Adult learning of non-adjacent dependencies in the linguistic and non-linguistic domain

Anne van der Kant[1], Claudia Männel[2], Mariella Paul[2], Barbara Höhle[1] Angela Friederici[2] & Isabell Wartenburger[1]

[1]Universität Potsdam, [2] Max Planck Institute for Human, Cognitive and Brain Sciences, Leipzig

CROSSING THE BORDERS
DFG FOR 2253

University of Potsdam

MAX PLANCK INSTITUTE FOR HUMAN COGNITIVE AND BRAIN SCIENCES LEIPZIG

Introduction

How does adult non-adjacent dependency (NAD) learning in the non-linguistic domain compare to NAD learning in the linguistic domain?

Adults were previously shown to need an explicit task when learning NADs in linguistic sequences[1,2] and to need similarity cues to learn NADs in tone sequences[3]. How do the domains compare when stimuli and paradigm are closely matched?

Which brain regions underlie the learning of non-adjacent dependencies in the linguistic and the non-linguistic domain?

- Controlled learning by adults is expected to engage frontal brain regions
- Activation of similar brain regions while learning linguistic and non-linguistic non-adjacent dependencies (NADs) might suggest a general NAD learning mechanism in both domains.

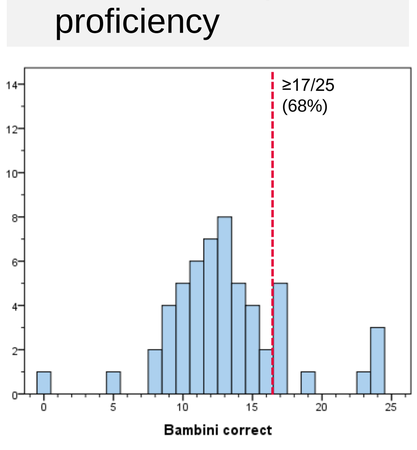
Behavioral data

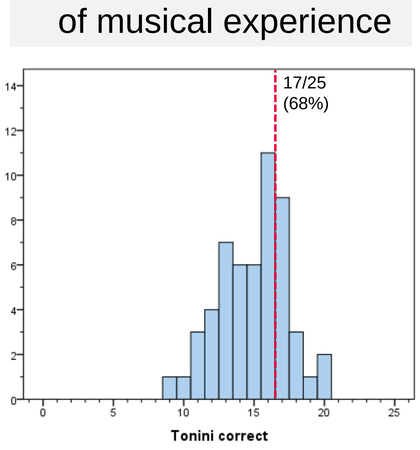
Linguistic stimuli:

- 10/56 adults learned
- 2 excluded: Spanish proficiency

Non-linguistic stimuli:

- 15/56 adults learned
- correlation with years of musical experience





Methods

Participants

- 56 healthy German-speaking adults (21 M, 35 F), ages 19-37 (Mean: 24,6)
- fNIRS data included: 35 participants (24 F) in linguistic and 38 (27 F) in non-linguistic experiment.

Methods

Functional Near-infrared spectroscopy (fNIRS): 46 channels, bilateral frontal, temporal & parietal cortex

Stimuli

The linguistic (Italian sentences) and non-linguistic (tone sequences) experiments contain correct stimuli with NADs and incorrect stimuli with NAD violations.

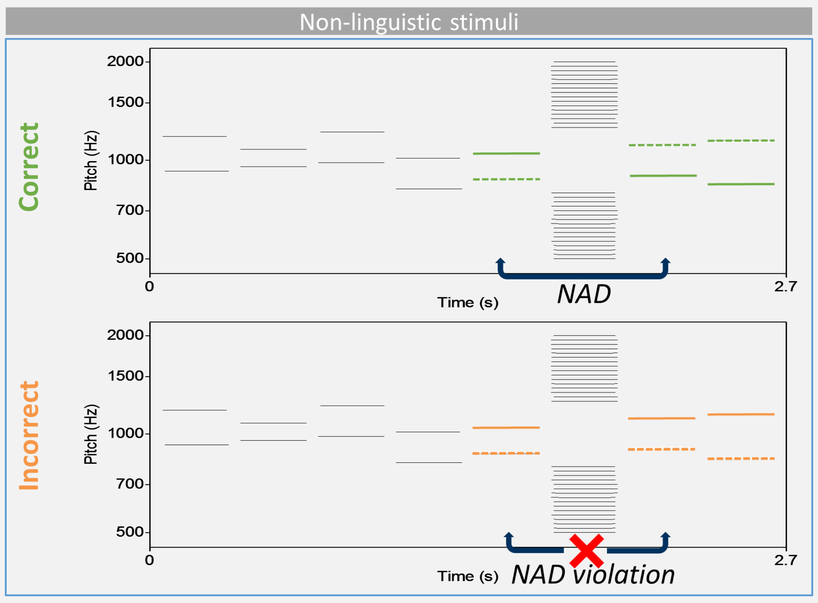
- Italian sentences: NAD between Adverb and Suffix (verb stem as variable middle element)
- Tone sequences: Italian syllables are replaced by pure tones, preserving NADs
- Linguistic and non-linguistic stimuli are matched on mean overall duration

and mean duration of the individual tones / syllables.

Linguistic stimuli

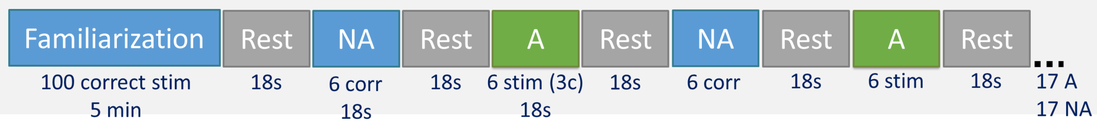
	NP (n=2)	Adverb (n=2)	V-stem (n=32)	suffix (n=2)
Correct:	La sorella	sta	cant-	ando
	La sorella	puo	cant-	are
		NAD		
Incorrect:	*La sorella	sta	cant-	are
	*La sorella	puo	cant-	ando
		NAD violation		

Non-linguistic stimuli



Paradigm

Stimuli are presented in a passive-listening alternating-non-alternating paradigm. *Non-alternating* (NA) blocks containing correct items (with NADs) are followed by *alternating* (A) blocks containing correct and incorrect items (with NAD violations). Comparison of fNIRS responses to alternating and non-alternating blocks reveals whether the dependency was extracted from the input.



Preliminary fNIRS data

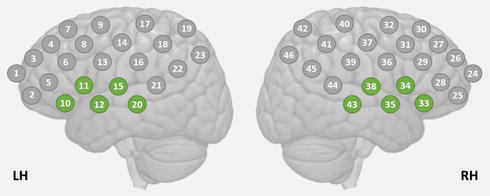
Linguistic stimuli:

differences in HbO and HbR between alternating and non-alternating blocks only apparent in participants who learned, located in right inferior frontal and right and left temporal region.

Differences have not been tested for significance.

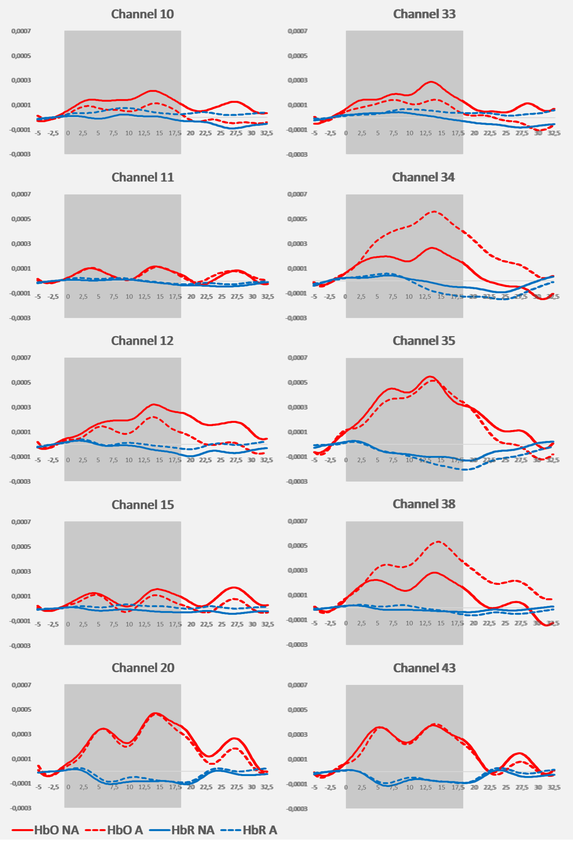
Non-linguistic stimuli:

HbO different from baseline in right temporal region. No apparent differences between alternating and non-alternating conditions.

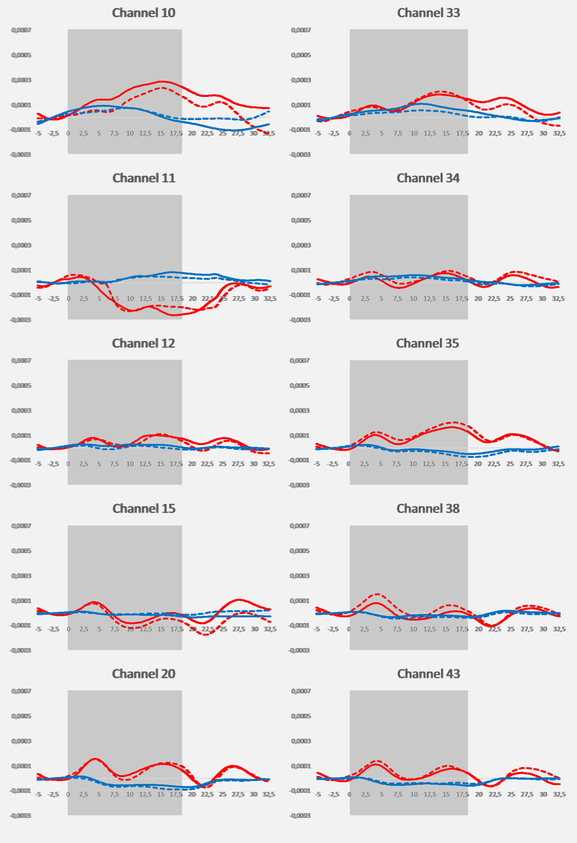


Channel positions projected on MNI template (10-20 positions)

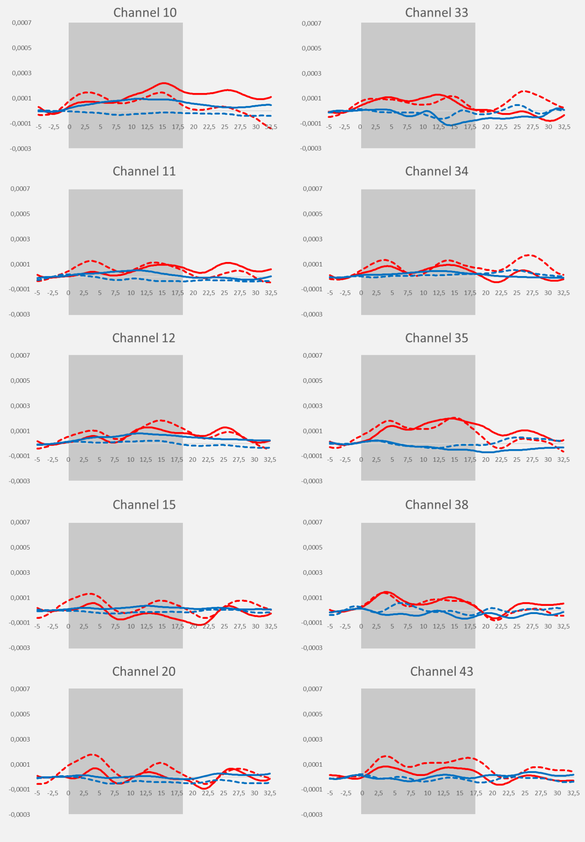
Group block averages linguistic stimuli learners (N=5)



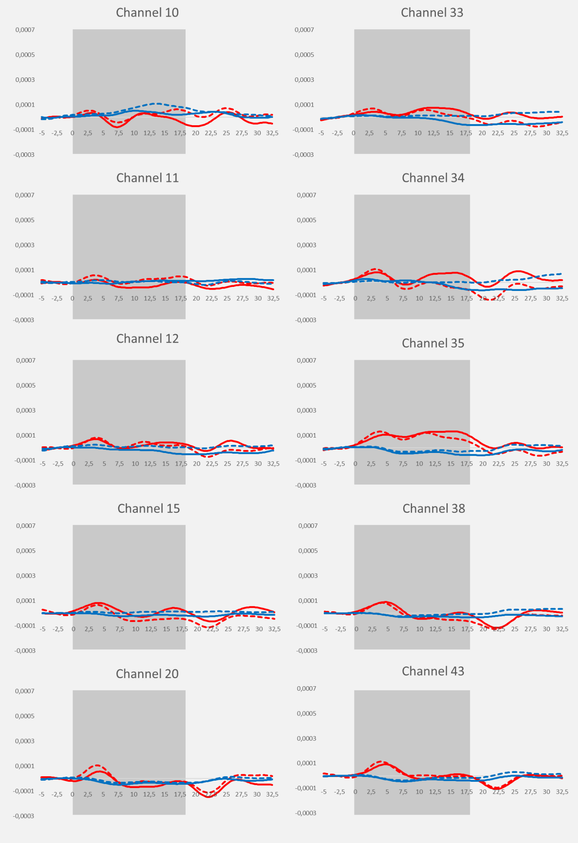
Group block averages linguistic stimuli non-learners (N=31)



Group block averages non-linguistic stimuli learners (N=10)



Group block averages non-linguistic stimuli non-learners (N=28)



Deutsche Forschungsgemeinschaft
gefördert von der DFG, FOR 2253, TP1

[1] Friederici, A. D., Mueller, J. L., & Oberecker, R., *PLoS One* **2011**, *6*(3), e17920
[2] Mueller, J. L., Friederici, A. D., & Männel, C., *PNAS* **2012**, *09*(39), 15953-15958.
[3] Creel, S. C., Newport, E. L., & Aslin, R. N., *J. Exp. Psychol.-Learn. Mem. Cogn.* **2004**, *30*(5), 1119.