworthy that the same heuristic may be used both consciously and unconsciously, so underlying social as well as nonsocial intelligence [30, 31].

Imaging

Imaging is probably the field in which Gestalt perception exhibits its maximum power of guiding medical thinking, but is also an area where the principles of closure,

proximity, similarity, common region, continuity, and symmetry can lead the radiologist to a misinterpretation of images and diagnostic errors [32]. Koontz and Gunderman observed that, for example, faulty figure–ground processing in interpreting radiologic images can lead one off the right path, as the eyes are drawn to the bright heart at the center of a chest radiograph, thus making it probable that one will overlook a thorough scan of the darker and more peripheral lung fields and surrounding soft tissues [32]. Likewise, in interpreting an abdominal CT examination one may focus excessively on bright areas of contrast enhancement, while ignoring darker features such as those of a pneumoperitoneum. The principle of closure plays its role when we review and interpret sequential axial images from a CT or MRI examination. Such planar images of internal anatomy differ markedly from the 3D appearance of each organ, yet the experienced radiologist instantly perceives the whole organ morphology, which novices may find difficult or even impossible to appreciate. The principle of closure plays also a role in several imaging artifacts. Radiologists are often asked to interpret imaging studies that contain artifacts (e.g., beam-hardening artifact on a CT scan), which distort the appearance of adjacent tissues. In these cases, the Gestalt principle of closure is sometimes applied, leading both to right diagnoses and the misinterpretation of images. The principles of proximity and similarity play a pivotal role in imaging, for example in the case of mammography, when the lymph nodes nearest to the primary lesion are not necessarily the most physiologically closest. The use of sentinel node lymphoscintigraphy in staging these diseases is a creative imaging response to this pitfall. The principle of continuity plays an important role, for example, in the radiologic evaluation of cervical trauma, wherein we learn to watch four imaginary anatomic lines when reading a lateral cervical spine radiograph in a trauma patient: the anterior vertebral line, posterior vertebral line, spinolaminal line, and posterior spinal line. Using the imagination to create such mental images enables the physicians to reliably detect cervical injuries. However, when deviations from these lines are subtle, it can be difficult and often misleading in the perception of the signs of injury. The Gestalt perception is so strong in imaging interpretation that it has been demonstrated that trained radiologists are able to detect abnormalities on chest radiographs after viewing each image for just 200 ms, with a performance that is correct in approx. 70 % of cases [33].

That strange patient, having "everything or nothing"

Each experienced physician has in a personal mental archive one or more patients easily classified as "my most difficult patient: the one with nothing wrong". Many of these patients are currently diagnosed as "functional" (i.e., somatisation syndrome, somatomorphic disorder and so on, according to the evolution of the DSM), but some have subsequently been diagnosed as having a serious disorder. These patients are not a "new" problem for the medical profession. In 1927, in the *Journal of the American Medical Association*, [34] Francis Peabody wrote the following about the functional patient: "*Speaking medically, these are not serious cases as to the possibility of dying. But they are very serious with respect to the possibility of living. Their symptoms almost never are fatal but their lives will be long and miserable and at the end, their families and friends will no longer continue with them*". We think that Dr. Peabody should have added: "and the risk of missing a serious diagnosis with these patients is disturbingly high". The so-called "functional" patients are also sitting ducks for iatrogenic injury, and some paradigmatic cases, sometimes with catastrophic consequences, have been published. Recently, a case of a middle-aged woman with a low-probability, low-risk chest pain, undergoing a pernicious cascade of diagnostic and therapeutic interventions has been published (i.e., CT coronary angiography leading to coronary angiography, causing perforation of the left main trunk, leading to emergency revascularization complicated by late graft thrombosis, ultimately leading to cardiac transplantation) [35]. What should hence be clear to everybody is that a test that is not sufficiently accurate to modify the clinical management of patients should not be prescribed, since it can not only be useless, but it might also turn out to be definitely harmful [6, 36]. Both clinical Gestalt and analytic methods play against the risk of acritical ordering of more and more tests, since there is an obvious need to make choices in their own nature.

There is no single test that is able to definitely identify a "healthy status", so that emotional requests from patients who seek reassurance of being "healthy" with a large battery of diagnostic tests should not be honored [6]. In the evaluation of these patients, Gestalt perception continues to play a pivotal role, and both laboratory and imaging testing remain ancillary. Maybe, the most pragmatic advertisement for managing these patients is "… do not believe in the myth of almighty technology, but observe and take your time". The great cardiologist Bernard Lown (Nobel Prize, inventor and developer of the defibrillator, and co-discoverer of the Lown-Ganong-Levine syndrome) ingeniously concluded that "*technology is erroneously considered a substitute for time*".

Somehow, Gestalt-based medical judgement is fighting against the emerging trend of super-specialization in medicine, carrying the risk of classifying each complex and challenging patient as: "He (or she) is not mine". What an Internist should think, instead, is "this is exactly the patient for whom I have studied and I have been trained".

Conclusions

As in many other fields of human intellectual activity, almost every medical action follows two steps, in accordance with the expertise of the physician. The young, relatively non-expert physician, although spontaneously oriented toward an intuitive and heuristic thought, needs to perform an analytical evaluation first, followed by a Gestalt perception of the whole aspect of the problem.

On the contrary, the skilled, expert physician, after years of analytical evaluations of hundreds of patients, and after incorporating in a personal toolbox a number of "spontaneous flowcharts", has developed a natural and spontaneous inclination to Gestalt perception of patient's problems first, followed (when needed) by accurate systematic analysis of the single aspects of the clinical picture. It is then likely that some pathognomonic medical clues are perceived instantaneously, in a Gestalt fashion, by the experienced physicians. However, second-order reflections are necessary to assess whether or not these instantaneous impressions withstand objective scrutiny and analytical evaluation [37].

A reasonable doubt emerges, then. Is it possible to teach students and young doctors how the Gestalt perception can be enhanced and improved? In our practical experience, this remains an unresolved issue. Some recent and preliminary studies, based on data that have allowed one to localize the "gestalt function" in a specific cortical area (i.e., the temporo-parietal junction) [38] have demonstrated that it may be possible to enhance Gestalt perception using psychological and neurophysiological interventions, such as transcranial magnetic stimulation (TMS) [23, 39].

We think that Gestalt perception, if cautiously and carefully conjugated with structured (techno)logical tools, should permit one to defoliate the often too-many-branches built diagnostic trees, making it possible to apply, even in the field of modern medicine, the logical principle of the Ockham's razor ("*Lex parsimoniae. Pluralitas non est ponenda sine necessitate*"; i.e., complexity should not be assumed unnecessarily). The Franciscan friar William of Ockham (Occam) (1287–1347) was one of the first philosophers looking for a method in science, so tracing the route for Francis Bacon, Galileo Galilei and many others. His influence has been invaluable, albeit often unrecognized to date [40]. But, unfortunately, medicine is a very entropic field of knowledge, and even the Ockham's razor sometimes fails [41].

Therefore, it seems reasonable to conclude that a wise synthesis of Gestalt perception, Bayesians principles, and technology should be performed in every field of medicine, but more urgently in those fields in which the available time is limited (i.e., emergency medicine, critical care), so making real the Mark Twain's (or, maybe, Oscar Wilde's) quote: "You never get a second chance to make a first impression".

Conflict of interest None.

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