Towards Using EEG to Improve ASR Accuracy

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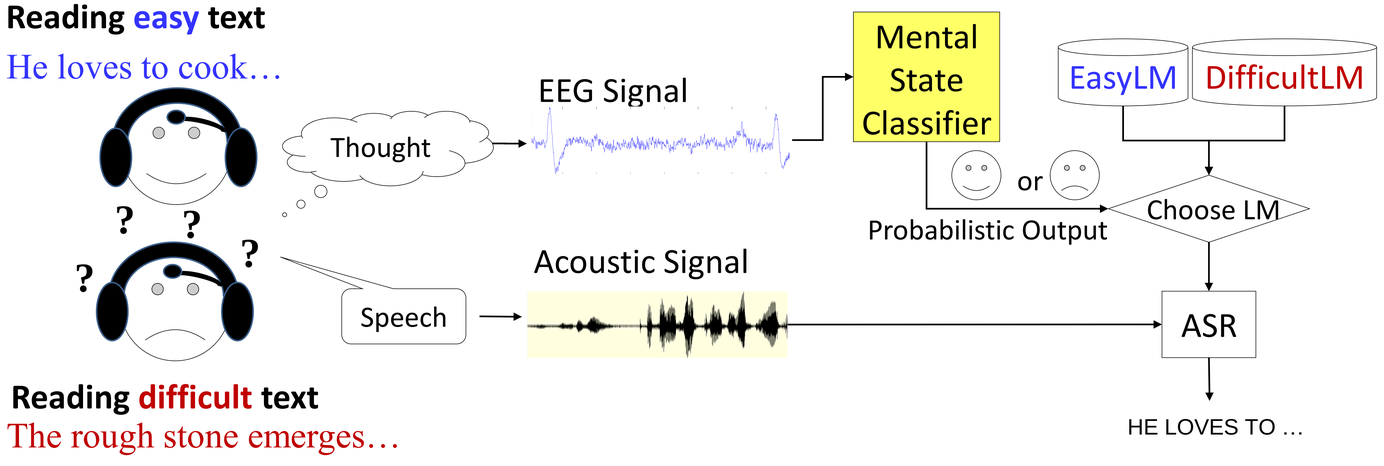
Project LISTEN (www.cs.cmu.edu/~listen)

Problem

- **Idea:**
  - **Brain activity differs in different mental states**
  - **Use brain activity to adapt automatic speech recognition (ASR)'s language model (LM) to speaker's mental state**
- **Background**
  - **AIED paper uses EEG to classify speaker's mental state as reading easy or difficult text for each utterance**

    Mostow, J, Kai-Min Chang, and Jessica Nelson. "Toward Exploiting EEG Input in a Reading Tutor," in AIED, 2011.
- **Approach:**
  - **Use classifier's output to choose LM**

Overview

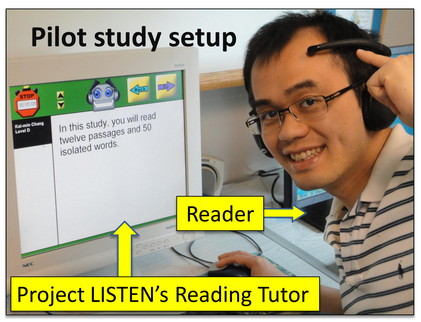


Mental State Classification Using EEG

- Input: brain activity – EEG – inexpensive, convenient
- Output: reading **easy** or **difficult** text?
- Classifier: logistic regression
- Within-reader classification result

  → **better than chance**

Neurosky Mindset



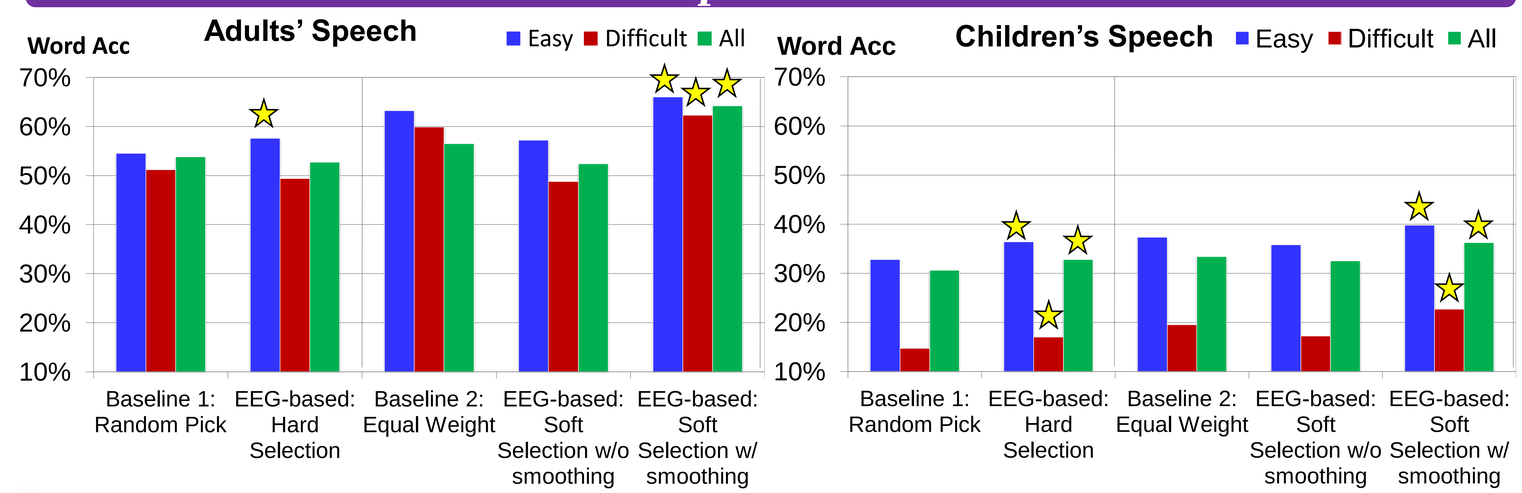
	Adult	Child
# Utterances	269	243
Accuracy	71.49%	58.74%

Language Model Adaptation for ASR

- **Idea: choose the weights for LM interpolation to decode the utterances**

1) Hard selection (single LM from EasyLM or DifficultLM)
   - RandomPick (baseline): randomly choose one
   - EEG-based: choose LM based on classification results
2) Soft selection (interpolate EasyLM and DifficultLM)
   - EqualWeight (baseline): equal weights for interpolation
   - EEG-based (w/o smoothing): weights from classifier's probabilistic output
   - EEG-based (w/ smoothing): smoothed classifier's output from 0.25 to 0.75
3) Combination with ASR output (see paper)

Experiments



Conclusions

- **Classifying EEG signals from an inexpensive single-channel device can help adapt LMs to improve ASR**
- EEG-based hard selection is better than Random Pick
- EEG-based soft selection w/ smoothing outperforms Equal Weight, because smoothing can compensate the classification errors
- Soft selection approaches are better than hard because interpolated LMs are more robust to classification errors
- Future work: use EEG to detect other mental states and to help ASR

ies INSTITUTE OF EDUCATION SCIENCES This work was supported by the IES, U.S. Department of Education, through Grant R305A080628. Any opinions, findings, and conclusions or recommendations do not necessarily reflect the views or official policies, either expressed or implied of the Institute or the U.S. Department of Education.