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CME article part 1: Visual perception, cognition and error in dermatologic diagnosis

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Aims:

1. Part 1: To identify and understand concepts in visual perception

2. Part 2: To recognize cognitive heuristics ("rules of thumb") that are part of visual diagnosis but also contribute to diagnostic error
3. Part 2: To describe methods to reduce and prevent diagnostic error

Part 1 Key Points:
1. Visual perception is affected by certain principles
2. Gestalt allows us to make diagnoses quickly and without effort
3. Inattentional blindness and heuristics (rules of thumb) aid gestalt but also potentially cause error

Abstract

Dermatologic diagnosis relies on vision primarily and auditory and verbal input secondarily. Accurate dermatologic diagnosis is predicated on 1) seeing and perceiving a skin finding, 2) categorizing and naming the finding correctly, and 3) comparing the visual data and data obtained from the totality of the clinical encounter (i.e., from other sensory modalities) with one's working mental database of dermatologic diagnoses. The baseline assumption – *which is false* - is that a dermatologist is expert at each of the aforementioned steps and transitions sequentially between them seamlessly in an error-free fashion. Each of these steps has inherent challenges, and the transitions between steps can also be problematic. In part one of this 2-part paper, we describe the pitfalls associated with visual recognition. In part 2, we discuss cognitive heuristics as they relate to the dermatologic diagnostic process and prevention of diagnostic error.

Introduction

The practice of medicine has traditionally been learned as an apprenticeship, with years devoted to intense learning during medical school, residency, and beyond; however, the exact factors involved in becoming an expert physician are unclear.[1] Experience and practice, real or

simulated,[2] is necessary, and Malcolm Gladwell says in his book *Outliers* that it takes 10,000 hours (5 hours/day over 6 years) of deliberate practice for true expertise to develop.[3-5] Perception and cognition are intimately related and at times inseparable in visual fields like dermatology and dermatopathology.[6] Deliberate practice in dermatology is augmented by knowledge of specific cognitive principles that affect visual perception.[6] Visual perception is complex and yet simple – we can often easily classify an animal as a "dog" rather than a "cat" despite the fact that there is no pathognomonic reason for such gestalt classification.[6] *Gestalt*, in which the whole (i.e. "dog") may be more than the sum of its parts (i.e. four legs, two ears, tail), is key to visual perception and quick classification. In this article, we will review visual perception and related cognitive concepts which underlie dermatologic diagnosis.

Key concepts (Table 1)

Visual perception is a product of the brain and may be less or more than what is actually "seen", when "seeing" is defined as the objects in the visual field. Important experiments in cognitive psychology have demonstrated time and time again that we have a limited capacity to perceive all that is around us. Our perceptual filters lead to an overall gestalt and also inattentional blindness.

Table 1: Key concepts and definitions

Key concept	Definition
Visual perception	Interpretation of what is seen visually, after processing of visual stimuli by the brain – affected by key factors which include perceptual filters, gestalt, and inattentional blindness
Gestalt	Overall assessment (the whole that may be more than the individual parts) ***Important elements of figure-ground separation***

	-Part vs. whole **-Proximity vs. similarity** **-Color**
Inattentional blindness	Inability to perceive an object that crosses the visual field, usually because attention is directed elsewhere
Bias	Systematic error that recurs predictably in particular circumstances
Heuristic*	A rule of thumb A simple procedure that helps find adequate, though often imperfect, answers to difficult questions* May be derived from a bias
System 1*	Gut assessment (characterized by *only one answer, no doubt*), fast thinking, automatic, intuitive, habit-based, involves pattern recognition **Examples:** expert thought, heuristic thought, automatic mental activities like perception (gestalt) and memory, driving a car
System 2*	Calculated assessment (characterized by *possible doubt and uncertainty)* Slow thinking, analytical, reflective, systematic, deliberate, effortful, involves decontextualization

*Kahneman D, reference 11.

Perceptual filters

Our perceptual filters limit what we perceive, leading to bias. There are many biases in medicine; two examples are confirmation bias and search satisfying bias.[7] *Confirmation bias* is the result of the tendency to look for supportive evidence and the failure to perceive findings that would refute our bias; a concerted search for pertinent negatives is helpful to avoid such bias. *Search satisfying bias* is due to the common predisposition to stop a search once something is found.[7] In addition to biases important in decision-making, personal bias is inherent within us all, and it refers to how we are influenced by our own experiences, including our geographic location, education, likes and dislikes, mood, and information from others.[8] Notably, our own biases may be the *same* or *different* from others' around us.[8] Biases are prevalent because they often help us think and can be useful as a mental shortcut, or heuristic. For example, a fungating, localized mass is more likely to be due to blastomycosis in Ohio and

coccidioidomycosis in California- these biases based on geographic location are practical. Heuristics particularly relevant to diagnosis and diagnostic error are further covered in Part 2.

Gestalt

Gestalt is a psychological term that means "unified whole", and gestalt recognition refers to an immediate, involuntary recognition of pattern. While the mechanisms behind gestalt recognition are complex and incompletely understood, such visual matching by pattern is an efficient way to learn to recognize different dermatologic diseases (Fig. 1).[9,10]

Gestalt is an example of rapid, effortless processing by the brain of large amounts of information, so-called System 1 thought.[11] Principles of perception that lead to gestalt include qualitative elements such as part vs whole, proximity and similarity, and the organization of such elements into figure-ground.[12] System 1 is at play when a dermatologist makes a diagnosis "from the doorway" or the dermatopathologist has instant pattern recognition of a slide at low magnification. Gestalt can be further confirmed or denied by System 2 thought, which is slower processing, the type of thinking we typically use when we multiply 71 x 13.[11] Dermatologists and dermatopathologists are primarily using System 2, and System 2's processing can be bolstered with mnemonics, algorithms, checklists, and lists of differential diagnoses for a given category of disease.

Part versus whole

While our brains can fail to perceive vast amounts of information, the brain also has the ability to fill in missing information. This can be to our detriment, but in general helps us navigate the world. As an example, we can read words that are missing letters

or incorrectly spelled, because our brains can correct for the missing information.[8] Similarly, in dermatology, clustered vesicles aid the perception of unilateral distribution, despite incomplete information (Fig. 2). While by no means ideal, experienced dermatopathologists can sometimes make a diagnosis on the stratum corneum alone (Fig. 3), without the majority of the epidermis.

Proximity versus similarity

The brain is trained to group things. For example, objects that are closer or similar tend to be grouped together.[12] A tendency to group by similarity (e.g. primary lesion morphology[13]) is obvious with a quick glance at any major textbook of dermatology and dermatopathology. Grouping by proximity can be a useful heuristic for rapid clinical diagnosis in many cases, common and rare, but can also lead to error in both a clinical skin examination and analysis of a microscopic slide. "Grouped vesicles" is a classic clinical example (see Fig. 2), that immediately brings to mind the category of herpetiform processes. The cognitive tendency to group is also helpful for different morphologies; for example, in Goltz syndrome, telangiectasia, flesh-colored papules, pigmented macules, and hypopigmented lesions are diagnostically unified by their location within a common streak (Fig. 4).

In dermatopathology, many disorders are defined by proximity of similar structures or cells; examples include pyogenic granuloma and sarcoidosis. Conversely, in lichenoid processes, it is now well recognized that clustering of cells within a nest (Fig. 5) does not mean that the cells are *all one type of cell, i.e. melanocytic*; immunohistochemical staining suggests that there is a mix of keratinocytes, inflammatory cells, and possibly melanocytes.

Color

Uniform color imparts connectedness and plays a large part in the brain's perception of figure, parts, and similarity.[12] Additionally, color perception is affected by surrounding colors; an identical color can be perceived as a different shade (Fig. 6).[14] This has well-known effects in dermatology; for example, the color of skin lesions is different depending on the skin type. Once skin color is accounted for, particular lesions and rashes do have characteristic colors. The eye can be trained to perceive even subtle differences in "erythema", which can vary from light pink to orange to dusky red (Table 2).

Table 2: Subtle differences in "erythema"

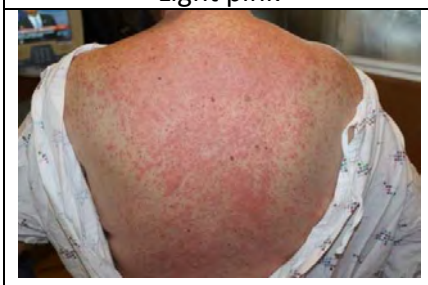
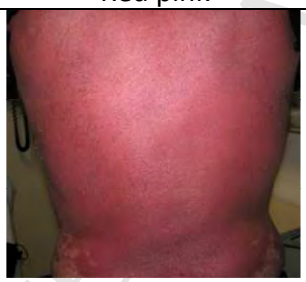
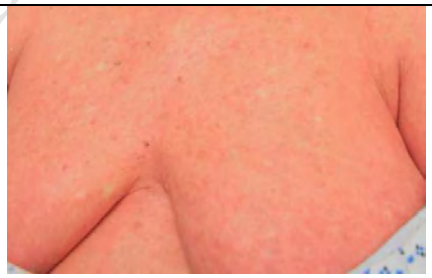
Classic color (in lighter skin)		
Light pink	Red pink	Salmon
		
Morbilliform drug eruption	Psoriasis	Pityriasis rubra pilaris

Figure-ground separation

Ultimately, gestalt separates key information from the background, i.e. the figure in the foreground from the less important background.[12] Many artists have played with this visual tendency, including artists such as M.C. Escher and Salvador Dali (Fig. 7). Training in dermatology and dermatopathology allows for quick recognition of figure (e.g. primary lesions) vs. background (unaffected skin). Occasionally, as with dyspigmentation, it can be difficult to ascertain the true figure (i.e. hypo- vs. hyper- pigmentation; Fig. 8) with examination alone. For

microscopic slides, initial classification as neoplastic or non-neoplastic is generally immediate, with recognition of a tumor as figure or inflammation as figure, respectively. Incorrect assignment of figure vs. ground can result in diagnostic error (Fig. 9).[15]

Inattentional blindness

Inattentional blindness (also known as *perceptual blindness, familiarity blindness, change blindness*) is the term given to the inability to see certain things that are in plain sight, given filtering by the brain. In a classical cognitive psychology experiment, about 50% of people, when concentrating on one task (i.e. counting basketball passes), missed a concurrent significant event (i.e. a gorilla passing through the basketball players).[16]

In a study of fully-trained radiologists who were instructed to scan computed tomographic images for abnormalities, 83% of seasoned radiologists did not notate the presence of a black gorilla in the scans.[17] While such inattentional blindness would not have altered the diagnosis, it is difficult to be sanguine about 4 of 5 experienced radiologists, expert observers, failing to discern an object that blatantly has no place in a radiologic image. This failure, however, is an expected, normal consequence of visual perception, as the brain does not perceive much of what it “sees”; eye tracking movements did indeed indicate that the radiologists in the previous study did look directly at the large gorilla.[17] While "seeing" can be defined as what crosses our line of vision, "perceiving" is the brain's heuristic processing and interpretation of what we see. We see much more than we perceive. We often, without being aware of it, are directed by our brain to overlook the unexpected, the unfamiliar, the camouflaged, and the abhorrent; this is critical for our brains to be efficient on an evolutionary

basis.[8] While it is difficult to recognize what we ourselves have overlooked in one moment in time, it is easier to note others' inattentional blindness. For example, in teledermatology or when skin examinations are presented by others, we may be able to point out important findings that others have not perceived. Microscopy is more amenable to documenting one's own inattentional blindness, as slides are static over time, and if we come to "suddenly notice" something on a second or third look, we know that it was always there. It is easy to stop observing once we have one diagnosis, and making sure to look at the patient or slide in entirety is important (Fig. 10). Taking the time to use system 2 proactively and consciously is important, mentally asking, "Could this be anything else? Am I missing anything else? Have I looked everywhere?"

Summary

Visual recognition in dermatology and dermatopathology is often instantaneous. For those new(er) to dermatology and in the case of unusual patterns, knowledge of largely subconscious cognitive heuristics (Table 3) helps increase visual intelligence, with the ultimate goal being accurate diagnosis. Conscious evaluation of pertinent positives and negatives for a given diagnosis, reassessing for what we may have missed, and taking the time to do so or ask others are necessary for deliberate practice and development of greater expertise. Part 2 of this 2- part review will address heuristics in greater detail.

Table 3: Thought processes in dermatology and dermatopathology. With greater experience, consciously evaluating a checklist is not necessary for correct diagnosis. Notably, the heuristics in this Table are only examples that may not apply to every lesion or rash; the listed order does not reflect importance as different heuristics are more useful for particular diagnoses (see Part 2).

Thought process

System 1	Gestalt (Instant recognition leading to a diagnosis)			
System 2	Conscious checklist	"2x" or "from the door" "40x" or "up close"	**Dermatology heuristics** -Overall distribution on the body -Overall pattern -Tumor vs. Infectious/Inflammatory -Uni- vs. multi-lesional -Color -Configuration -Primary lesion -Secondary characteristics	**Dermatopathology heuristics** -Location (e.g. epidermal, dermal, subcutaneous) -Neoplastic vs. nonneoplastic -Inflammatory pattern (e.g. spongiotic, lichenoid, perivascular) -Tumor: benign vs. malignant -Cell type/Cytology -Mitoses -Inclusion bodies

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Fig. 1. Gestalt - pattern recognition. Eczematous and papulosquamous are two major patterns of dermatologic disease. A,B) Allergic contact dermatitis. C,D) Psoriasis. Allergic contact dermatitis (A,B) is a classic acute eczematous pattern with vesiculation of the epidermis. Psoriasis (C,D) is the prototypical papulosquamous disorder with erythematous plaques and adherent scale. Many physicians with little dermatology training may perceive only a "rash" on the arm. *A, C, Courtesy, Yale Dermatology Residents' Collection.* B,D, hematoxylin and eosin, original magnification 20x.

Fig 2. Part vs. whole. Herpes zoster. In this photograph of the trunk, most of the body is not pictured, but a sense of unilateral, dermatomal restriction is perceived. This perception is a

cognitive illusion based on the morphology of the clustered vesicles placed within a dermatomal pattern. Dermatologists with extensive experience can appreciate that while the rest of the exam could certainly confirm unilateral restriction, similar lesions could be present more widely. In the latter situation, disseminated zoster and an immunocompromised state would be in the clinical differential diagnosis. *Courtesy, Yale Dermatology Residents' Collection.*

Fig. 3. Part vs. whole. A Seborrheic keratosis. The stratum corneum above a seborrheic keratosis has characteristically whorled keratin. B Myrmecial wart. This photomicrograph of mostly stratum corneum has rounded parakeratosis, papillomatosis, and foci with viral inclusions.

Fig. 4. Grouping. Goltz syndrome (focal dermal hypoplasia). This close-up view of the ankle shows part of a linear streak that extended down the entire leg. There are hypopigmented foci (blue arrow), telangiectasia (green arrows), and hyperpigmented macules (black arrows); the presence of these 3 different morphologies is characteristic of Goltz syndrome. Soft yellow papules (herniations of fat) and atrophy are also typical but not evident here. *Courtesy, Richard Antaya, MD.*

Fig. 5. Grouping. Pseudomelanocytic nests of a lichenoid process. The patient had bilaterally symmetric lesions over the cheeks; divorced from the clinical presentation, the microscopic findings could be misinterpreted as melanoma in situ. *A, Courtesy Jeffrey Alter, MD.* B, C, hematoxylin and eosin, original magnification 10x (B) and 40x (C).

Fig. 6. Color perception. A) Around the cylinder, the inner gray horizontal bar is all one color. The heart is all the same color but appears to be two different shades (more yellow superiorly and more blue inferiorly) depending on the background color. B-D) Eruptive xanthomas. The yellow-pink tinge to the papules on the knee is more apparent in lighter skin (B) compared to darker skin (C). The similar light blue color (arrows) aids the perception that the material (lipid) is all the same, despite being spatially dispersed. *B, C, Courtesy, Yale Dermatology Residents' Collection.* D, hematoxylin and eosin, original magnification 20x.

Fig. 7. Untitled drawing by Morton Schamberg, 1881-1918, ca. 1916, graphite on paper. Purchase, Bertram F. and Susie Brummer Foundation, Inc. Gift, 1968 (public domain); courtesy of the Metropolitan Museum of Art, New York.

Fig. 8. Figure-ground separation. Axillary dyspigmentation in pigmentary mosaicism. Occasionally, it can be difficult to ascertain if lesional skin is hypo- or hyper-pigmented. *Courtesy, Richard Antaya, MD.*

Fig. 9. Figure-ground separation. Syringotropic mycosis fungoides. In the patient's initial biopsy, eccrine gland/duct hyperplasia was extreme and the eccrine structures were initially perceived as the figure with a background of inflammatory cells (A). Ultimately, syringotropic

mycosis fungoides was diagnosed (B). Another biopsy from the same patient (C) showed enlarged eccrine units with surrounding lymphocytes. A-C, hematoxylin and eosin staining, original magnification 40x.

Fig. 10. Inattentional blindness. Superficial basal cell carcinoma (BCC, long arrows) and intradermal melanocytic nevus (IDN, short arrows). As it is relatively uncommon to have 2 different diagnoses in a small biopsy specimen, one or the other could potentially be overlooked.