

The medical eye: Conclusions from eye tracking research on expertise development in medicine

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The medical eye: conclusions from eye tracking research on expertise development in medicine

Jarodzka, Jaarsma, Dewhurst, & Boshuizen (Open University of the Netherlands / CELSTEC)

To address the question of how visual diagnosis in the medical profession is constituted and how it develops we systematically reviewed empirical research that adheres to three premises: the comparison individuals of at least two expertise levels, the use of medical images as stimuli, and the use of eye tracking as a direct measure of visual processes. As such empirical research is still limited, lessons learned from adjacent and well established fields, such as eye tracking research on scene perception, investigations of medical expertise by means of verbal protocols, or multimedia research are included as recommendations on how to push knowledge on visual diagnosis further. Three main conclusions can be drawn on the stimulus and domain, the type of diagnostic task, and the expertise development.

First, most research has so far been conducted on radiography and mammography, which can be characterized as static, greyscale visualizations. Technical progress, however, led to daily use of far more complex images (colourful, 3D, dynamic, interactive) in clinical practice. A meta-analysis on multimedia research showed that dynamic images pose a higher burden on cognitive capacities, but when appropriately designed they are more beneficial for cognitive processing in comparison to static images (Höffler & Leutner, 2007). Indeed, studies included in this review show diverse findings depending on the type of stimulus (see below). Hence, further research should focus on more complex images. Examples on how to combine eye tracking and navigation data through medical tissue are presented (e.g., Lång et al., in prep.).

Second, research has shown that experts excel less experienced individuals in the visual search and detection performance of abnormalities in medical images. These steps, however, are only a part of the complex diagnostic process including building a mental representation based on patient data, activating, testing, and discarding illness-script, and finally yielding a diagnosis (cf. Jarodzka, Boshuizen, & Kirschner, 2012). First studies try to capture more *cognitive* aspects by combining verbal and eye tracking data (e.g., Balslev et al., 2011). Moreover, detailed *visual* processes are often only described and not statistically tested. From eye tracking research on scene perception we know that novel scanpath similarity measures allow to show statistically relevant relations between scanpath features and cognitive processing (e.g., Foulsham et al., in press).

Third, conclusions on the development of visual diagnostic expertise can be drawn. To make statements about expertise development, we considered studies that compared at least three expertise groups. Interestingly, findings depend on the type of stimulus used: for static images either no expertise differences (which may be due to too small sample sizes, though) or linear expertise effects were found on both performance and visual search were found. On more complex images, again linear expertise effects were found on performance, but on visual process measures intermediates differ from the other two groups. Such an effect is already known from medical expertise research with verbal protocols under the term 'intermediate effect' (Boshuizen & Schmidt, 1992) and should be further investigated in visual diagnosis.

In sum, based on existing research many statements can already be made on expertise development in visual diagnosis. Still, many issues remain open. To address these, this research area should get inspired by research from adjacent fields.