Benefits of **Adaptive Learning** Transfer from Typing-Based Learning to Speech-Based Learning

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Background

- Adaptive learning (AL) systems improve the efficiency of vocabulary learning by tailoring the learning process to the needs of individual learners.
- They typically use behavioral indices like response times (RTs) and accuracy scores to estimate the extent to which a learner has memorized a fact, and create optimally efficient item repetition schedules.
- So far, **the majority of AL systems are limited to typing-based learning**, **and do not allow for speech practice**.

Aims

Here we explore speech-based adaptive learning. There are two aims:

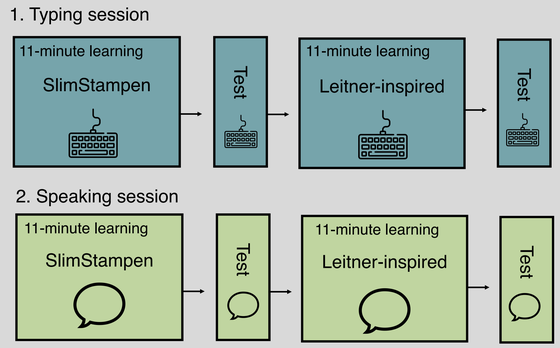
1. Examine the functional similarity of typing- and speech-based learning. **Can we use the same memory model to capture individual learning differences** for both modalities?
2. Study the benefits of speech-based AL**. Can we improve speech-based learning using adaptive scheduling?**

Methods

Participants studied vocabulary items. There were two experimental manipulations:

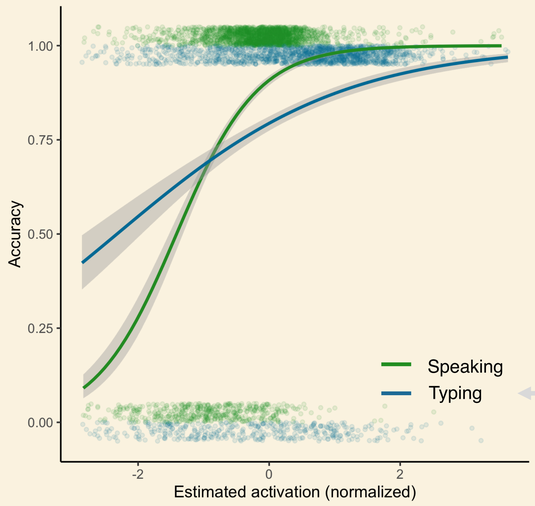
1. ***Learning modality*** – **typing or speech**.
2. ***Item scheduling*** – **SlimStampen**, based on an ACT-R model that estimates how well a learner knows a fact using RTs and accuracy, or **Leitner-inspired** scheduling using accuracy scores only.

In the speaking session, we used **automatic speech recognition** (ASR) software to transcribe participants' voice utterances to text.



Model estimations for speech-based learning are accurate…

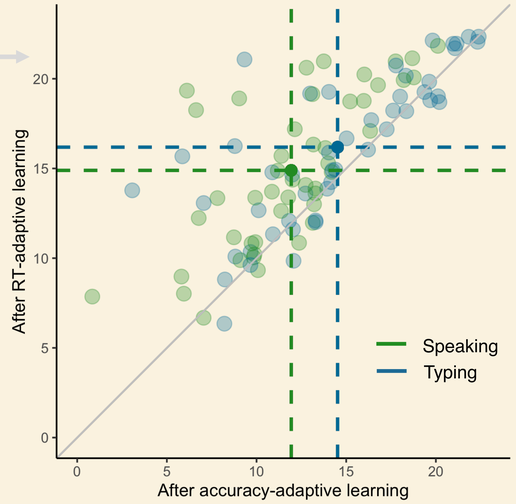
- Typing- and speech based learning resulted in **similar average performance**.
- Behavioral learning indices for **both typing- and speech-based learning could be used estimate the extent to which a learner had memorised an item** (memory activation) and predict accuracy.
- **Spoken RTs led to better estimations** of later accuracy than typed RTs ($D(3963) = -5.74$, $p < .001$).



Predicting accuracy. Dots show empirical accuracy, lines show accuracy predictions. Memory activation estimated using spoken RTs (green) was a stronger predictor of accuracy than keypress RTs (blue), as shown by the steeper green line.

… and AL benefits generalize from typing to speech

Number of items recalled on immediate test. Dots represent individual participants, dotted lines represent condition averages. Most dots lie above the grey diagonal line that indicates equal performance for both scheduling systems.



- Using RTs to personalise learning schedules **successfully improved learning efficiency**:
- Participants studied more items using the SlimStampen system than using the Leitner-inspired system.
- These **AL-benefits were found immediately after studying and after a week**, **both for typing- and speech-based learning** ($z = 3.04$-5.54, $p < .001$-$.002$).

Future work: speech features

In future studies, we will examine if we can use **high-level prosodic speech features,** such as speaking **rhythm, intonation** and **stress,** to further improve model predictions.

	RT	Pitch slope	Pitch average	Intensity	Speaking speed	Shimmer (local)	Jitter (local)
Correct	*** −0.37	*** −0.1	* −0.03	*** 0.05	*** 0.07	0	−0.02
RT		*** 0.11	0.01	*** −0.05	*** −0.07	* 0.03	** 0.03

Pilot results are promising: RTs and accuracy scores are associated to changes in pitch, speaking speed and intensity.

Conclusions and implications

We are the first to present a speech-based vocabulary learning system that adapts to the needs of individual learners. The results of this study are important in two ways:

1. They contribute to understanding the **memory mechanisms** involved in typing- and speech-based learning.
2. They can inform the development of **educationally relevant applications** that focus on one of the most important aspects of learning a language: to practise speech.

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