Université de Montréal

Show me what you see

An easy way to assess thoracic imaging learning

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Introduction:

We have developed an innovative e-learning strategy for the development of visual perceptual skills and clinical reasoning.
The thoracic imaging learning by concordance of perception is now part of the program of our 300 students in the 2nd year of medicine.
Following short clinical vignette, student has to delineate online the abnormality observed on chest X-ray in order to access to the feedback prepared by the instructor.
The digital assessment of the visual perceptual skills can be used in several application fields in which it needs to be explored.

Objectives:

1. Test the validity and reproducibility of the digital evaluation of the visual perception skill.
2. Evaluate the visual perception skills of a group of students during a thoracic imaging training.

Methodology:

A. 292 students surrounded areas on the chest X-rays of 2 clinical cases on both the postero-anterior (PA) and lateral (LAT) views :

- **Case A**: **Right Lower Lobe Pneumonia**
- **Case B**: **Posterior Mediastinal Mass**

B. The responses of 50 randomly selected students were subjected to the instructor's visual assessment for each view of the 2 clinical cases above, for a total of 4 images.
The instructor evaluated the students using a 4-level scale: **Success** / **Acceptable** / **Insufficient** / **Failure**

C. Afterward, the selected areas of each each student have been digitally assessed by comparing them to the targeted areas defined by the instructor.
Overlapping and non-overlapping areas are the cornerstones of this numerical evaluation of pixels.

D. The final digital score (%) assigned to the areas surrounded by each student was calculated using the following formulas :

Dice Similarity Coefficient DSC

$$\left(\frac{2 \times \text{Overlap between Learner and Authors Areas}^{\text{Pixels}}}{\text{All Learner Area}^{\text{Pixels}} + \text{All Authors Areas}^{\text{Pixels}}}\right) \times 100$$

Dice, Lee R. (1945) – Ecology. 26 (3) : 297-302
Sorensen, T. (1948) – Kongelige Danske Videnskabernes Selskab. 5 (4) : 1-34

Instructor's digital score IDS

A. If Area of Authors decreased by the ***Error tolerance threshold*** is included in the Learner Area and Learner Area in included in Area of Authors increased by the ***Error tolerance threshold***:
Assessment in % =100%

B. If Overlap between Learner-Authors Areas >= 80% and Non-Overlap Learner Area <= 20%
Assessment in % = 100%

C. If Overlap between Learner-Authors Areas >= 80% and Non-Overlap Learner Area > 20%
Assessment in % =

$$\left(\frac{100}{100 + \%\text{ of Learner Area which is out out of Authors Area}}\right) \times 100$$

NB: Assessment = 0% if the Learner Area is 3 times larger than Authors Area

D. If Overlap between Learner-Authors Areas < 80% and Non-Overlap Learner Area <= 20%
Assessment in % = % of overlap between Learner-Authors

E. If Overlap between Learner-Authors Areas < 80% and Non-Overlap Learner Area > 20%
Assessment in % =

$$\left(\frac{\text{Overlap between Learner and Authors}^{\text{Pixels}}}{\text{All Learner Area}^{\text{Pixels}}}\right) \times 100$$

NB: Assessment = 0% if the Learner Area is 3 times larger than Authors Area

F. If no overlap between Learner and Authors Areas:
Assessment in % = 0%

E. Then a comparison has been done between the instructor's visual assessment, the **Dice Similarity Coefficient** DSC and the **Instructor's Digital Score** IDS . v
F. Finally, after defining the digital score (%) which best correlate to "**Success**" or "**Fail**" instructor's assessment for each of the 4 images, we determined the rate of success and failure of the cohort

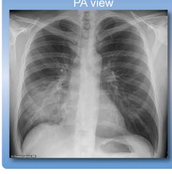
Results:

For 50 randomly selected students
Instructor's visual assessment / DSC/ IDS

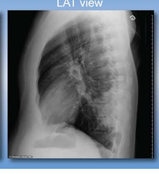
Extrapolation of results
for the entire class of 292 students

Case A: Right Lower Lobe Pneumonia

PA view



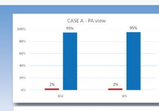
LAT view

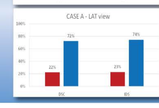


Cohort A

PA view	N	DSC (Min - Max)	IDS (Min - Max)
Failure	4 (8,0%)	0-2%	0-3%
Success + acceptable	42 (84,0%)	60%-92%	43%-100%

LAT view	N	DSC (Min - Max)	IDS (Min - Max)
Failure	9 (18,0%)	0-1%	0-2%
Success + acceptable	40 (80,0%)	63%-93%	54%-100%





Case B: Posterior Mediastinal Mass

PA view

LAT view

Cohort B

PA view	N	DSC (Min - Max)	IDS (Min - Max)
Failure	28 (56,0%)	0-21%	0-27%
Success + acceptable	22 (44,0%)	45%-92%	33%-100%

LAT view	N	DSC (Min - Max)	IDS (Min - Max)
Failure	16 (32,0%)	0-13%	0-1%
Success + acceptable	32 (64,0%)	38%-69%	27%-76%

Calculation of correlations between Kendall's Tau b coefficient
for students classified as "**Success**"or "**Failure**" only (n = 135)

	DSC	IDS
Instructor's visual assessment	0,75	0,77
IDS	0,92	

"**Success**" and "**Acceptable**"
"**Failure**"

Discussion:

- The digital assessment of the areas delimited by the students of **cohort "A"** and **cohort "B"**, either by the **Instructor's Digital Score** IDS or by the **DICE Similarity Coefficient** DSC are well correlated with the visual assessment regarding the students in both case of "**Success**" and "**Failure**".
- The definition of the criterias separting the "**Acceptable**" and "**Insufficient**" performance remains problematic for the visual evaluation of the instructor, and hence for the choice of the indexes of the automated scores separating the students in one category or the other.
- The delineations drawn by the students of **cohort "B"**, whether assessed by digital process or by the instructor's visual appreciation, reveal very lower success rates than the ones of **cohort "A".** This was an expected result considering non -knowledge of this pathology by 2nd year students and the lack of clinical clue leading to this discovery, rather fortuitous.

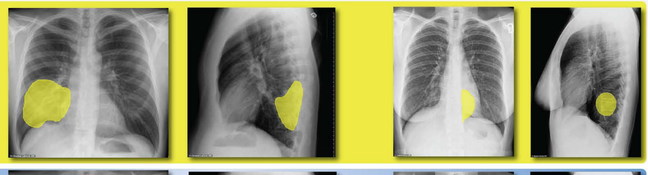
Conclusion:

- For undergraduate students, automated analysis of perceptual concordance test results discriminates students who successfully recognize an abnormality on chest imaging or do not recognize it at all.
- The automated analysis of results in the Concordance of Visual Perception allows to quickly identify students with significant perceptual difficulties or radiographs on which an abnormally high number of students fail.
- Considering the level of knowledge of the students and the complexity of the cases submitted, the digital assessment of areas delimited by the students can be modulated by granting a different threshold of passage.

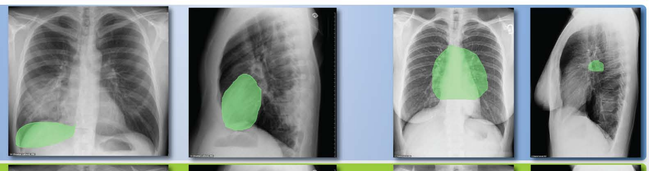
Examples:

Case A: **Right Lower Lobe Pneumonia** — **Case B**: **Posterior Mediastinal Mass**

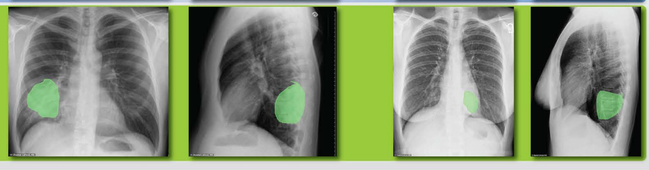
A. Example of "**Success**"



B. Example of "**Failure**"



C. Example of "**Acceptable**"



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