



Intelligent Information Processing Systems Creating Co-Experience  
Knowledge and Wisdom with Human-Machine Harmonious Collaboration



# Quantified Learning by Deeply Sensing Learner's Behavior

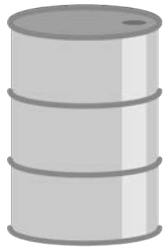
July 11, 2018

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# Resources



Natural



Money



Goods

free market  
such as Mercari



Work

crowdworks



anything unexplored?

# Experience as Resource

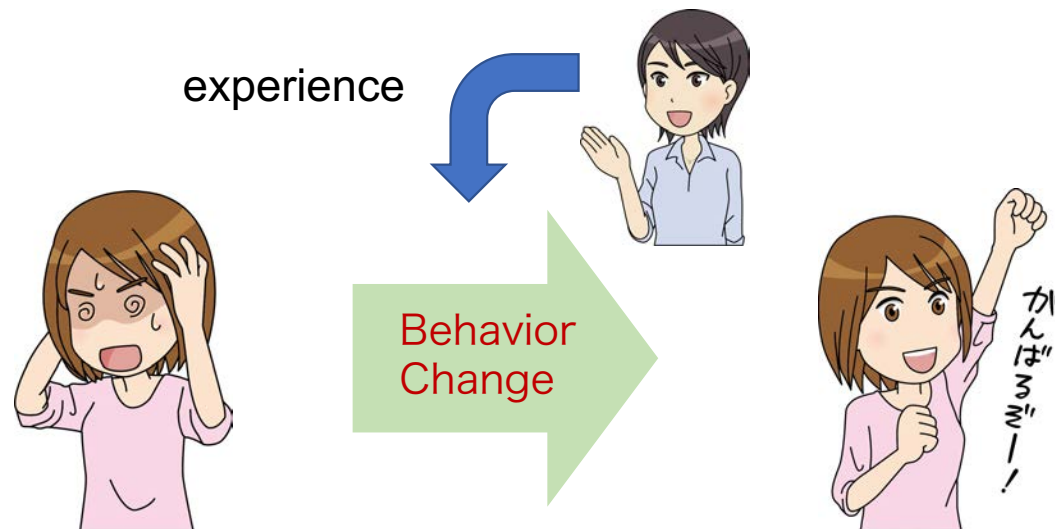
- Big data fuels artificial intelligence
- Experience fuels natural intelligence
- Can be generated only by humans
  - cannot be generated by AI

## Experiential Supplements

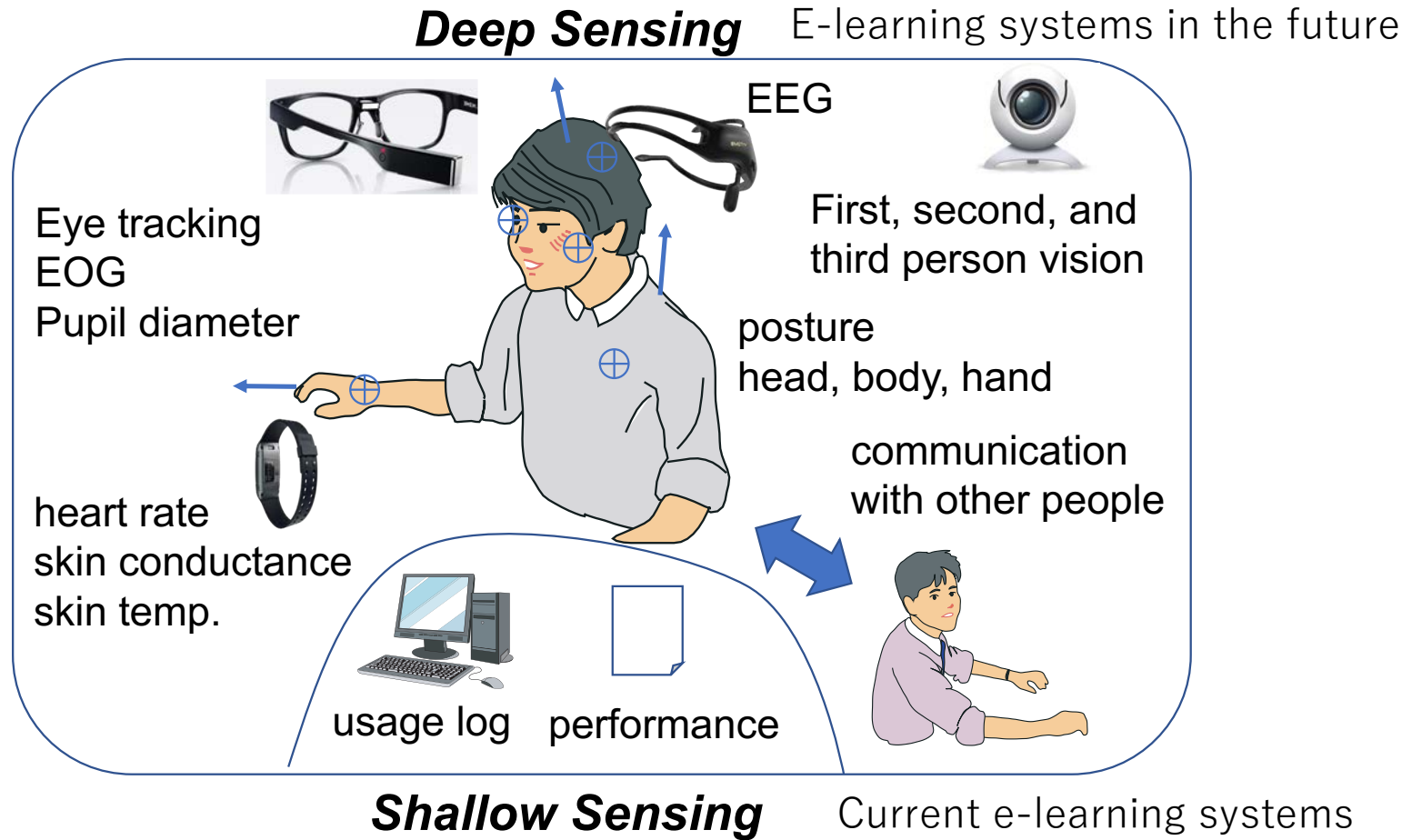
information produced  
from experiences

## Research Issues

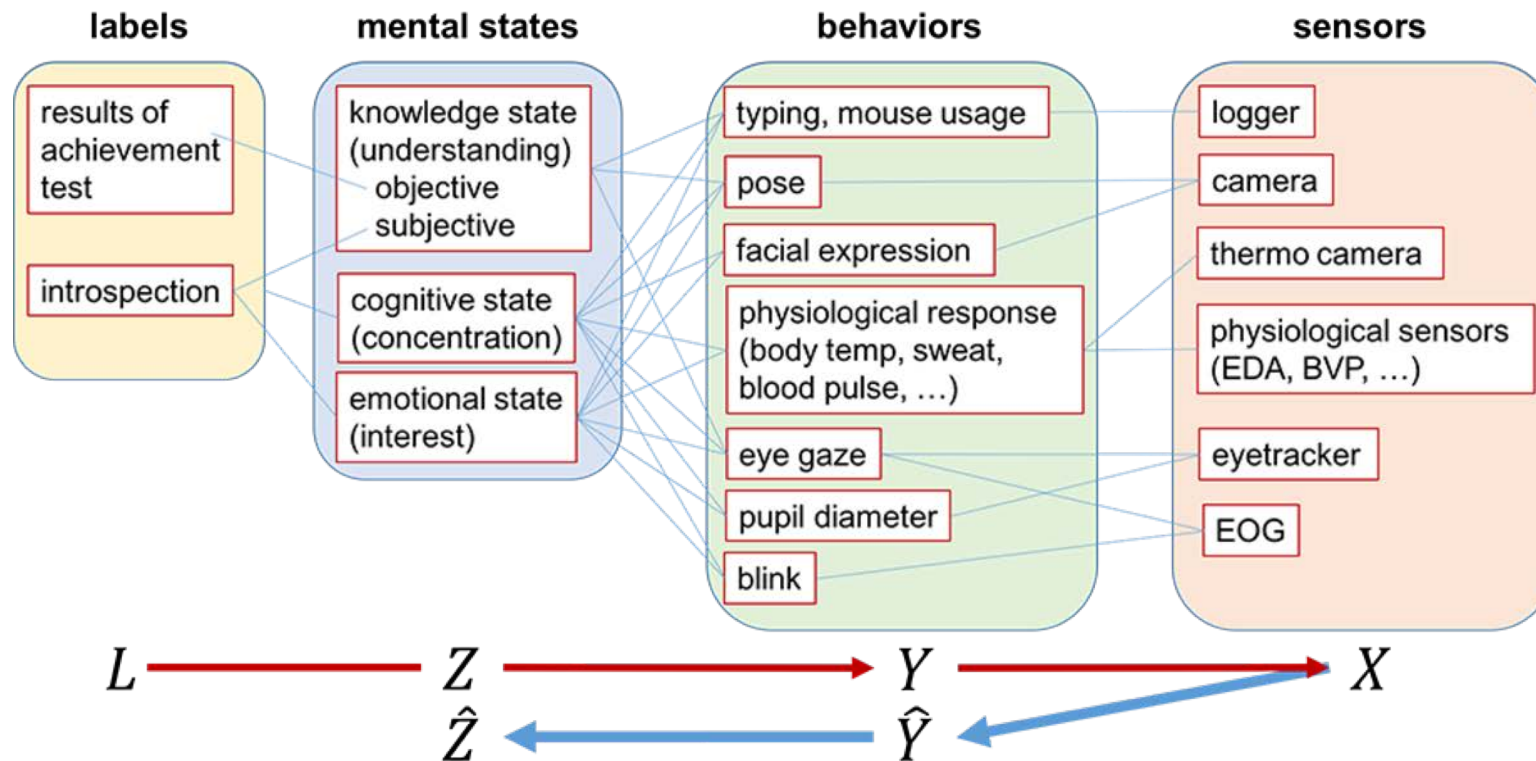
How to sense  
How to produce  
How to apply



# Shallow vs. Deep Sensing



# Deep Sensing Framework



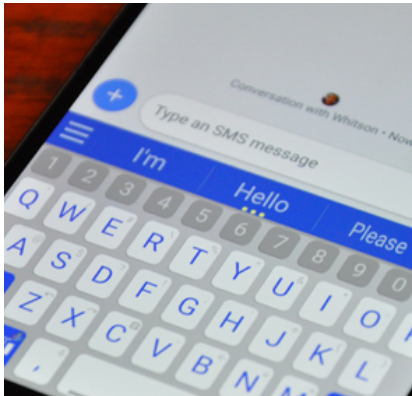
# How to sense the learning experience?

**Cognitive activity and internal states**

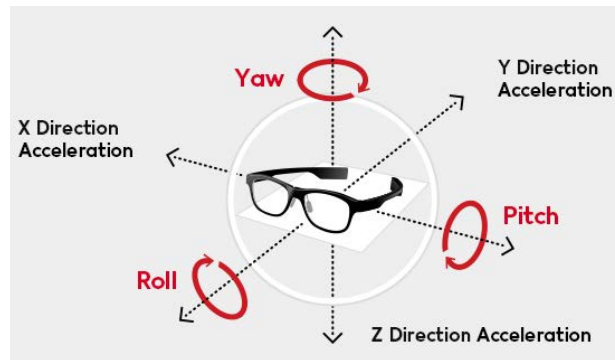
**->Physical and physiological sensing**

# Physical: concentration, interest

Keystrokes



Accelerometer  
& gyroscope



Seat pressure

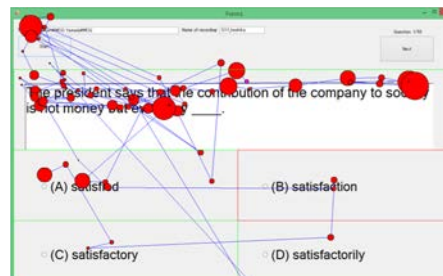


# Physiological: stress, confidence...

BVP, EDA...



Eye tracking



Thermographic  
camera







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# Applications



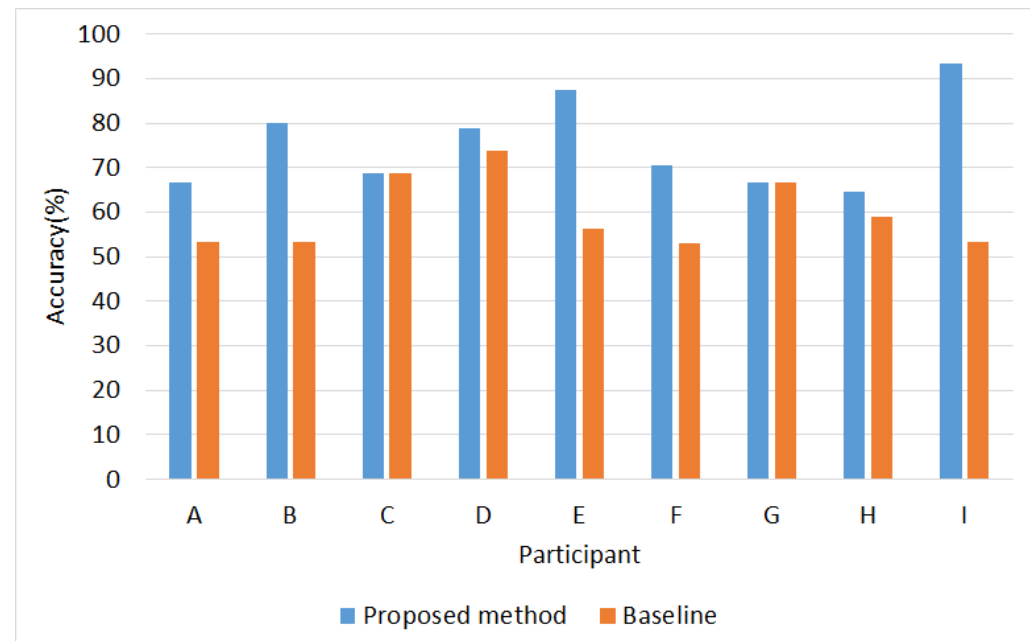
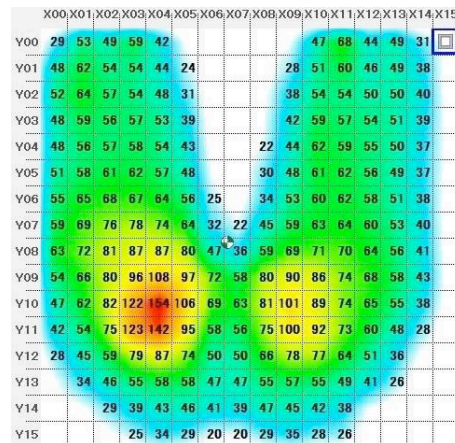
# Estimating the confidence based on keystrokes



Experiment: 12 participants x 120 questions

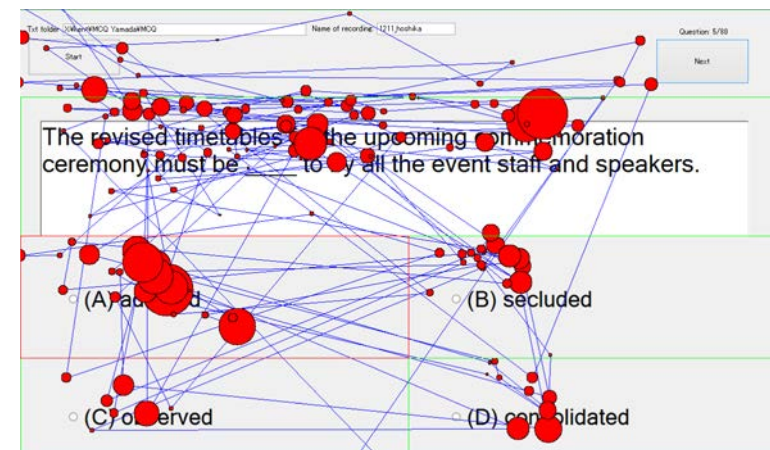
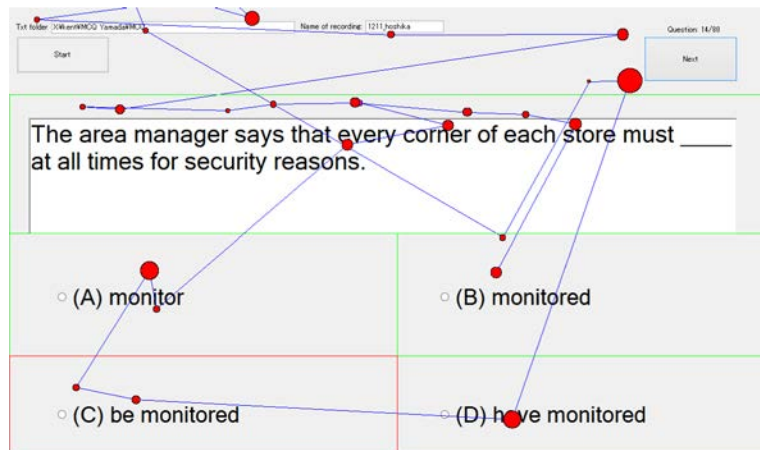
<i>Validation</i>	<i>Classifier</i>	<i>Accuracy [%]</i>
baseline		62.27
user-independent	SVM	<b>89.10</b>

# Estimating the engagement with a seat pressure sensor

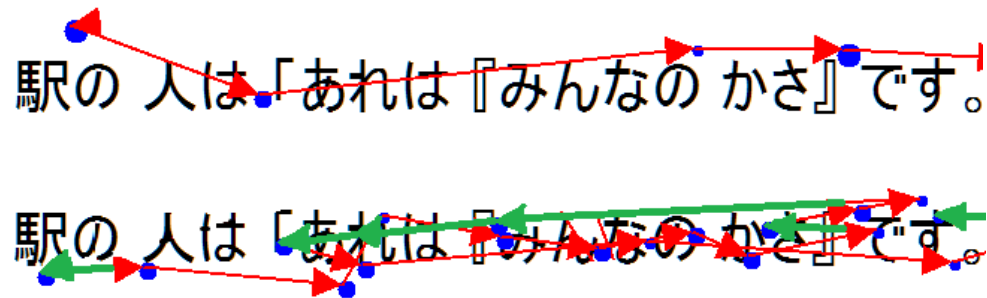


# Estimating the confidence with an eye tracker

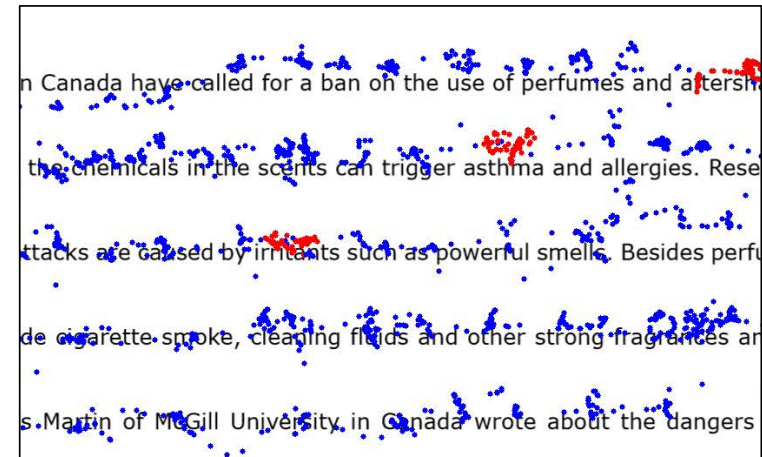
	Confident	Unconfident
Correct	😊 Good!	😐 Luck?
Incorrect	😞 Misconception?	😐 Revise!



# Estimating the understanding with an eye tracker



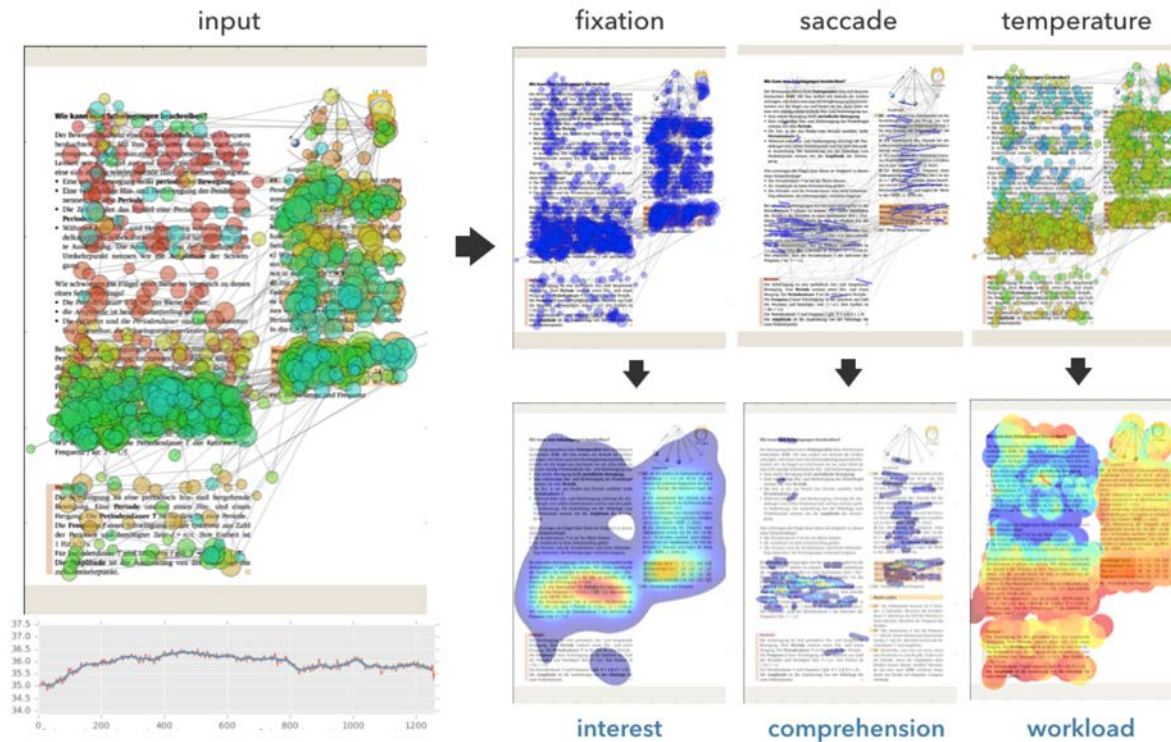
Subjective and objective understanding



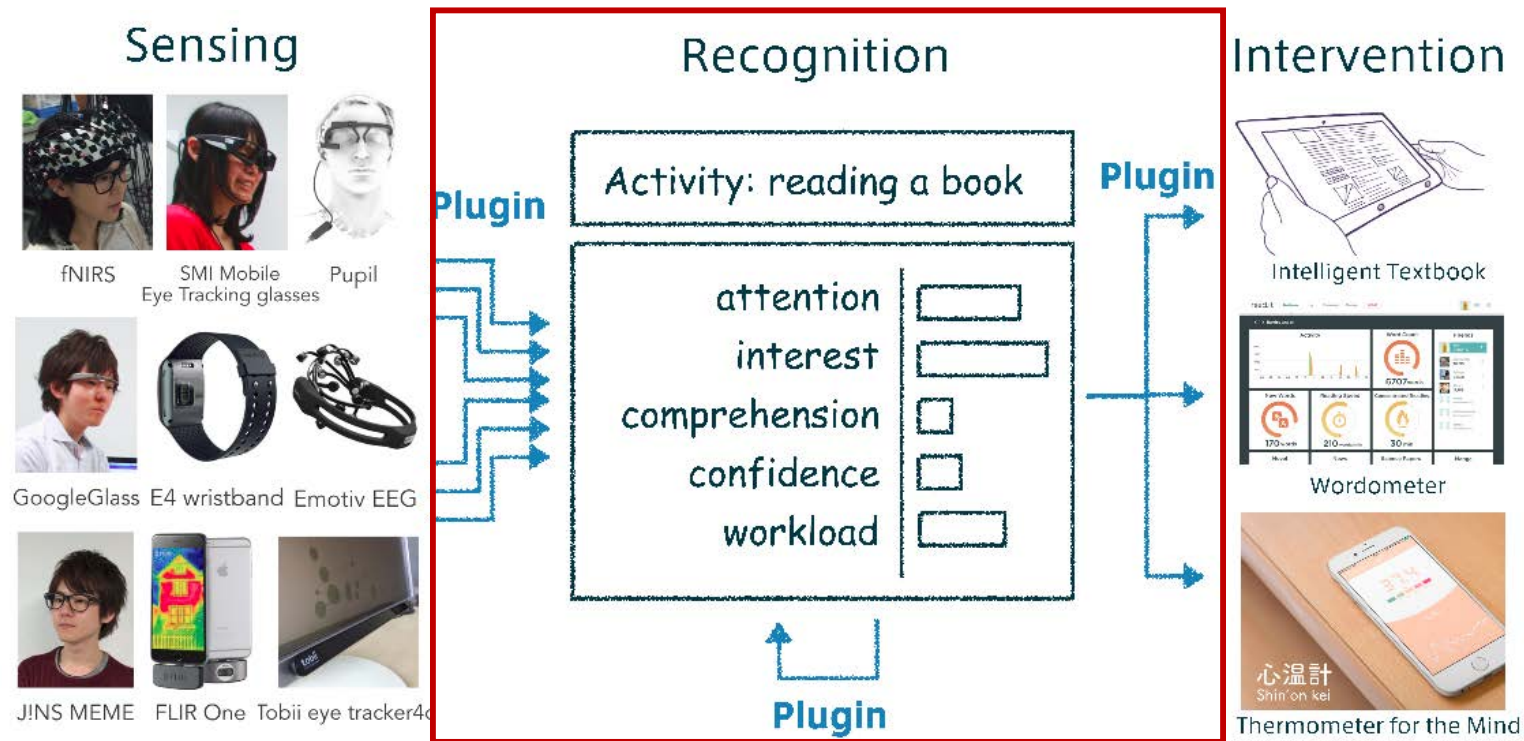
Predicting difficult words



# Estimating the mental workload with a thermo. camera



# Machine-in-the-loop to assist students





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