

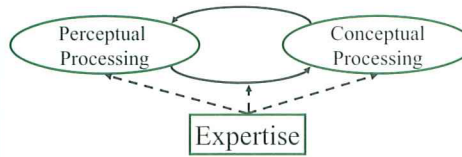
Expertise in Interactions of Perceptual and Conceptual Processing

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1. Introduction

Medical image diagnosis is a task in which a physician makes a diagnosis while viewing medical images such as radiography or CT (Computed Tomographs) images.

Medical image diagnosis involves two activities
 Perceiving abnormal findings on a medical image (**perceptual processing**)
 Making a diagnosis about what disease affects the patient. (**conceptual processing**)



The aims of research

1. To investigate the development of expertise in CT diagnosis
2. To reveal the nature of the interactions between perceptual and conceptual processing

2. Experiment

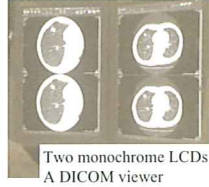
2.1 Materials

The experiment was performed in a room located in the radiology department at Nagoya University, where participants in our experiment usually work.

In the experiment, participants were required to make "differential diagnoses of lung nodules."

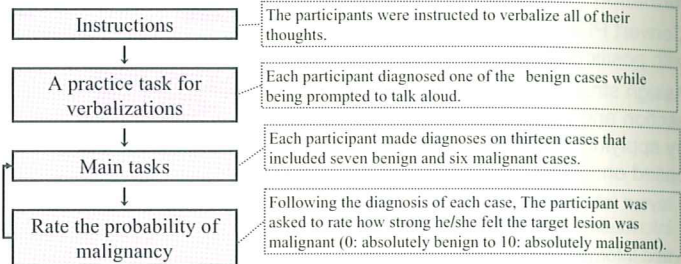
Participants	
Novices (n = 5) (Residents)	Experts (n = 5) (Radiologists)
Materials (Cases)	
Benign cases (n = 8)	Malignant cases (n = 6)

Devices for viewing CT images



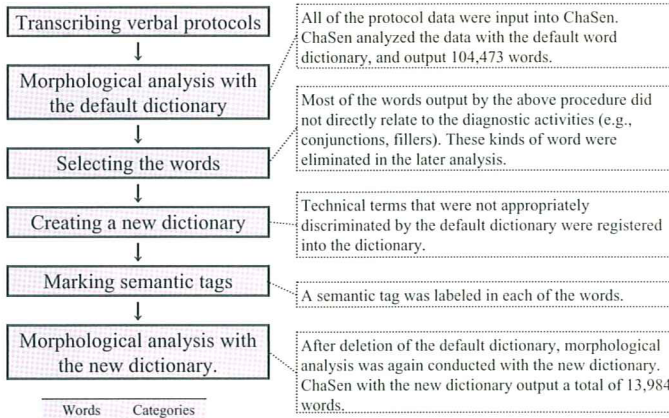
2.2 Procedure

The experiment required a total of two to four hours, which was divided into the four stages.



3. Protocols analysis

We developed a *semi-automatic protocols analysis method*, in which the Japanese morphological analysis system ChaSen was used.



Outputs of ChaSen with new dictionary

Words	Categories
S8	Region
S10	Region
Right-lung	Region
S10	Region
Nodule	Percept
Spicula	Percept
...	...

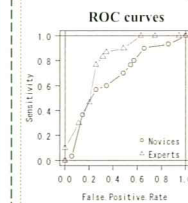
Categories	Examples
Percept	small, large, round, polygon, spiculation... (338 words)
Concept	tuberculosis, Lung cancer, post surgery... (143 words)
Region	right/left-lung, S1, S2... (166 words)
Goal	window-level, HRCT... (15 words)

Four categories of tags

4. Results and Discussions

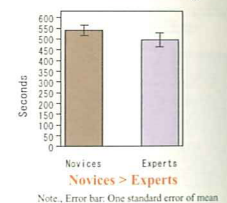
4.1 Performance

4.1.1 Accuracy of diagnosis



Areas under ROC curves
 Novices < Experts
 Novices = 0.69
 Experts = 0.79

4.1.2 Time to make a diagnosis

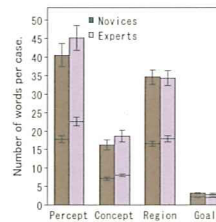


Note. Error bar: One standard error of mean

The experts were superior to the novices in CT diagnosis.

4.2 Results of protocol analysis

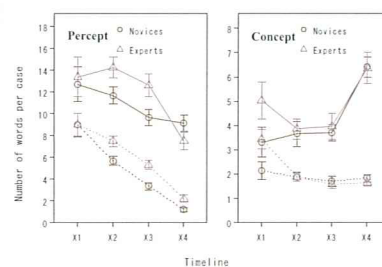
4.2.1 Overall patterns of tagged words



The experts verbalized more types of "Percepts" and more types of "Concepts" than novices.

Note: Upper value of each bar: Mean numbers of words per case
 Lower value of each point: Mean numbers of different types of word per case
 Error bar: One standard error of mean

4.2.2 Tagged words in the earlier and later diagnostic processes



Note: Upper value of each point: Mean numbers of words per case
 Lower value of each point: Mean numbers of different types of word per case
 Error bar: One standard error of mean

The novices: Perceptual processing \Rightarrow Conceptual Processing
 Serial bottom-up process (a decrease of "Percepts" and an increase of "Concepts" from the earlier to later phases)
 The experts: Perceptual processing \Leftrightarrow Conceptual Processing
 Interactive processes (conceptual processes in the earlier stages)

5. Conclusions

The results of protocols analysis demonstrated that the development of expertise changes both perceptual and conceptual processing (4.2.1).

Also, our study revealed effects of expertise on the interactions between the two components (4.2.2).

We consider that our study has a methodological implication in protocols analysis studies (3).