Textures as Global Signals of Abnormality in the Interpretation of Mammograms

Yelda Semizer[1], Melchi M Michel[1], Karla K Evans[2], Jeremy M Wolfe[3,4,5]
[1]Department of Psychology, Rutgers University
[2]Department of Psychology, University of York
[3]Department of Ophthalmology, Harvard Medical School
[4]Department of Radiology, Harvard Medical School
[5]Department of Surgery, Brigham and Women's Hospital

Evans et al. (2016) demonstrated that radiologists can discriminate between normal and abnormal breast tissue at a glance. To explain this ability, they suggested that radiologists might be using some "global signal" of abnormality. Our study sought to characterize these global signals as texture descriptions (i.e., a set of stationary spatial statistics) and to determine whether radiologists rely on such texture descriptions when discriminating between normal and abnormal breast tissue.

We generated synthetic images representing sections of breast parenchyma using a texture synthesis algorithm (Portilla & Simoncelli, 2000) based on texture descriptions extracted from sections of mammograms confirmed via biopsy to be normal or abnormal. Because the texture descriptions of the original and synthesized sections were identical, any global statistical signals of abnormality in the original sections were also present in the synthesized sections.

Radiologists completed a task that required rating the abnormality of briefly presented tissue sections. We manipulated both the type of image (original or synthesized) and the type of tissue (normal or abnormal). Abnormal patches were extracted from cancerous breasts, and contained either the pathological (lesion-present) or non-pathological (lesion-absent) tissue. In a control experiment, BI-RADS breast density judgments confirmed that synthesized sections represented the original sections in terms of breast density.

When the abnormal tissue was non-pathological, radiologists seemed to rely on global texture descriptions; performance was similar across original and synthesized sections. However, when the abnormal tissue was pathological, radiologists seemed to use additional mechanisms beyond the texture description. In particular, the existence of a lesion increased the performance only for the original sections.

These findings confirm that radiologists can use texture descriptions as global signals of abnormality in diagnostic tasks. Further analyses reveal the specific statistical features of the texture description that constitute the global signal.