What are you looking at?

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Above all the practice of medicine is a discipline of direct contact; diagnosis is built on history and examination. In paediatrics there may only be a second-hand narrative so the art of recognising illness from observation alone makes it an even more appealing but challenging career. Medical education has previously concerned itself with teaching the clinical signs of illness (e.g. chest retractions) or abnormal postures or positions adopted (i.e. in a child with a dystonia) or the sounds made (i.e. stridor in upper airways obstruction). Furthermore clinically important visual or auditory patterns are not always found by directly looking at the patient. For example, it is also important to teach how to recognize the waveforms of abnormal electrical traces representing breathing (capnography) or cardiac patterns (asystole). Medical pedagogy has traditionally centred on teaching how to determine normal from abnormal by teaching *what* students needed to look at. The advent of accessible technology to adequately determine the direction of gaze has opened up a new paradigm of educational investigation in understanding *where* a person is looking and for how long, therefore helping us understand *how* to look at patients.

Gaze analysis is a technical science with a number of definitions but the key measurements involve the determination of Fixation, Dwell and Saccade (Table 1). An example of the interplay between these is demonstrated in Figure 1. There are multiple locations you can look (fixation) and for different lengths (dwell) in a given patient or image and gaze analysis

(typically investigated by the user wearing specially designed goggles) provides a way of measuring this.

Table 1 Descriptions used in gaze analysis

Term	Description
Fixation	Essentially the time the eye is in a certain position, measured by the time the eye is still (this is not exactly the same as the time information is processed but is a reasonable surrogate) This can be a time measure or a count measure – the latter being the number of times the eye is still on the area of interest.
Dwell	This is a gaze or glance at a certain area of interest. Dwell time would be the amount of time spent looking at one area of a chest x-ray for example
Saccade	These are the movements of the eyes between fixations in which information is not meaningfully acquired or absorbed.

Figure 1 Eye movements of one student studying a chest radiograph. Circles are fixations; the size of the circle represents its duration. The lines between the circles are saccades

Image via Kok E, Jarodzka H. Before your very eyes: the value and limitations of eye tracking in medical education Medical Education 2016, Volume: 51, Issue: 1, Pages: 114-122, DOI: (10.1111/medu.13066)

Eye-tracking is an established science in the airline industry where novice pilots are taught how more experienced pilots look at flight dashboards. This makes sense given the huge amount of data there is available in the cockpit. Given the human body, and its associated data streams, are even more complex it is perhaps surprising there hasn't been a school of thought that we should be teaching in this way. While "Airway, Breathing and Circulation" is a mantra of resuscitation management we don't know if there is a sequence of gaze that experts use to make diagnoses. Two articles recently published will start to help us answer this question.

Katz and colleagues [1] performed a feasibility exercise on the use of wearable eye tracking glasses during the simulated resuscitation of a neonatal manikin using a respiratory function monitor. This is important work as it is all too easy to get excited about new technology to find it's just not practical in clinical application. Of note, and supported by this authors own personal experience, the tracking devices can't accommodate glass wearers (which are not an insignificant number of the medical profession). Hopefully this minor delivery issue will be ameliorated as equipment improves and becomes more widely available.

Katz and colleagues showed wearing eye tracking devices was feasible and successful but highlighted an initial challenge with the educational application of gaze analysis *"visual attention doesn't necessarily mean cognitive focus"*. This is an important consideration for ongoing research in this field. Qualitative feedback from participants will be important and determining some core outcomes specifically for gaze analysis would be a useful initial collaborative exercise.

McNaughten and colleagues [2] examined the differences between Paediatric trainees, General Paediatric consultants, Paediatric Intensive Care (PICU) consultants and Paediatric Emergency Medicine consultants when managing a mannequin in ventricular fibrillation (VF) secondary to a tri-cyclic antidepressant overdose. The fixation count and dwell time were calculated for four pre-identified areas of interest (the airway, cardiac arrest algorithm, chest of the child and the defibrillator). Using gaze analysis equipment they determined the PICU consultants spent more time looking at the chest of the child than other groups and

their time to delivery of an adequate shock was faster. This is in keeping with the likely frequency they may be seeing this particular condition but it also fits with a theoretical construct for how visual images are processed when making diagnostic decisions. Thomas Balslev has previously described a sequence used by paediatric neurologists when classifying seizures which ranges from data exploration (where the important movements are occurring), to theory building (describing those movements) to theory evaluation (determining what the movement pattern is consist with) [3]. In studies of experts (paediatric neurology consultants) reviewing patient video cases it was found they explored data less and evaluated more hypotheses in a given space of time than novices [3]. From the perspective of the PICU consultant the data exploration phase is very prompt and theory building is almost intuitive (the pattern recognition of VF will be unconscious to them). The gaze analysis software allows us to quantitatively measure this, an important tool in being able to understand decision making processes which have hitherto been conceptual [4]

A new field of investigation into decision making has now been opened up. With the increasing acceptance of Human Factors science and theory it is likely we may see more rapid translation of these study findings into practice than previous exploratory medical education research has done. The challenge will be rigorously testing hypotheses and avoiding taking correlation as causation. If your gaze pattern as an expert is at odds with other experts, what would this mean for your practice and is a prompter acquisition of gaze processing as a student a good determinant of specialty potential?

References

1. Kautz T, Nadkarni, V, te Pas A, Foglia E. Identification of visual attention patterns on a neonatal respiratory function monitor. Arch Dis Child F& N
2. MCNaughten B, Hart C, Gallagher S, Junk C, Coulter P, Thompson A, Bourke T Clinician's gaze behaviour in simulated paediatric emergencies.
3. Arch Dis Child Balslev T, Jarodzka H, Holmqvist K, de Grave W, Muijtens AM, Eika B, et al. Visual expertise in paediatric neurology. Eur J Paediatr Neurol 2012 Mar;16(2):161-166.
4. Roland D, Snelson E 'So why didn't you think this baby was ill?' Decision-making in acute paediatrics Archives of Disease in Childhood - Education and Practice Published Online First: 01 March 2018. doi:10.1136/archdischild-2017-313199