Review of: "Holistic processing only? The role of the right fusiform face area in radiological expertise"

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A review and appraisal of Kok et al. (2021) “Holistic processing only? The role of the right fusiform face area in radiological expertise” published in PLoS ONE.

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Kok et al. (2021) article “Holistic processing only? The role of the right fusiform face area in radiological expertise” published in PLoS ONE, describes a study in which laypeople and radiologists in training diagnosed 66 radiographs in 2s each and subsequently checked their diagnosis in an extended (10-s) period. Kok et al. aimed to investigate the specific function of the right FFA in visual expertise tasks in radiologists in training. There is indeed ample evidence to suggest that the right FFA plays a crucial role not only in face perception but more broadly in visual expertise (e.g., Gauthier et al., 2000). Kok et al., used a functional-localizer procedure to identify individual regions of interest (ROIs) for the right and left FFA and right V1.

The view underlying this study is that expertise in medical image perception reflects the ability of experts to engage in holistic or global processing of overall patterns. A variety of theoretical frameworks have incorporated “holistic” or “global” processing mechanisms as a core component of expertise in medical image perception, including the holistic model (Kundel et al., 2007), the global-focal search model (Nodine and Kundel, 1987), and the two-state detection model (Swensson, 1980).

According to Kok et al., and as elaborated in the holistic perspective, medical experts rapidly extract a global impression of the retinal image. This impression consists of a comparison between the contents of the image and the expert’s prior knowledge about the appearance of normal and abnormal medical images (i.e., the expert’s schemata). This enables experts to identify perturbations (deviations from their schemata that indicate possible abnormalities) and direct their eyes toward their corresponding locations for further (i.e., foveal) examination - a slower checking mode (Nodine and Kundel, 1987; Sheridan and Reingold, 2017). Features are subsequently scrutinized and tested against schemata to determine whether a finding is suspicious, in which case diagnostic decisions are made (Waite et al., 2017b).

Kok et al. study, however very interesting and important, raises some issues that I detail below: theoretical, methodological and interpretation of results.

Theoretically, I highlight three aspects. First, Kok et al. adopted the rigid assumption that holistic processing only occurs during the initial stage of processing an image (Swensson, 1980). Other models have instead assumed that holistic processing can continue throughout the trial, by operating either in parallel (Kundel et al., 2007; Drew et al., 2013) or recursively (Nodine and Mello-Thoms, 2000) with other types of processing. Second, the models of medical image perception espoused by Kok et al. are based on the premise that expert observers process a medical image holistically at the first glimpse. However, a Flash Preview Moving Window (FPMW) study by Litchfield and Donovan (2016), drawing from both “flash” methodology and “moving window” paradigms, failed to support the assumption that holistic processing is isolated to the initial glance at an image during medical image perception. Third, there at least two other theoretical perspectives that also contribute to explain radiologists processing of images. Selective attention to the image can be guided by information stored in long-term memory, which is gathered based on relevant experience. These memories can be retrieved relatively quickly and can strongly influence what we perceive, as proposed by long-term working memory theory (Ericsson & Kintsch, 1995). Also, experts are expected to be able to guide their attention to the target items relatively quickly and to quickly identify less relevant areas of the scene (Todd et al., 2012). This visual search strategy was defined in the “guided search” model (Wolfe et al., 1989) and later, from a more applied perspective, in the information-reduction hypothesis (Haider & Frensch, 1999). These two theories proposed to explain perceptual-cognitive skills, together with the holistic perspective may be complementary in explaining X-ray interpretation (Brams et al., 2020).

Methodologically, the study also raises some issues. Participants diagnosed 66 radiographs in 2s each and subsequently checked their diagnosis in an extended (10-s) period. It is assumed that the two second task reflects holistic processing. However, and as proposed by the holistic model of image perception (Kundel, Nodine, Conant, & Weinstein, 2007), experts are able to extract significant information about the scene with a brief glimpse (Biederman, Rabinowitz, Glass, & Stacy, 1974). This very fast extraction of the global image allows experts to access the “scene gist” (i.e., the understanding the basic meaning of the scene). During this brief glimpse, the observer is preattentively processing the scene (i.e., before intentionally attending to certain scene locations). For example, expert radiologists were able to detect 70% of abnormalities when chest films were displayed for only 200 ms (Kundel and Nodine, 1975; for similar findings see Kundel and Nodine, 1975; Carmody et al., 1980a, 1981; Oestmann et al., 1988; Gale et al., 1990; Mugglestone et al., 1995; Evans et al., 2013, 2016a; Jaarsma et al., 2014; Houghton et al., 2015), and experts were capable of detecting some nodules that were 15◦ away from their point of fixation (Carmody et al., 1980ª). The 2-second duration of the “short” task might allow participants to engage in more controlled processing of the image.”. As we have seen before, it is possible, according to certain

models, that holistic processing is ongoing throughout a trial instead of isolated to the initial glimpse, but it seems nevertheless difficult to isolate holistic processing from a two-second time window. A second methodological problem is that participants were required to check their diagnosis based on the short-presentation runs during the long-presentation runs to elicit the checking mode. Thus, the order of short- and long-presentation runs was not counterbalanced and new set of images were not used in the long-presentation runs. As the authors ackowledge, this could have caused order effects and/or effects of novelty. Finally, Kok et al. requested participants to engage in diagnostic reasoning while the image was on the screen, rather than afterwards (when the question was on the screen) to optimize when diagnostic reasoning would take place. But there seems to be no easy way of checking if this indeed happened.

A final set of problems is related to the conclusions drawn by Kok et al. The authors say that “Our results provide tentative evidence from a diagnostic-reasoning task that the right FFA supports the holistic processing of visual stimuli in participants’ expertise domain.”. However, one can identify several problems in the pattern of results found. First, Kok et al. found only tentative support for the hypothesis that. radiologists in training have higher involvement of the right FFA in diagnosing radiographs as compared to laypeople, during short-presentation trials but not during long-presentation trials. Indeed none of the post-hoc t-test showed significant differences between laypeople and radiologists in training. Second, the analyses of V1 activity cannot exclude that increased attention for the stimuli by residents compared to laypeople might explain the pattern of results in the right FFA. A third issue relates to the absence of significant correlations between the diagnostic performance and the right FFA activation level for radiologists in training either for short-presentation trials and long-presentation trials. A final issue is the absence of significant correlations between activation level within the right FFA and experience level for radiologists in training. Thus, it is rather difficult to extract a coherent conclusion about the idea that right FFA supports the holistic processing of radiographs in experts.

In sum, Kok et al. study is a valid and important contribution to the literature on radiological image processing, but there are several issues that seem to prevent strong conclusions about the role of right FFA in radiologists’ perception and diagnosis of medical images.