Cognitive Errors in Veterinary Diagnostic Pathology
Why we make mistakes and how to manage the risk

Paul C. Stromberg DVM, PhD
Diplomate, ACVP
The Ohio State University

“Life is short, the art is long, opportunity is fleeting, experience delusive, judgment difficult.”
Hippocrates of Cos
460 BC

Cognitive Errors in Medical Diagnosis……it happens!

“Every doctor is fallible. No doctor is right all the time. Every physician, even the most brilliant, makes a misdiagnosis or chooses the wrong therapy.”
Dr. Jerome Groopman MD

Recent studies reveal that ~80% are caused by a cascade of cognitive errors, not ignorance of clinical facts.

As many as 15% of all diagnoses in human medicine are inaccurate

Lessons from Human Medicine

Because of the nature of what we do as veterinary pathologists we are insulated or “immune” to some of these errors.
We are separated from “our patients”
We have little emotional involvement.
We neither like nor dislike them.
We do not interact with them or their owners.
We usually have little clinical data.

Our errors are related to the perception and analysis of the visual patterns we see...
…but there are many pitfalls associated with this

What we see and how we think about it
Radiologists and Pathologists

Good research on errors in human radiology are highly relevant to veterinary pathologists. Currently, the average diagnostic error rate in interpreting medical images in human medicine is in the 20-30% range!

Practice of image interpretation has two components

**Perception** = We make an observation

**Cognition** = We analyze what we see, what it may mean and the possible explanations for it. (Reading our “Rosetta Stone”)

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Perception

We teach our students to 1) systematically inspect each component of the organ or tissue; 2) deconstruct the image pattern before them and 3) see the component parts. Then by analysis of all the component parts, we make a judgment and arrive at a diagnosis.

The Observation: “It’s a smart phone”

Deconstructed iPhone 6s Plus

The Interpretation: “It’s an iPhone”

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Perception

But with experience, we abandon this deliberate deconstruction of images and “see” at a glance what is abnormal = “Pattern Recognition.”

It is really confusing!!!

But different observers may “see” different patterns!
"Pattern Recognition"

An intuitive assessment based on visual data that does not occur in a linear, step by step combination of clues (Yet that is what we teach our students to do!!!)

Pattern recognition, called "Gestalt", is a very "soft" subconscious thing

Affected by:
1) innate variability of the pathologic process
2) technical aspects of the image
3) your mental state, emotions, fatigue

(What else is going on in your life when you’re looking at the image?)

"Gestalt" is heavily influenced by our own individual experiences

Lesion Pattern Variation

Lesions have a range of expression.

We learn the "classic" or "Prototype" appearance during our training then spend the rest of our lives learning the variations and becoming comfortable with the range of variation around the prototype.

"It is the ability to operate confidently in the ranges of variation that marks the experienced pathologist.

Nodular acinar hyperplasia of the pancreas
Lesion Pattern Variation in Feline Renal Lymphoma

But........
Patterns of different disease entities may overlap!!!

It's the "interpretation" of variation overlap around the prototypic lesions that leads to the divergence in diagnoses among pathologists because we all have different (but often overlapping) experience

And........
Where we make many of our errors in thinking, some of this can be mitigated by total patient evaluation and proper "framing" and additional testing (special stains, immunohistochemistry etc)
Lesion Pattern Overlap
In Feline kidneys

Prototypic LSA
Prototypic FIP

Lesion Pattern Overlap
In Feline kidneys

Prototypic LSA
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What’s YOUR Diagnosis?

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In poorly differentiated nasal neoplasia in the dog, the lesion patterns of carcinomas and sarcomas overlap and may converge.

What’s YOUR Diagnosis?
Pattern Overlap in Canine Cutaneous Spindle Cell “Tumors”

Pattern Overlap in Canine Cutaneous Round Cell Tumors

...judgment is difficult

... judgment is difficult
"Pattern ("Gestalt") Recognition"

"Pattern Recognition" is real and important and often right. It's the mark of an experienced pathologist that becomes refined over years of practice aided by remembering when you were wrong.

Doctors achieve competence by recognizing their mistakes and incorporating them into their memory.

"Identify your mistakes, analyze them, keep them accessible at all times."

Granulation tissue vs FSA

The problem for veterinary surgical pathologists is we get relatively little feedback for our diagnoses.

We are missing an important opportunity to learn "...opportunity is fleeting"

Clinicians at least see the patient again but often, we make a Dx and never learn if it was correct or not.

"Pattern ("Gestalt") Recognition"

"It can also be dangerous!"

Research shows that most medical judgment is made within seconds after perception.

(Medical experts form an opinion on average in 20 sec.)

The more seasoned and experienced you are, the greater is the temptation to rely on "Gestalt" alone.

"Cogent pathologic evaluation combines the 1st impression in pattern recognition with deliberate analysis"

"...Experience is delusive"
Cognitive Errors in Veterinary Pathology

“So it’s errors in thinking, not ignorance of facts”.

We have learned what to look for in lesions and how to record the findings. (How to translate the “hieroglyphics” on our Rosetta Stone into the language of pathology)

But…..most of the errors we make are in “How we think about what we see”

“What mistakes in thinking do we make that lead to errors in diagnosis?”

“Anchoring”

One of the dangers of “Gestalt” diagnosis = the observer does not consider multiple possibilities but quickly and firmly latches on to his “First Impression” and ignores discrepancies that would argue to reject it

We see only the landmarks we want to see and so become “anchored” to our 1st opinion

“Confirmation Bias”

= the tendency to search for or interpret new information in a way that confirms or reinforces our diagnosis and avoid or ignore information that contradicts or would lead us away from prior belief.

“Cognitive Cherry Picking”

Usually follows “anchoring” obtained in a “Gestalt” diagnosis
"Confirmation Bias"

"Describe first, then interpret"

We must work to stay uncommitted to a diagnosis until we have seen or considered all of the facts. Remember this on the Board Examination.

Ironically, this is easier for students than for experienced pathologists because students lack "Gestalt," or don't have "convictions" generated by the confidence of experience and so delay their Dx.

"Experience is delusive"

A common problem seen on the histopathology section of the ACVP exam is a candidate who decides at the top of their essay what the diagnosis is, then writes a description of that entity, rather than what is on their slides. That's "confirmation bias" in action.

"Search Satisfaction"

= The natural cognitive tendency to stop thinking when we make a major finding. The detection of one finding interferes with the detection of others.

A Well known error among human radiologists!!

In this example, observers found Elizabeth Hurley, then stopped before finding the branchial pouch cyst. A major factor in false negatives.

We test this on the board exam with "Two-fors"
Oh Thou who didst with Pitfall and with Gin,
Beset the Road I was to wander in,
Thou wilt not with Predestined Evil round
Enmesh me, and impute my fall to sin”

What’s a “Two-for”?
- A question, gross image or microscopic slide, that contains more than one diagnostic entity or lesion.

Because it happens in the real world
Because, by testing for it, it teaches
“The Standard”
Because it’s highly discriminating

Well, I’m sorry but I am afraid we will….Why?

Neonatal lamb with multifocal plaques on the skin. Everyone sees the plaques. Most overlook the sparse fleece perhaps some have forgotten how much hair a neonatal lamb should have.

Search Satisfaction
Hypotrichosis is consistently undiagnosed in this case when I present it either as a gross image or as a histopathology case. Most pathologists stop looking when they find the pustular dermatitis and Staph colonies.

Hypoplastic hair follicles with normal sebaceous glands

Pustules and Staph

False Negatives

Our minds favor the perception of “positive” data over the “negative”. We are more likely to see lesions that are present than lesions that are the result of the absence of something.

Especially if the lesion is symmetrical or diffuse. All the hair follicles in the lamb are hypoplastic.

The Paradox of Anatomic Pathology

“Sometimes the most extensive, widespread or diffuse lesion is the easiest to overlook because there is no normal for comparison.”
Everyone who looks at this image sees the edema and most diagnose lymphoid hyperplasia because of the prominent lymph nodes.

The Paradox can apply to positive data images too.

102 pathologists looked at this skin biopsy from a cow. Many saw the microbes in the crust and correctly diagnosed Dermatophilosis.

But what about this?

Only 4 pathologists saw the eosinophilic cytoplasmic inclusions in most of the basal keratinocytes and diagnosed Pox virus (incorrectly).

None diagnosed Familial Acantholysis which is the underlying disease and is almost always accompanied by dermatophilosis.

Did they suffer “Search Satisfaction”? Succumb to “The Paradox”? 

... and...
"Is the image normal or abnormal?"
"What's abnormal?"

1) Diffusely enlarged optic nerves
2) A pars intermedia adenoma

The Paradox
You have to remember that the optic nerves in horses are not normally this large.

Also the enlarged pituitary gland w/ a pars intermedia adenoma may have been "satisfying".

Bilateral diffuse granulomatous optic neuritis with Halicephalobus gingivalis
“Framing”

Focusing on what is wrong and the cause of the problem; drawing attention to what is important. Mostly for surgical pathologists, the clinician “frames” the case. **No or inadequate framing is a serious problem for surgical pathologists.** Certification exams have traditionally provided little or no framing! That is going to change!

“Framing”

It is likely that concern about improper framing or leading the pathologist astray is what motivates some clinicians to say **“Don’t tell the pathologist anything, you will bias him.”**

In reality, without some clinical clues, perception and cognition are significantly hampered. We may lead to error in surgical pathology by at least some framing of the case by clinicians. (Value of the proper submission form)

Accept the “Frame” but be aware it can mislead you. “In essence For yourself”

Tissue from a bovine

1) Morphologic Dx
2) Name the Dx
Most pathologists see the Suppurative meningitis

Vascular engorgement

"Corroborative testimony" for inflammation

3 day old calf w/ multiple external congenital anomalies

Now. What's your diagnosis?

When told there is more than one lesion, or it's "a neonatal calf with multiple external congenital anomalies", many were able to name a specific disease and saw more lesions but few pathologists see all the lesions.

Because "Framing" the case assists us in judgment.

The importance of complete case information = "Total Patient Evaluation"
Partly because of “search satisfaction”, partly because of poor or no “framing” and partly because the "lesion" is something that is mistaken symmetrical and easily overlooked.

The pathologist Dx "furunculosis w/ eosinophils" Commented that most furunculosis is infectious and that eosinophils could ~ arthropod bite

Technician (not the vet) phoned requesting clarification “Patient has "bumps" on his head and ventral abdomen did not Rx Rx-Antiab therapy.”

Pathologist explained the keratin in the Rx could drive inflammation in the face of Antiab treatment

3 skin biopsies received w/ no history [Total lack of framing]

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Then the technician asked if the dog could have follicular dysplasia.

Pathologist: “Does dog have abnormal coat color?”

Technician: “Yes”

Pathologist: “Dog likely has follicular dysplasia. Will look at slide again.”

The Sk was improperly oriented w/ few complete sections of follicles. A few follicles had abnormal melanin. In the context of complete information, pathologist made the correct Dx

What Happened?

1) Failure in “framing” the case gave pathologist no clue about clinical problem.

2) Marginal quality biopsy w/ few scattered lesions characteristic of the Dx

3) Cognitive error (“search satisfaction”) in observation w/ focus on furunculosis

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If clinician provided proper Hx and PE, and R/O follicular dysplasia.

The pathologist's attention would have been → follicles and the underlying Dx made the 1st time
"Availability"

The tendency to judge the likelihood of an event (diagnosis) by the ease with which relevant and recent examples come to mind.

Every pathologist I show this image to diagnoses FIP (maybe LSA)

What's YOUR diagnosis?

"When You Hear Hoof Beats……”

We teach our students to make the “Most likely Diagnosis” given the image or facts

“When you hear hoof beats, think horses, not zebras”

It's a good rule because most of the time "common things occur commonly". But if you get “anchored” to this idea, you will miss some unusual diagnoses.

Cryptococcosis
A word about “Zebras”

Remember that “Zebras” are a "geographically relative" concept.

While hoof beats in the USA are usually horses, in Tanzania, hoof beats usually mean actual "Zebras"

"Remember, what’s rare in some places may be common in others”

{ So sometimes when you hear hoof beats, it really is a zebra! }

Ngorongoro Crater, Tanzania 2014

"Availability"

What's YOUR Diagnosis?

K9 Pulmonary Blastomycosis

1984

1997

2012
Canine Lung Disseminated metastatic adenocarcinoma

Feline Lung

Dr. Sarah Chaney was in her 4th month of residency when she took this photo.

What's YOUR Diagnosis?

Feline Pulmonary Histoplasmosis

Texas A&M 1984
“Availability”

Feline Lung 2010

Feline Lung 2012
OSU Metastatic Carcinoma

Feline Pulmonary Histoplasmosis

Dr. Chaney, “unburdened” by experience in 2010, “Nailed” the Dx 1st

“Zebra Retreat”

= The shying away from a rare diagnosis

Powerful forces discourage “zebra hunting” in medical diagnosis

1. Cost containment
2. Zebra hunters are “showoffs”
3. Lack courage of convictions ~ lack of experience w/ rare or unusual diseases
Cat 1: Incidental finding in normal cat
Cat 2: one of 2 critically ill house cats from the same household

“Gestalt”
Availability
Anchoring
Confirmation Bias
Zebra retreat

The Law of Parsimony

Bedrock Principle of the Scientific Method
Explanation of any phenomenon should make as few assumptions as possible in the explanatory hypothesis

“All things being equal, the simplest solution tends to be the correct one.”

Applies to decision making in veterinary pathology

But...sometimes the correct answer is complex

“Diagnosis Momentum”

= A “ripple effect” through a group of pathologists.

One pathologist makes a Dx that is accepted by peers and subordinates w/out challenge. Subsequent opinions agree and soon the Dx is universally agreed upon.

**Especially if 1st Dx is by a senior or more experienced pathologist.

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Uncertainty

All observers have characteristic ways they manage the threshold of uncertainty in decision making.

1. Risk takers – have more false +
2. Risk averse – have more false –

The facts are, in medicine important decisions must be made in the face of uncertainty every day.

Uncertainty doesn’t go away as you become more experienced; you just become more “comfortable” with it.

The Evolution of Uncertainty

Pathology

Training

Board Prep

ACVP Certification

“I’m Superman”

“I can walk on water!!!”

“The Crisis Event”

“Certainty”

“Time”

“Welcome to the real world of Pathology”

“I don’t know squat” (“Oh Shit!”)

The Danger Period

Management of Risk

“Be aware of the ramifications of your error”

“I try to err on the side of least damage if I am wrong.

Know the clinical consequences of a mistake in the case at hand. Its different for different clinical diseases.

“Primum non nocere”
Uncertainty

Surgeons complain about pathologists who will not commit to firm diagnoses.  Our job is to help as much as possible.  I tend toward making a diagnosis whenever possible but am guided by the “1st Rule”

Desire to help
Give them their $$$ worth
Working with impunity as to consequences of my diagnoses; “Flying under the legal radar”

But……. I manage the risk.
Be honest with clinicians in your reporting

“Nothing competes with honesty in the surgical biopsy report”

Juggling

Juggling seemingly contradictory bits of data simultaneously in your mind while seeking other information to make a decision one way or another.

Total Patient Evaluation (Correlative Testimony)

1. Find a middle ground
2. Be aware of the cognitive errors
3. Recognize that certain patterns may not conform to prototype

“The Mark of an Expert Pathologist”

When the lesion pattern is at the extreme limit, opinions among pathologists may differ remarkably, and regardless of what they say, the certainty of the Dx is low.

Pathologists should communicate the unusual appearance or atypical pattern that does not easily fit into a diagnosis or that would likely elicit divergent opinions in the clinician can better manage the uncertainty.

Clinicians should understand the variable nature of disease patterns and that it’s a subjective opinion.

This is why two pathologists can look at the same slide and render 2 very different diagnoses.

“How can 2 board certified pathologists look at the same slide and have 2 different diagnoses?”
1. **Be aware of the cognitive traps**
   
   Know the different errors in thinking we commit and accept that you commit them.

   Management of errors begins with “Accepting your story”

2. **Slow the perception and analysis process**
   
   “Time opens the mind”
   
   (But time is the most precious commodity in medicine!!)

   Few of us have the luxury of unlimited time in performing our descriptive tasks; consult with colleagues on difficult cases when possible. Set the case aside and come back to it later.

   “Most things are better by morning”  
   Lewis Thomas

3. **Deconstruct the pattern recognition image mentally or in writing**
   
   (Just as we teach our students to do)

   Use your “Gestalt” or “Pattern Recognition” skills but check it with the facts:

   “Corroborative testimony”

   I ask myself “Does it all add up?” or “What else could this be?”

   SEW - “Can I defend this?”
4. **Describe Uncertainty** — forces you to slow down and evaluate the separate parts of the “Gestalt” image and collect your thoughts. Use a style that fits the task. Be judicious in what you describe to control effort and fatigue; focus on what is important and meaningful.

“Uncertainty stimulates description”

“The amount written is inversely proportional to the certainty of the Dx.”

“Its different for everybody”

5. **Make a mental list of DDx** & work from that.

The ECVP and ACVP certification examinations favor generating DDx lists for common diseases and lesions. They help you organize your thoughts and bring to mind what is possible or likely.

**Framing!!**Clinicians can assist by adding their list or R/O’s on the submission form.

Framing = Drawing attention to what’s important.

6. **Use the Total Patient Evaluation concept**

“Get all the pieces of the puzzle together before you interpret the “picture”

Information from a properly “Framed” case can lead you to the correct diagnosis.

It’s purposely withheld in some tasks (board exams) or omitted by others (clinicians)

“Interpret cautiously as it can also lead you down the wrong path

“Two roads diverged in a yellow wood And sorry I could not travel both…” —Robert Frost
Pathological Myopia

- the tendency to over weight the data immediately in front of you and ignore other information pertinent to the diagnosis. Especially common in surgical pathology when all you have is the glass slide.

The Judgment of Competing Uncertainties

Total patient evaluation can help to focus your thinking and assist in the decision. If not, “Take those two aspirin and look at it again in the morning.” Then seek some opinions from your colleagues.

The “Myth” of Infallibility

The Expectation of Being Perfect is Unreasonable

Long chain of events w/ multiple critical points before the pathologist even sees the case.

The vagaries and subjectivity of pattern recognition. There are going to be mistakes and some diagnoses cannot be reached by consensus.

What is an acceptable error rate? 5%?

Recent studies in human medicine indicate:

Interobserver variability ~ 20%

Intraobserver variability ~ 5-10%!!!
“And finally, there is judgment. We try to teach it to our students, but we wonder if we understand it ourselves. Sometimes the course that seems right for this particular patient today is exactly opposite of what seemed right for someone with what seemed to be exactly the same problem yesterday. If even statistics give fuzzy answers, how much more unsteady must be judgment? Were it infallible, doctors would never disagree. The problem thus distills itself down to the first aphorism of Hippocrates; judgment is difficult to learn, to apply and even to recognize; medicine has few certainties—the ancients correctly called it the Art.

Sherwin B. Nuland MD
"Doctors: The Illustrated History of Medical Pioneers"

"Life is short, the art is long.
Hippocrates of Cos, 460 BC"