Detecting the "gist" of breast cancer in mammograms.

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Rationale:

The visual system quickly extracts the global structure and statistical regularities of everyday scenes, allowing us to 'get the gist' of our environment before attention captures the details. Gist processing gives us an entry into the meaning of a scene: E.g. On first glance, this is a store where I might find something I want to buy. How might gist processing apply in medical image perception? E.g. This is an image in which I might find something of clinical significance.

Methods I:

To investigate this, Evans et al. (2013) presented radiologists and cytologists with normal and abnormal medical images for 250 to 2,000 msec and asked them to rate the level of abnormality and to mark the most likely location of the lesion on a blank image, after this brief exposure.

Intermediate results:

Results showed that abnormalities could be detected at above chance levels under these conditions even with subtle signs of cancer (at 500 msec, radiologists viewing bilateral mammograms d' = 1, cytologist viewing Pap smears d'=1.2). Radiologists were at chance when they attempted to localize the lesion, suggesting the gist signal is a global/texture signal, rather than an occasional lucky fixation on the lesion. Radiologist continued to perform above chance with images of a single breast. Thus, the signal is not an asymmetry between the breasts nor is it correlated with measures of breast density. Radiologists can distinguish normal from abnormal patients at above chance level even when the 'abnormal' breast is the breast contralateral to the cancer with no presence of the lesion in the image (Evans et al, 2016). These and other findings indicate that some aspect of the texture of the breast, other than the appearance of a lesion, can indicate abnormality. Is that signal present before the cancer, itself, appears?

Methods II:

Radiologists were presented with bilateral mammograms that had been acquired 3 years prior to the mammograms that showed visibly actionable cancer. Thus, the abnormal cases were “normal” mammograms from patients who would become “abnormal” in 3 years, developing breast cancer. These cases were intermixed with completely normal mammograms. Radiologists were asked to rate the abnormality of the images on a 0-100 scale after exposure for 500 msec and later rate density of the same images.

Results:

The results revealed an ability to distinguish images of the breasts of normal patients from those who would later develop cancer. The signal is small ($d'=0.2$) but statistically significant ($p< 0.001$). Even though radiologists were viewing images taken 3 years prior to any visible signs of cancer being detected, they were able to classify images as normal or abnormal at above chance levels. These decisions were not based on their breast density judgements.

Conclusion:

This further supports the hypothesis that radiologists have access to a global, non-selective signal of abnormality. If that signal could be reliably detected by humans or by computational systems, it could be a valuable part of the effort to assess an individual woman’s risk factors and detect cancer early.