

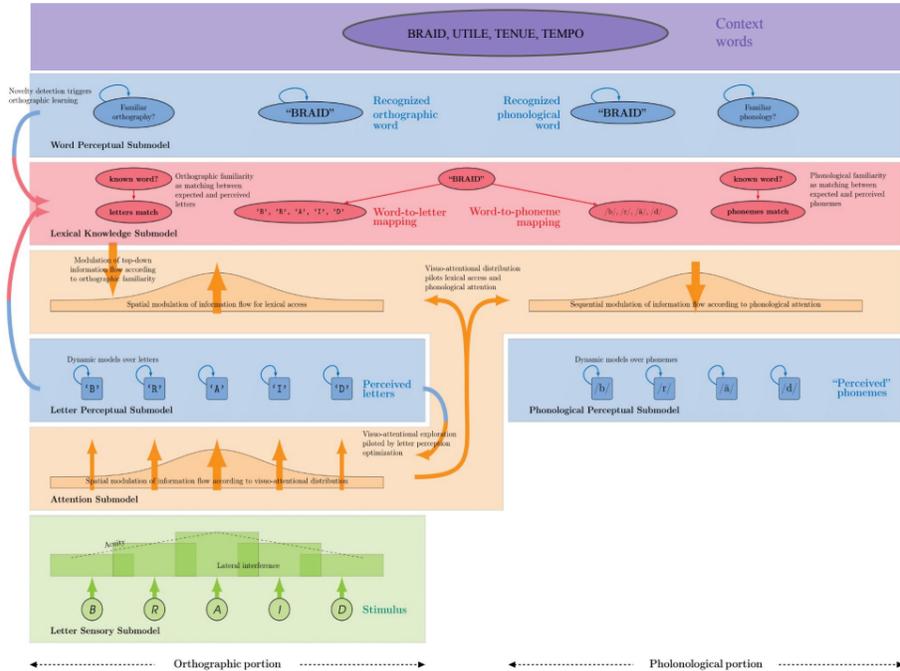
Going beyond the self-teaching theory with BRAID-Acq, a Bayesian model of reading acquisition

Background

- Orthographic learning allows fast word recognition and fluent reading (Castles, 2018).
- Self-teaching theory: successful phonological decoding of novel written words enables orthographic learning (Share, 1995).
- Self-teaching computational models: prior knowledge of the word's phonological form necessary for successful learning (Ziegler, 2014; Pritchard, 2018)
- A complete computational model of word learning should:
 - (1) correctly decode most novel words, (2) decode better when the phonological form is previously known, (3) learn even when decoding is incorrect, (4) learn better when the phonological form is previously known.

The BRAID-Acq model of reading acquisition

BRAID-Acq is a probabilistic model, an extension of the BRAID (Phénix, 2018), BRAID-Learn (Ginestet, 2022) and BRAID-Phon (Saghiran, 2020) models

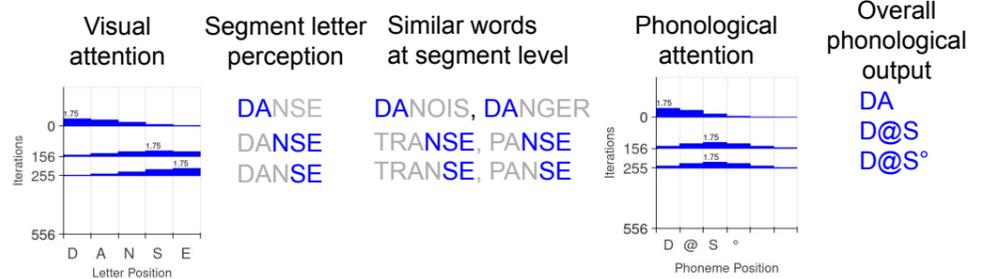


An attentional module for segmentation

- segmentation of the stimulus through visual attention
- coupling of visual and phonological attention

An original decoding mechanism

- Activation of orthographically similar words at segment level
- Decoding through phonological lexical information
- Phonological top-down support to match a phonological lexical form



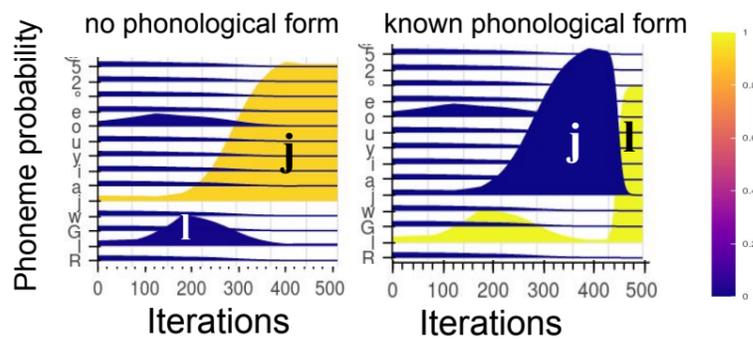
Orthographic and Phonological Learning

- Familiarity assessment via lexical membership assessment and context information
- Subsequent learning according to the familiarity assessment
 - Creation/update of associated orthographic and phonological lexical traces
 - Even when decoding is incorrect

Illustration of the phonological knowledge influence

- French irregular word "ville"
- **Expected decoding** : /vij°/ by analogy with the words "fille" (/fij°/) and "bille" (/bij°/)
- **Lexical phonological form** : /vil°/

Third phoneme probability



Materials and Method

Materials

- List of 4-to-10 letter words, randomly selected from a French lexicon
- Orthographically novel words (i.e., excluded from the orthographic knowledge).
- Phonological novel or known words (i.e., excluded or not from the phonological knowledge)

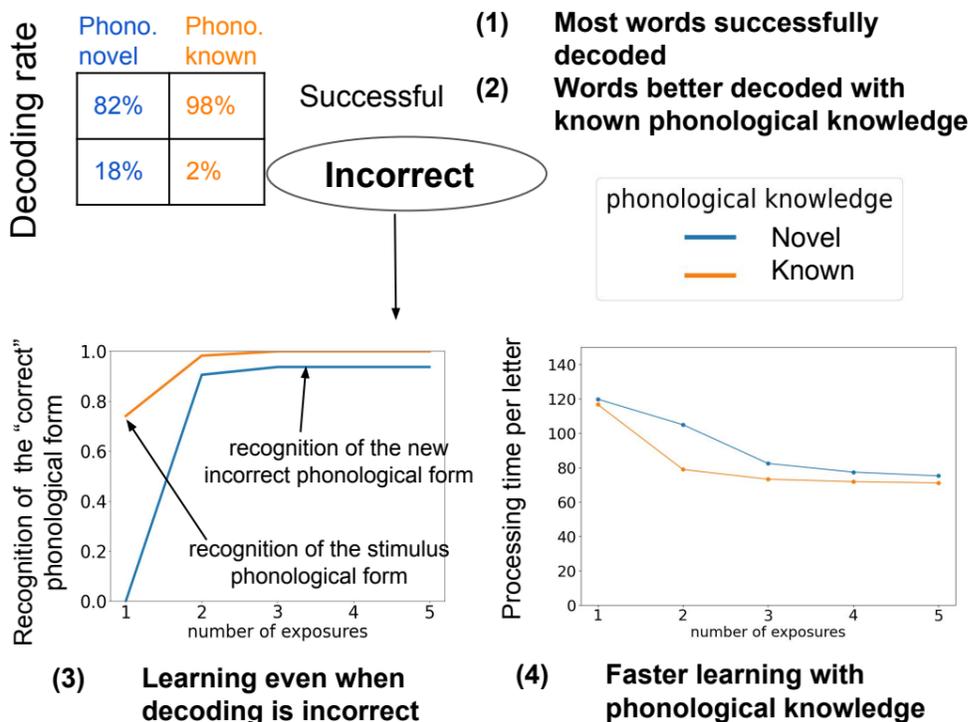
Simulation

- Stimulus decoding until a termination criterion (on letter perception) is met.
- After each of the 5 exposures, orthographic and phonological learning occurs.

Measures

- Decoding rate:
 - Successful if identical to the stimulus lexical phonological form
- Recognition of the correct phonological form:
 - Corresponding either to the stimulus lexical form (when known) or to the newly created phonological form (when novel)
- Processing time

Results



Conclusion

- BRAID-ACQ decodes most novel words successfully.
- Prior phonological knowledge improves decoding.
- The absence of prior phonological knowledge does not prevent orthographic learning (creation of a new phonological form).
- Novel words can be learned even when decoding is incorrect (by either associating the new orthographic form with the stimulus phonological form or creating a new phonological form).
- **Overall, BRAID-Acq accounts for a wider diversity of learning situations than previous self-teaching computational models.**

References : Castles, A., Rastle, K., & Nation, K. (2018). Ending the reading wars: Reading acquisition from novice to expert. *Psychological Science in the Public Interest*, 19(1), 5-51. Ginestet, E., Valdois, S., & Diard, J. (2022). Probabilistic modeling of orthographic learning based on visuo-attentional dynamics. *Psychonomic Bulletin & Review*, 1-24. Phénix, T., Valdois, S., & Diard, J. (2018). Reconciling opposite neighborhood frequency effects in lexical decision: Evidence from a novel probabilistic model of visual word recognition. In *40th Annual Conference of the Cognitive Science Society (CogSci 2018)* (pp. 2238-2243). Pritchard, S. C., Coltheart, M., Marinus, E., & Castles, A. (2018). A computational model of the self-teaching hypothesis based on the dual-route cascaded model of reading. *Cognitive Science*, 42(3), 722-770. Saghiran, A., Valdois, S., & Diard, J. (2020). Simulating length and frequency effects across multiple tasks with the Bayesian model BRAID-Phon. In *42nd Annual Virtual Meeting of the Cognitive Science Society* (pp. 3158-3163). Share, D. L. (1995). Phonological recoding and self-teaching: Sine qua non of reading acquisition. *Cognition*, 55(2), 151-218. Share, D. L. (2004). Orthographic learning at a glance: On the time course and developmental onset of self-teaching. *Journal of experimental child psychology*, 87(4), 267-298. Ziegler, J. C., Perry, C., & Zorzi, M. (2014). Modelling reading development through phonological decoding and self-teaching: Implications for dyslexia. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 369(1634), 20120397