Neurocognitive Task Analysis: What Happens as Medical Students Develop Perceptual Abilities?

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Abstract: Cognitive task analyses help educators identify the knowledge, skills, and abilities that comprise successful performances and thereby develop relevant learning experiences. Here we argue that it is now possible, and helpful, to investigate the neuro-cognitive bases of performance.

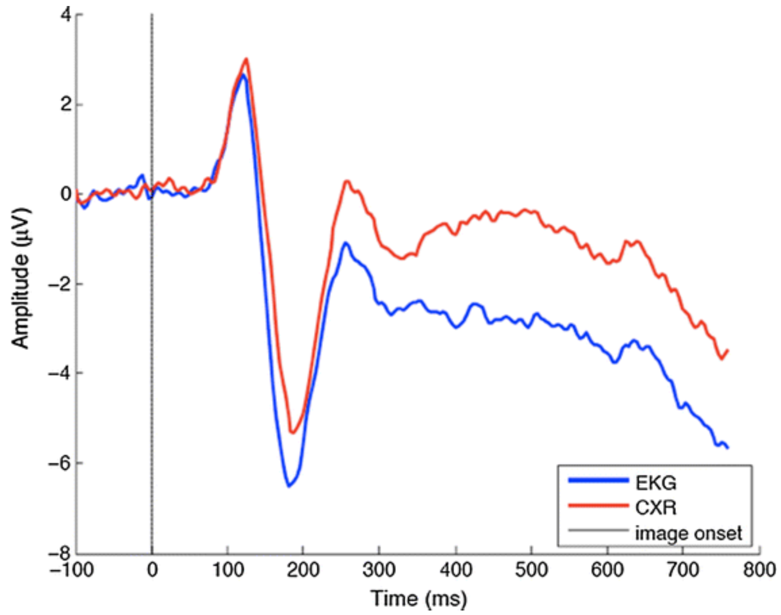
Diagnostic imaging is a central component of modern medical practice, with millions of images ordered and read daily. The differences between normal and abnormal results are subtle, and interpreting images accurately and consistently is difficult even for experienced clinicians. The ability of medical educators to impart this ability to trainees is uneven, as multiple meta-analyses have concluded (Rourke, Oberholtzer, Chatterly, & Brassard; 2015; Rourke, Leong, & Chatterly; 2018).

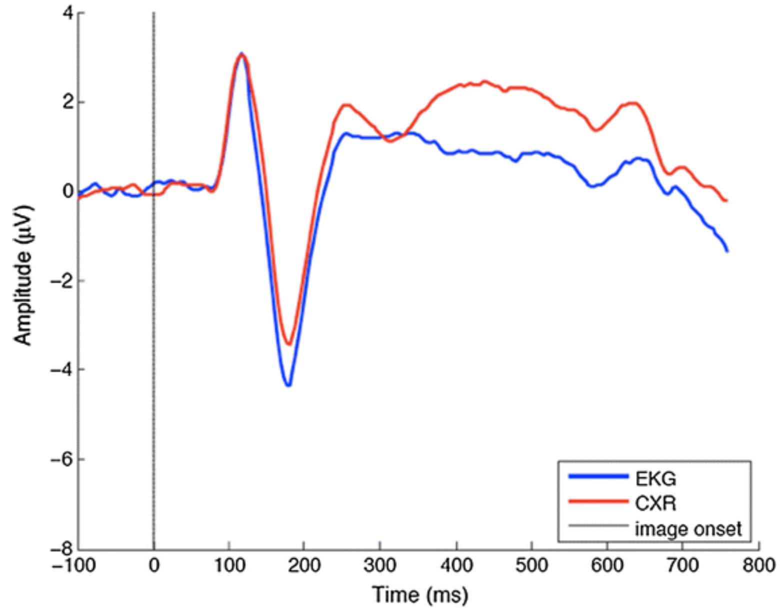
One problem, we argue, is that medical educators construe the ability as a cognitive one that draws on declarative knowledge and clinical reasoning rather than a visual skill drawing on cortical networks tuned sharply to the task. Thus, training emphasizes the acquisition of a large amount of basic knowledge along with some clinical experience, but it marginalizes the visual categorization diagnostic images.

Researchers in the cognitive neurosciences have studied visual experts from a number of domains including birders, dog-show judges, lepidopterists, handwriting and fingerprint analysts, mycologists, and chicken sexers. Some of the researchers have demonstrated convincingly that many instances of visual expertise are stimulus driven, bottom-up, forms of processing that occur very quickly after the onset of an image—too quickly to involve top-down, attentional and conceptual input in any substantial way.

If diagnostic image interpretation is isomorphic with these forms of visual expertise, training should include guided, structured visual categorization in addition to the acquisition of basic knowledge. Unfortunately, image interpretation has rarely been conceptualized or studied in this framework. Moreover, there are many reasons to think that image interpretation is different—behaviorally, cognitively, and neurally—than other forms of visual expertise. Briefly, images such blood smears or skin lesions are unlike the other stimuli that have been studied (cars, birds, dogs, etc.,) in that they do not have a natural top-bottom orientation, they are not small variations of a central prototype, and the task of the expert is not to individuate stimuli that are otherwise homogeneous.

In our study we asked cardiologists and pulmonologists to read electrocardiograms and chest xrays—one being their specialty and the other a general ability—while we recorded their brain activity using scalp electroencephalography. We found patterns of activity similar to those of previously studied visual experts while the physicians read images from their area of expertise, but not while they read the other category of images. This suggests, provisionally, that reading diagnostic images is isomorphic with other forms of visual expertise and therefore should be trained and assessed in the same manner that other types of visual experts are trained.





Figures 1 and 2. Wave plots of the cardiologists' (Fig 1) and pulmonologists (Fig 2) brain activity as they read 64 EKGs and 64 chest radiographs. The plots represent the grand average of the N170 ERP recorded at channels T5 and T6 across the 520 trials that were performed by each of the participants.

References

Rourke, L. (2018). Conditions-based learning theory as a framework for comparative-effectiveness reviews. *Teaching and Learning in Medicine*, 30.

Rourke, L. (2015). Learning to detect, categorize, and identify skin lesions: a meta-analysis. JAMA dermatology, 151(3), 293-301.

