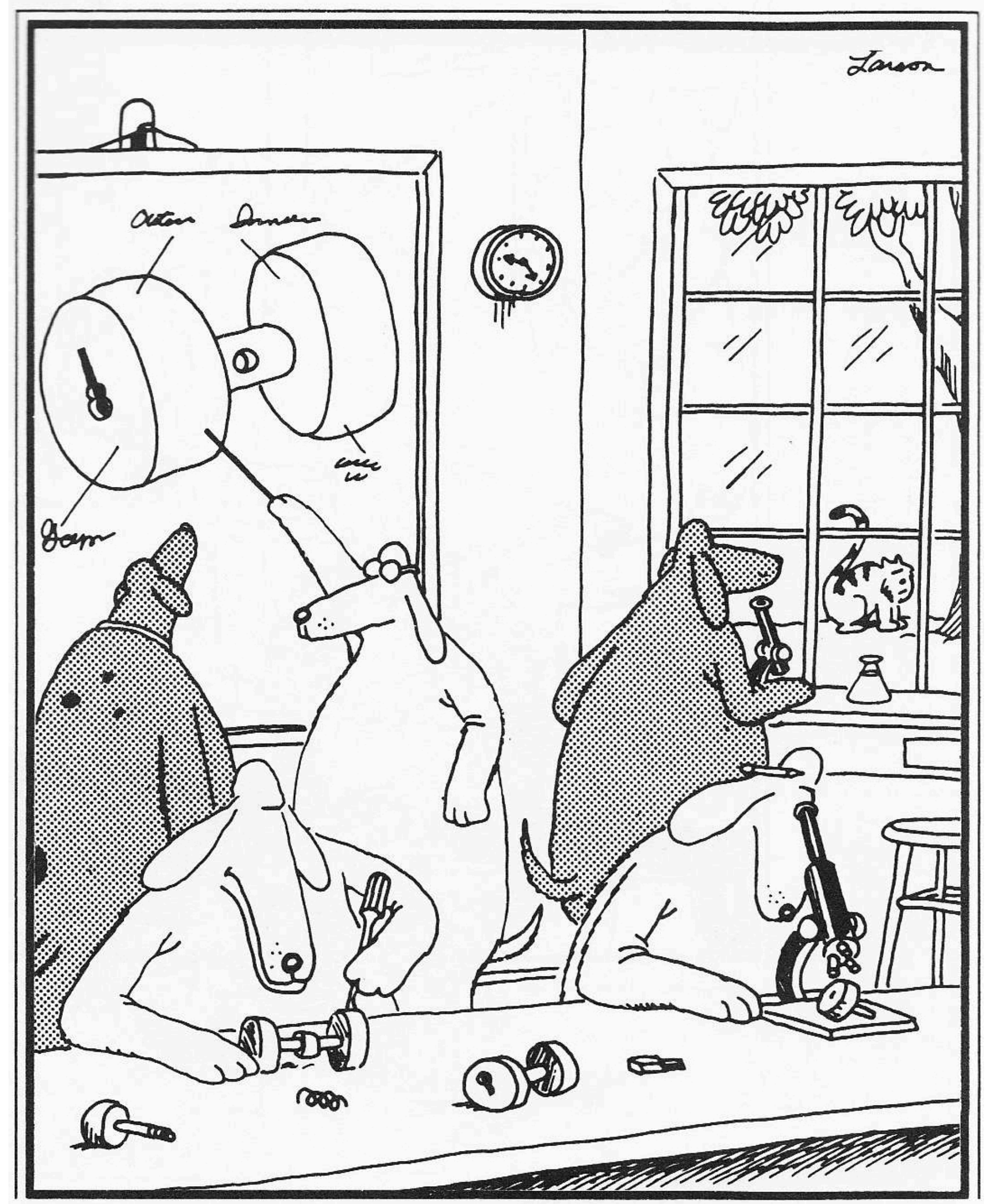

MoH 101
2014

Graduate school

Bright-eyed and bushy-tailed

- British idiom (re fox hunting)

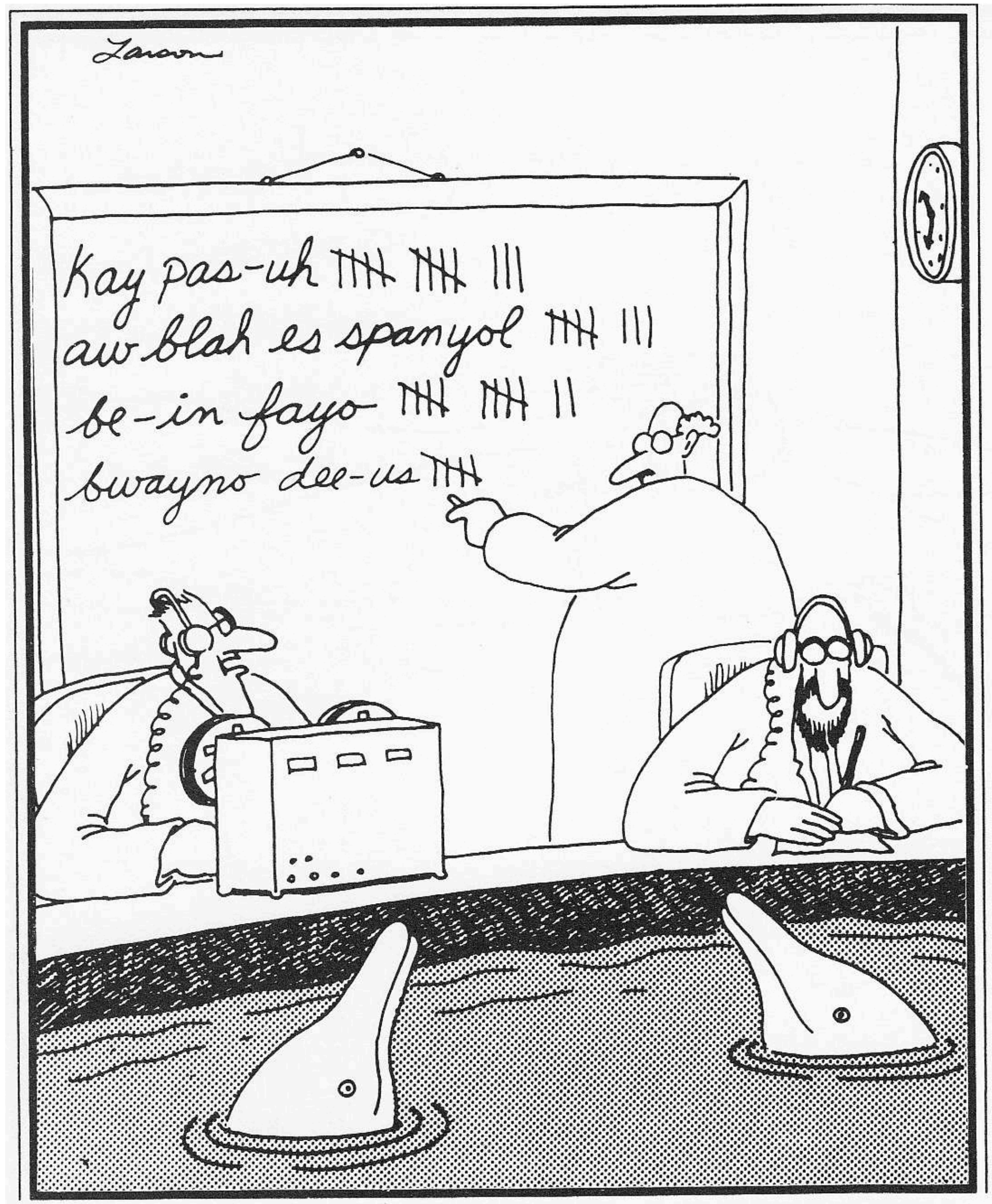


Knowing how it could change the lives of canines everywhere, the dog scientists struggled diligently to understand the Doorknob Principle.

Post-doc

"We have to remember that what we observe is not nature herself, but nature exposed to our method of questioning."

- Werner Heisenberg

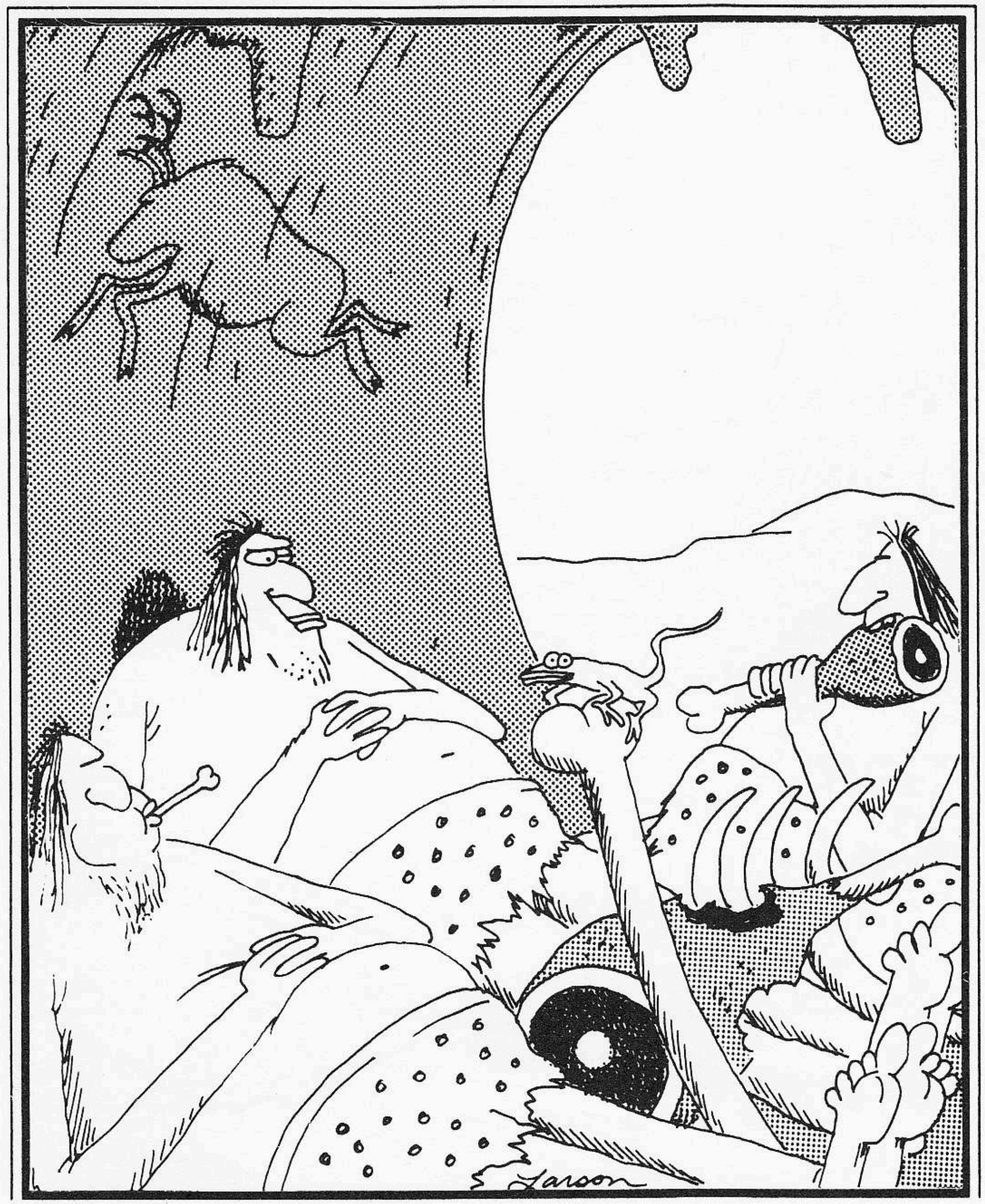


"Matthews … we're getting another one of those strange 'aw blah es span yol' sounds."

<u>Asst. Prof.</u>

"A civilized society is one which tolerates eccentricity to the point of doubtful sanity."

- Robert Frost



The origin of "dessert"

Some questions...

1. Notion of 'micro' versus 'macro'
- At what 'level' are these two separated? A spatial length? Cellular versus molecular? Systems versus cellular?
- Is there an optimal means to bridge the two? Is this ultimately a statistical mechanics problem?
- At what level does nonlinearity arise? Some sort of intrinsic nonlinear aspect(s) at the cellular/molecular levels (e.g., mechanotransduction, nonlinear capacitance)? Do additional nonlinear features emerge at a collective 'systems' level (e.g., feedback loops across a spatial region of OHCs)?

2. For various theoretical model classes of the auditory periphery, what features are they or are they not able to capture?
- For linear models (e.g., CRT), how can they account for nonlinear features such as 'suppression' methods?
- Should/can one strive to build a model that extends from sound pressure at the eardrum down to the action potentials at the level of the auditory nerve? Or would interesting aspects get 'lost' in such efforts?
- Is it worthwhile to distinguish between developing a 'computational' model and a 'analytic' one (i.e., one tractable for mathematical analysis)? For models that are heavily computational (e.g., finite element), how necessary is it to provide some degree of 'analysis' (rather than just numerical results)?
- How pervasive are concepts from linear systems theory (e.g., notion of impedance) in cochlear modeling? How valid are such, given nonlinear aspects?
- How do models at the level of a single hair cell ultimately scale 'upwards'? That is, do additional essential features only start to emerge when one considers a 'system'?

3. What 'essential' biophysical aspects do we need to consider in theoretical models?
- What is the role of inertia, given the fluid boundary layer a given hair cell bundle experiences? How does such an answer affect the notion of 'tuning'? Coupling between adjacent hair cells (i.e., elastic versus viscous)?
- In terms of 'energy flow', what distinguishes a traveling wave versus a series of coupled oscillators? How does such relate to 'slow' versus 'fast' waves? Or the notion of a 'wave' in general?

4. Comparative aspects to hearing
- What is the ideal animal to study hearing?
- In terms of better understanding human hearing, what do we learn about such by studying, say, a mouse? Or some other type of small/fuzzy/warm-blooded thing? Or a bird? Or a lizard? Or a frog?
- What do we learn about hearing by studying the vestibular system? And vice versa?
- What is the value in studying the evolutionary path(s) of hearing?

5. Other thoughts/questions:
** Outer hair cells (read: prestin) seems a unique adaptation in the cochlea, but there are alternatives to the work done by prestin, e.g. an active process associated with the hair bundle/mechano-transduction channels (frog, turtle). Related to this, what about cycle-by-cycle amplification? How is it that there is an AC response in membrane voltage at high frequencies given the "RC problem"?

Some questions...

** Tuning sharpness across species?
-> "Why is it that across many species ANF have similar Q-factors for a given CF? Does this point to a common underlying principle (i.e. not prestin), or are there alternative (perhaps complementary) mechanisms."

** Tuning from (SF)OAE delays.
-> "What happened to the traveling waves? Why is it that all of a sudden all of the delays associated with these OAEs stem from some filter, and not from actual travel time?"

** What is the optimal "design" for an auditory epithelium?
-> "Nature shows great diversity in this. We have the (mammalian) cochlea, that has a "gliding" tonotopic gradient, brought about by continuously changing physiological/physical properties (e.g. BM stiffness). The frog AP shows a similar continous gradient, but without the presence of a BM. So, is it all in hair-cell gradients? Or maybe the tect. membrane? On the other extreme we have the frog BP, where several dozens of hair cells are all tuned to the same frequency (no tonotopy). And then there are intermediate forms, e.g. the gecko where the tonotopic axis is broken down into discrete sallets. Is it that in some organs there is a concerted effort by "identical" hair cells (BP, indiv. sallets), and in other organs it is every hair cell for themselves...."

** an active power amplifier:
-> "[One] can already see AND hear Jont Allen yelling "THERE IS NO AMPLIFIER" or similar :-) But I agree, there is pretty clear evidence what happens once the OHC are gone - even though we do not yet know how in detail stuff works...but this might a good point to clarify/put together some ideas (somatic/bundle motility, role of TM, "place" of amplification, cycle-by-cycle amplification...)"

** a transducer (i.e., an auditory filter)
"People say all the time that cochlear filtering/frequency selectivity IS an auditory filter..I think this is wrong - by the way an auditory filter is measured, we can simply not deduce where along the pathway the selectivity is ultimately defined...that it is cochlear filtering ONLY is a strong assumption, maybe even speculation. But it IS used by many people and MoH might be a good forum to start getting this out of the papers... :-)

** "Another point here would be the role of "off-frequency" listening, boiling toward frequency selectivity of IHC..."

** The multiple roles a hair cell plays:
- an active power amplifier
- a transducer (i.e., an auditory filter)

- one element of an embedded system (the whole being more than the sum of the parts that is)