ESR8

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This project received funding from:
European Union's Horizon 2020
Marie Sklodowska-Curie Grant Agreement No 860755

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University of Oslo

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Effortful Listening, Cognitive Energy, and Learning in Children with Cochlear Implants

Introduction

Learning novel words is dependent on the listener's ability to compare the phonetic patterns of an input signal with the phonetic and semantic representations in the lexicon [1] (see Fig 1). In cochlear implant users, the uncertainty caused by the limited cues in the input can enhance lexical competition [2] and challenge the identification of novel versus known words.

Additionally, the degraded reception of the auditory signal represents an increasing demand for cognitive resources and can be interpreted as a continuous situation of effortful listening [3]. In this sense, the allocation of more energy to the discrimination and recognition of phonetic patterns, could lead to less spare cognitive energy for lexical processing and novel word encoding, ultimately affecting the acquisition of novel words.

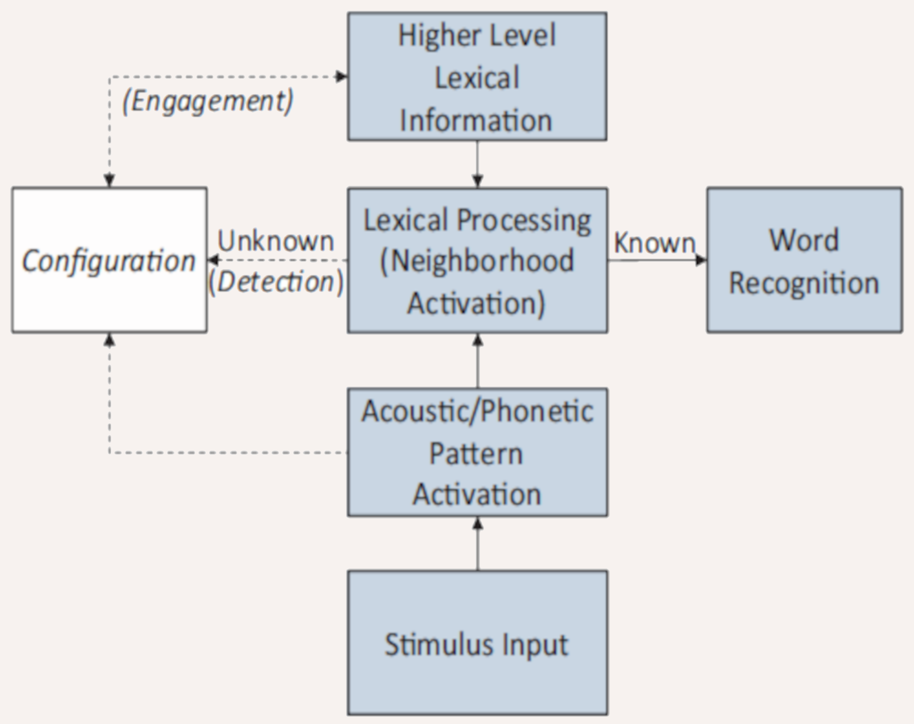


Figure 1. Framework of Familiar Word Recognition and New Word Learning. From: Pittman et al., 2017 [1].

Purpose

To investigate the role of phonological perception (discrimination and recognition) to the detection and learning of novel words, in school-aged children

Research questions

a. How does the ability to discriminate phonological contrasts influence the rate of novel word learning?

b. How does the ability to discriminate phonological contrasts relates to the detection of a novel word in a sentence context?

c. How do working memory mediate the detection and learning of novel words?

d. Can the working memory offset possible limitations on phonological discrimination?

e. How do environments requiring high listening-effort impact novel word learning and what are how are the working memory determinants in this process?

Current Research Status

Material Development

STEP 1: Searching and selecting available nonword material in Danish.
- DANOK [4] and PiTU [5] nonword recordings available, used for discrimination and learning tasks.

STEP 2: Development of new nonword corpus suitable for nonword detection in sentence and development of sentences with embedded non words (Fig 2).

(a)

gaver	gæʊ	daver	dæʊ
røde	ʁœð	høde	hœð
sorte	sɒdə	horte	hɒdə
babyen	bæbin	labyen	læbin
finder	fenɐ	ninder	nenɐ
flotte	flɒtə	klotte	klɒtə
gamle	gamlə	lamle	lamlə
gamle	gamlə	tamle	tamlə

(b)

Katten solgte nye **daver**
Damen ejer **gore** planter
Hun **pår** tunge jakker
Dukken finder **pide duse**
Babyen **nøbte pøde** kopper
Manden **båner** sorte **sasser**
Han **saskede lamle** bukser
Rigen tegnede **vule** blomster

Figure 2: Examples of nonwords generated from real words (a), and example of the sentence list with embedded nonwords (b). Nonwords generated were submitted to real-word similarity assessment and sentences were submitted to "meaningfulness" assessment by n=14 native-Danish speaking adults

STEP 3: Construction of the research protocol in computer-based tool. We used Oticon Medical Experiment Builder (OMEXP - Fig 3), constructed by an extension of the open platform OpenSesame [6]

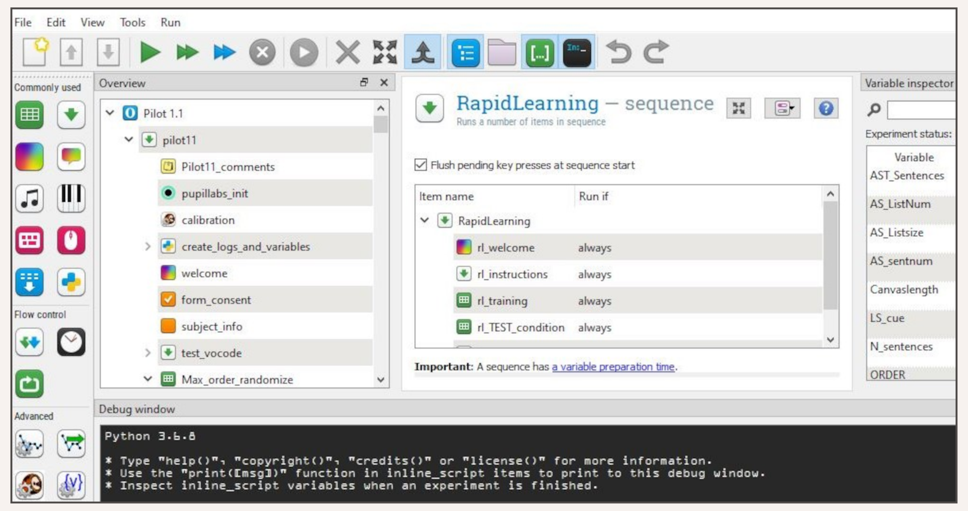


Figure 3: Example of the design of a rapid word learning task in OMEXP, showing the "drag-and-drop" modules in the experiment sequence.

Pilot Study

Protocol and Pilot: To Investigate usability of the research protocol, and sensibility of the stimulus selected/developed, a pilot study was conducted with 6 native-Danish adults (age 22-54, complete superior education). Degraded speech simulation was performed using a 8-channel noise vocoder. The following tasks were performed:

a. Phonological discrimination of nonword minimum-pairs (Fig 4a)
b. Nonword detection within sentences (Fig 4b) [7]
c. Rapid novel word learning (Fig 4c) [7] in two conditions:
- phonologically similar grouping
- phonologically discriminant grouping (see examples)

Results: Performance on the **discrimination task** was almost ceiling for both non-vocoded and vocoded stimuli. Both the **rapid word learning** (Fig 5) and **detection** (Fig 6) tasks were sensible to sound degradation. Speech degradation and phonological similarity slowed down learning by a factor of ~2.0, pointing that the test was sensible to differences in conditions.

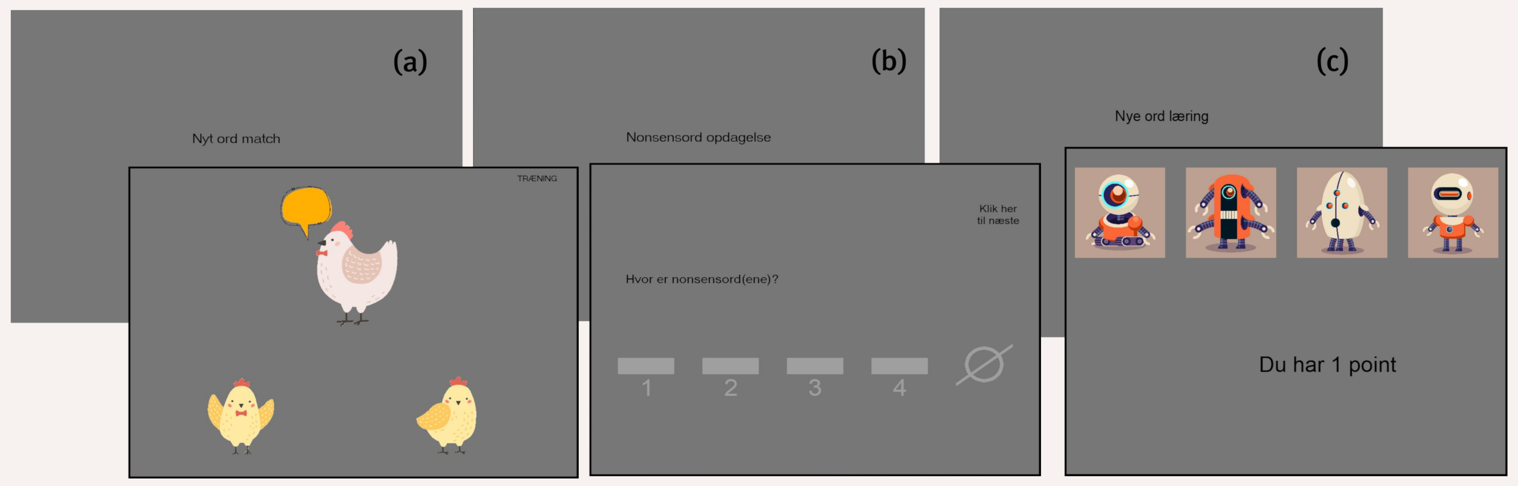


Figure 4: (a) Phonological discrimination task on a 2AFC paradigm; (b) Nonword detection within sentences, in a localization paradigm, where after hearing a 4-words sentence, subjects should locate the nonwords placement ('Hvor er nonsensord?'); (c) Rapid novel word learning task, with simultaneous learning of four nonwords-image pairs by trial-and-error. Nonwords were grouped by phonological similarity (e.g. */pafə/, /fakə/, /fapə/, /hapə/*) or dissimilarity (e.g. */talə/, /katə/, /namə/, safə/*)

Figure 5: Mean growth curve for all subjects for each of the four conditions marked by bins of 10 trials, and trials to criterion (dashed gray line)

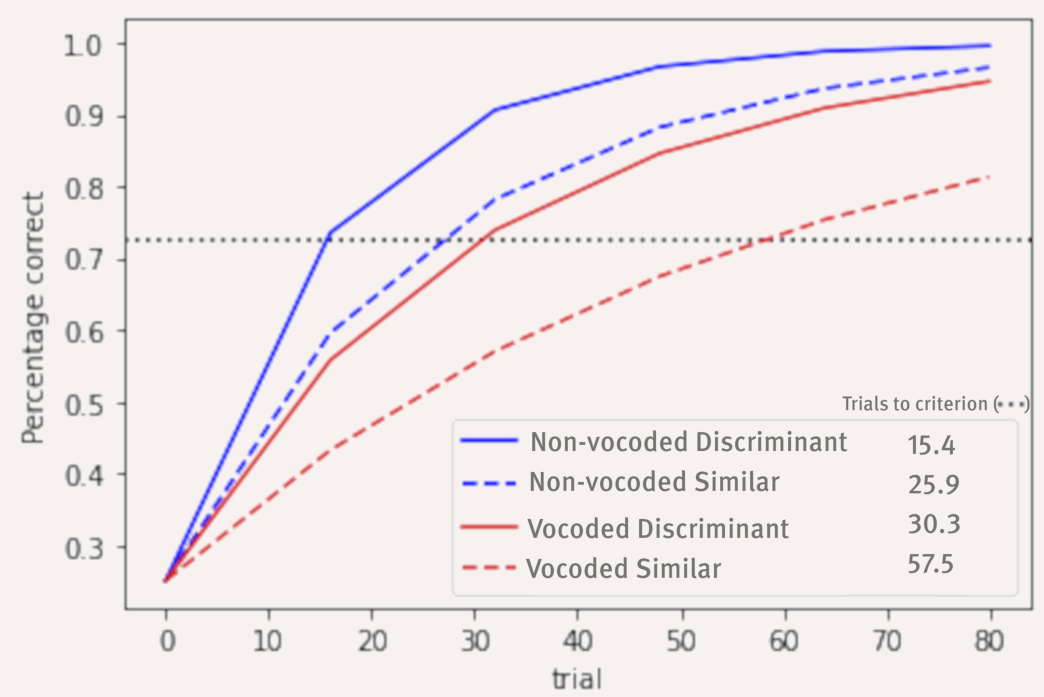
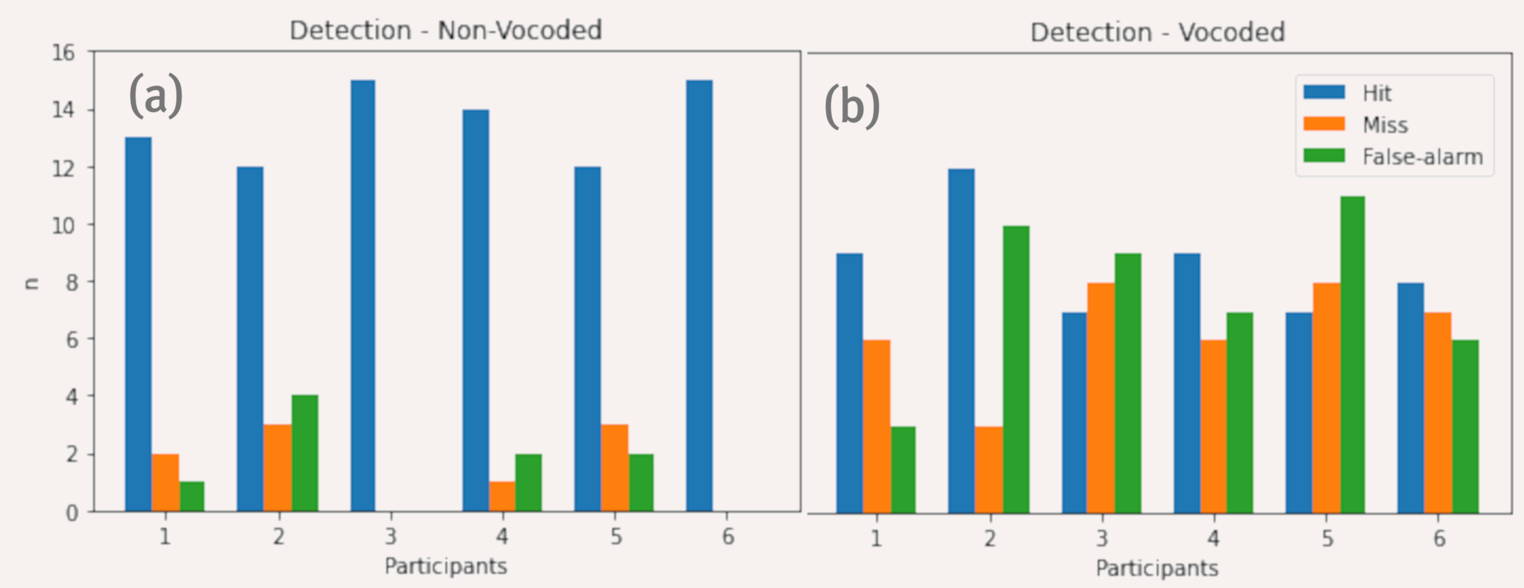


Figure 6: Number of hits (max 15), misses and false alarms in the nonword detection task per participant in the (a) non-vocoded and (b) vocoded conditions



Refereences

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