

# Simultaneous measurement of speech and autonomic nervous activity during a conversational creative problem-solving task

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**Abstract** Since creative problem has no correct answer, subjective confidence in answer of the problem should be useful to evaluate the answer's quality. To extract an objective indicator of the confidence for real-time evaluation, we evaluated speech and autonomic nervous activity during a conversational creative problem-solving task. The task was pair work consisting of an answerer and a supporter. Each pair performed five trials. We divided trials into high and low confidence trials based on the confidence, and compared speech and autonomic nervous activity. In high confidence trials, answerer's speech duration was significantly longer than that of supporter's. In addition, answerer's skin conductance was significantly high and contrastively that of supporter was significantly low in high confidence trials. Results suggest that contrast differences of speech and sympathetic nervous activity between an answerer and a supporter are indicators of the confidence.

## Motivation

- Interpersonal communication can support creative problem solving  
→ How can a supporter effectively support?
- Confidence in answers is useful to evaluate the quality of problem solving [1]  
→ How can we evaluate the confidence objectively and real-time?

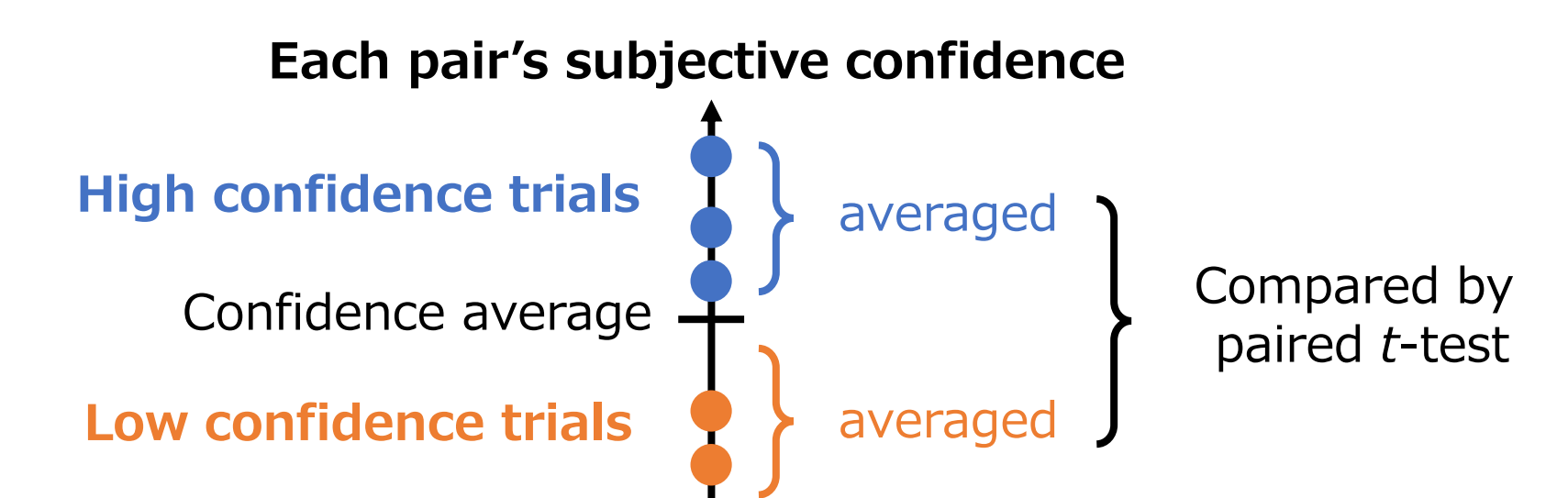


We evaluated **speech** and **autonomic nervous activity** during a conversational creative problem-solving task

## Results & Discussion

### Grouping

The threshold to classify high and low confidence trials were set by the average value by each subject

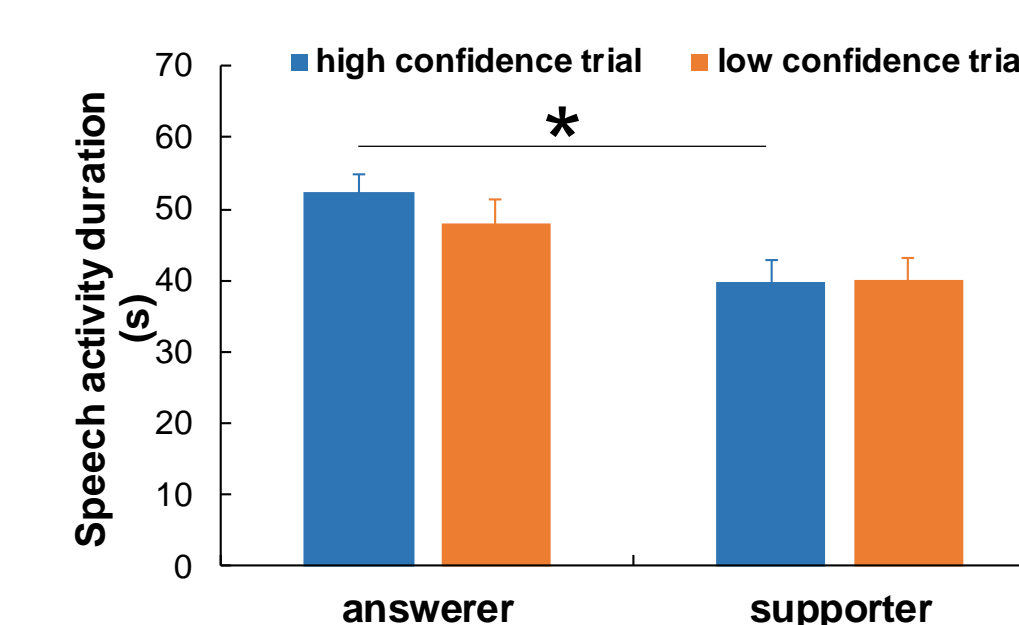


### Speech Activity: In high confidence trials

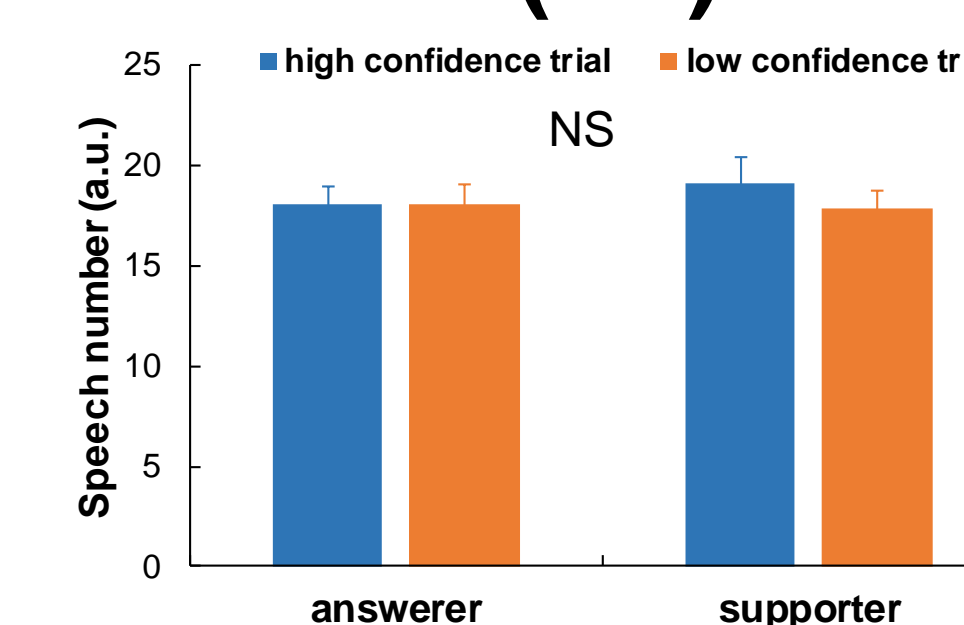
\* : p<0.05 NS: No Significant

- Answerer's speech duration was longer than that of supporter's
  - Answerer's number of short time utterances was smaller than that of supporter's
- Contrastive speech activity between an answerer and a supporter were found

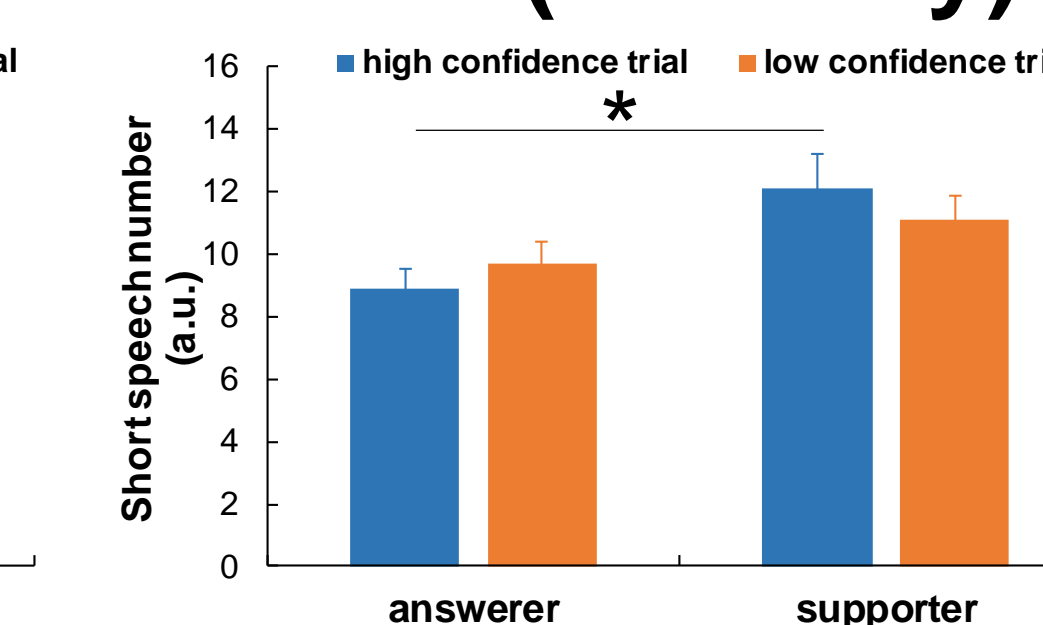
#### Duration



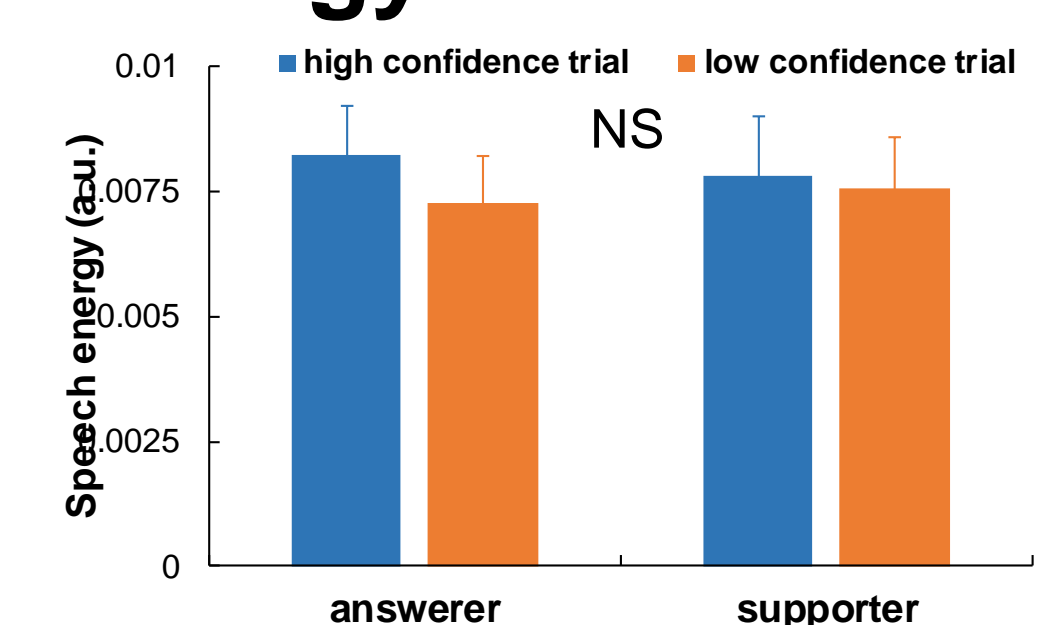
#### Number (All)



#### Number (<2s only)



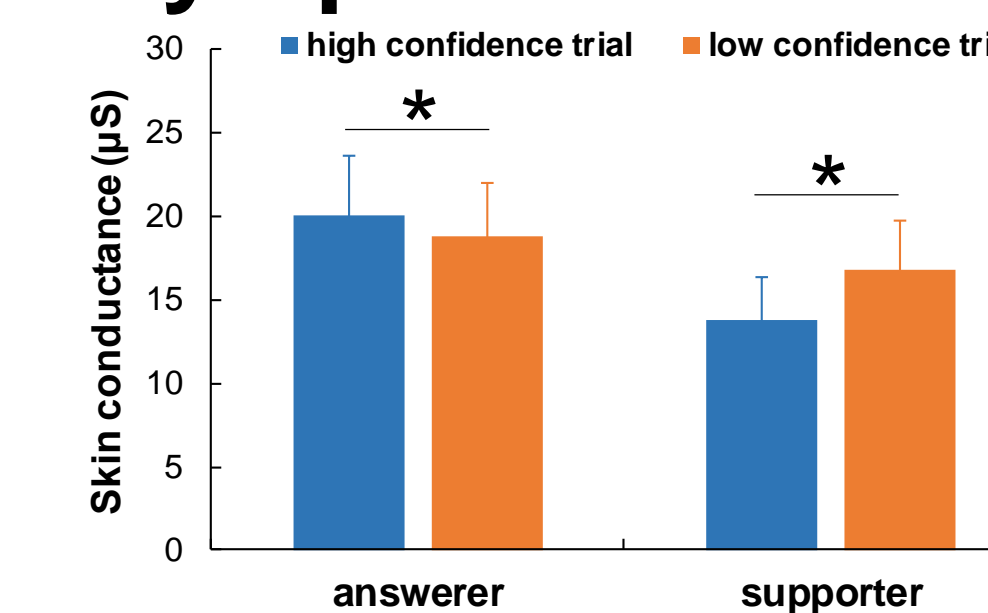
#### Energy



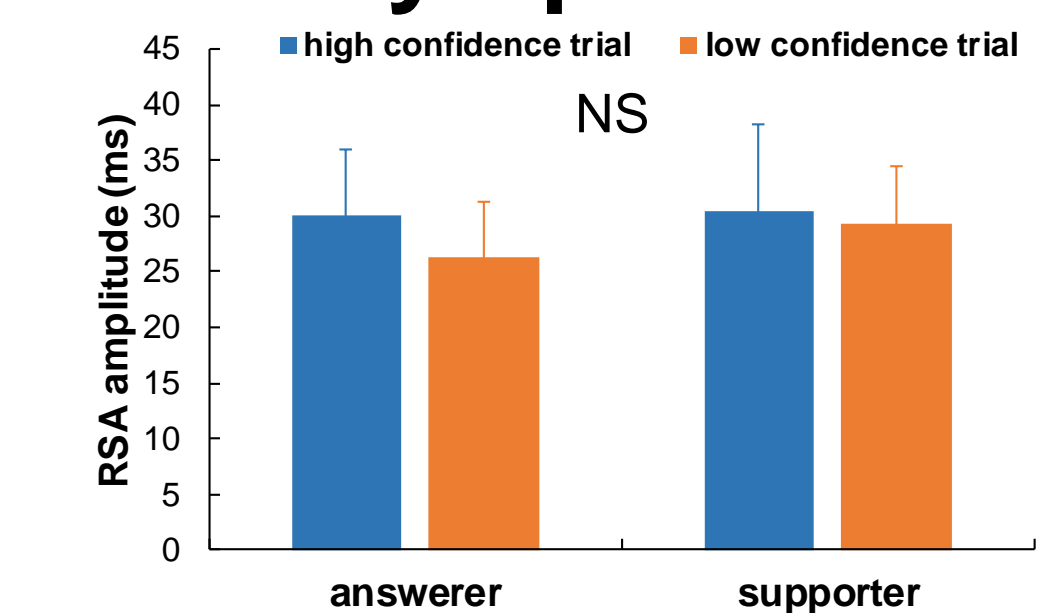
### Autonomic Nervous Activity: In high confidence trials

- Answerer's skin conductance was high
  - Supporter's skin conductance was low
- Contrastive sympathetic nervous activity between an answerer and a supporter were found

#### Sympathetic



#### Parasympathetic



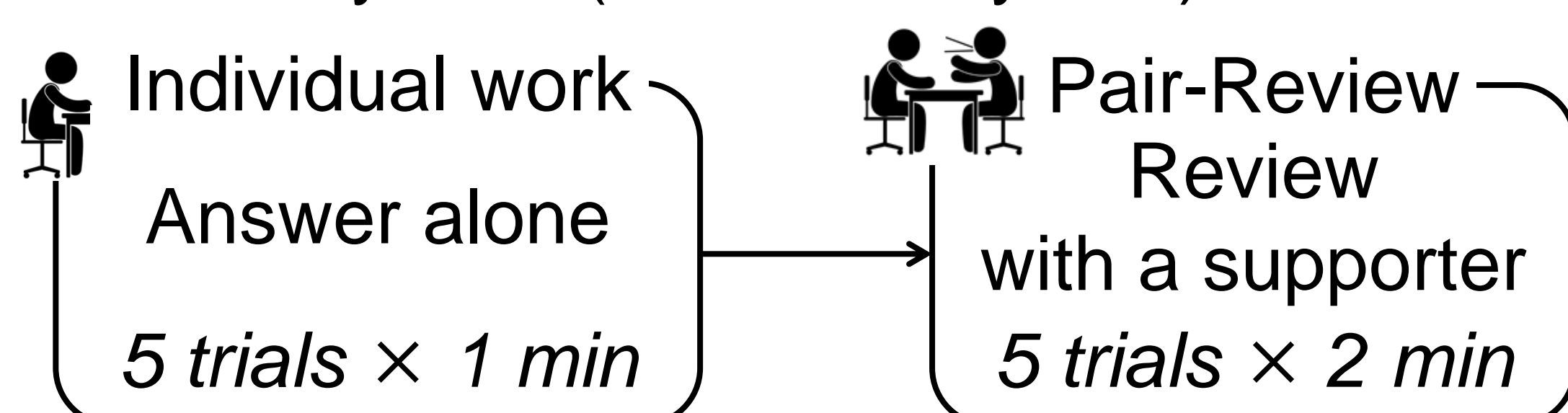
## Material & Methods

### Creative Problem-Solving Task

Fermi questions; estimate quantities of something [2] e.g. *How many cars in Japan?*  
5 questions were randomly chosen from 70 questions for each participant

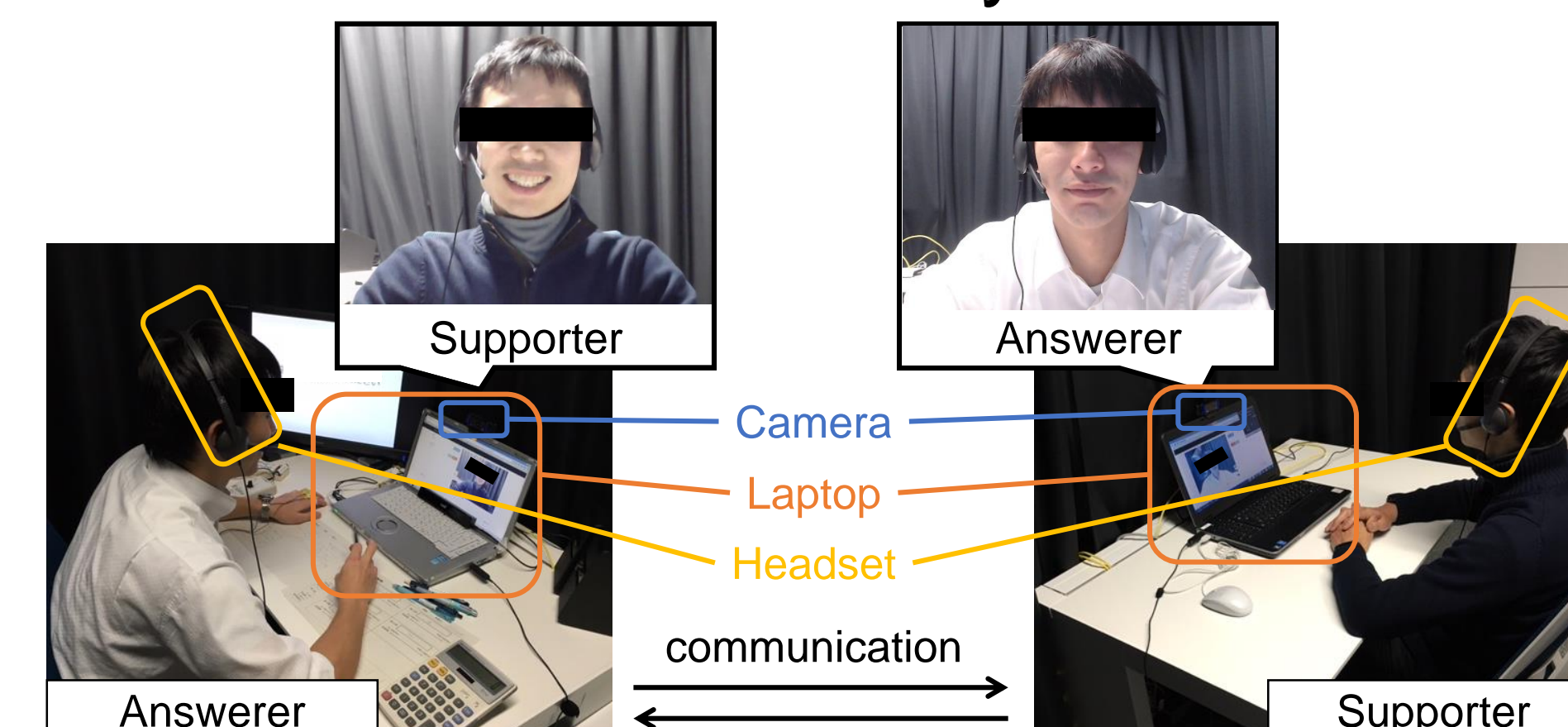
### Experimental Procedure

10 healthy men (23.9 ± 1.9 years)



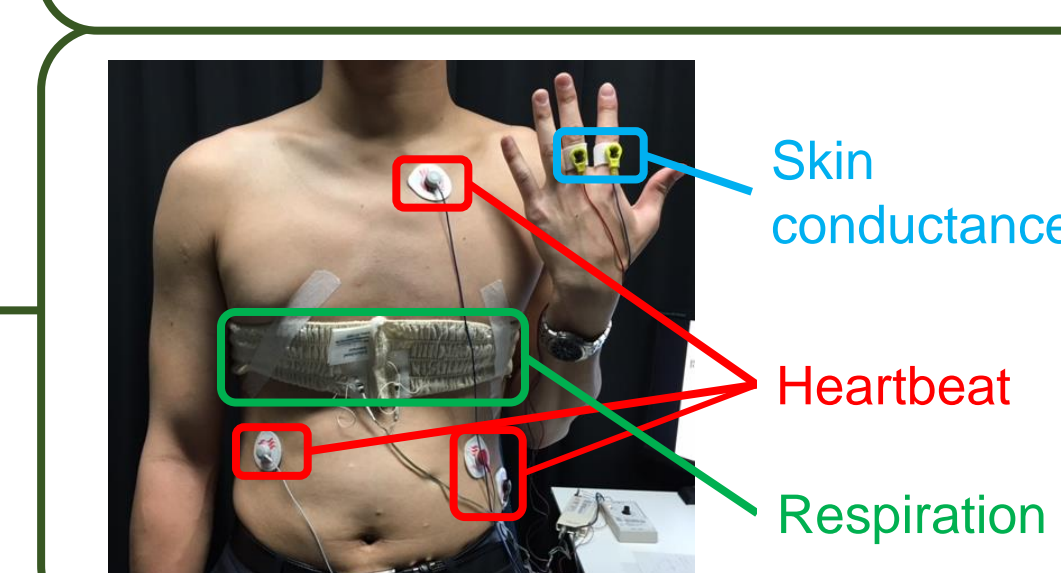
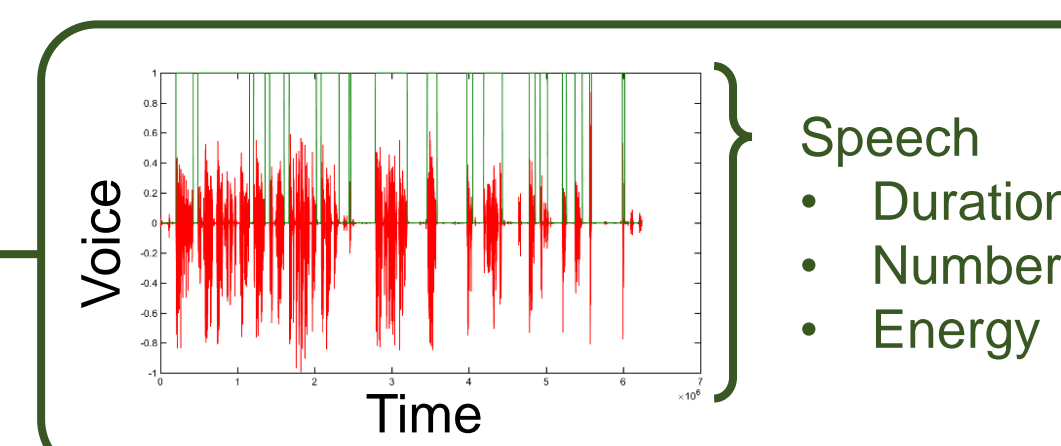
### Pair-Review Environment

Online communication system



### Measurement & Analysis

- Improved score by pair-review
- Subjective confidence by VAS
- Speech activity by short-term energy & zero crossing rate [3]
  - Speech duration
  - Speech number (all / short-time (within 2s) utterances)
  - Voice energy
- Autonomic nervous activity
  - Sympathetic: Skin conductance
  - Parasympathetic: Respiratory sinus arrhythmia amplitude [4]



## Conclusion

Promoting contrastive speech activity between an answerer and a supporter would help creative problem solving, and contrast differences of speech and sympathetic nervous activity between them can be indicators of the confidence.

## References

- [1] T. Numata, Y. Inoue, T. Miyoshi, K. Kotani, H. Sato, 2019 SPSP convention, C-177 (2019)
- [2] P. M. Anderson, and C. A. Sherman, Journal of Applied Business and Economics, 10(5), 33 (2010)
- [3] M. Jalil, FA Butt, and A. Malik, Technological Advances in Electrical, Electronics and Computer Engineering, 2013 International Conference on IEEE, pp.208-212 (2013)
- [4] K. Kotani, I. Hidaka, Y. Yamamoto, and S. Ozono, Methods of Information in Medicine, 46(3), pp.376-385 (2007)