

Introduction: The cognitive, neural, and genetic basis of linguistic giftedness are poorly understood (Biedron & Pawlak, 2016), yet critical insights can be gained in investigations of individuals with exceptional linguistic abilities. We here focused on polyglots – individuals who master multiple languages, sometimes dozens.

Research Questions:

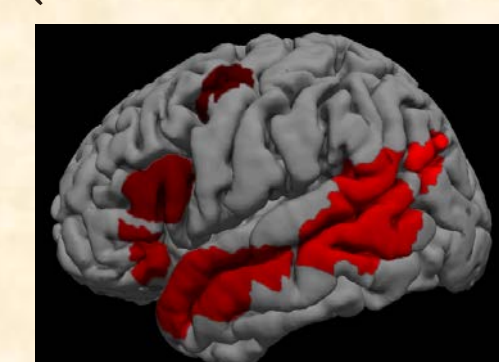
- (1) Does the fronto-temporal language network in polyglots differ from non-polyglots during the processing of their native language (Study 1)?
- (2) How are multiple languages represented and processed in polyglots' brains (Study 2)?

Polyglot Sample (n=20):

- M(languages spoken)=15.9, MDN=13, range: 5-55
- 9 females; 1 left-handed
- M(age)=30.7
- 9 hyperpolyglots (>10 languages)
- compared against (i) a matched sample of non-polyglots (n=20), (ii) a larger sample of non-polyglots (n=217)

Study 1: Does the language network in polyglots differ from non-polyglots?

- Language Localizer Task (Fedorenko et al., 2010)



SENTENCES > NONWORDS

Figure 1. Examples of the trial of the Language Localizer task.

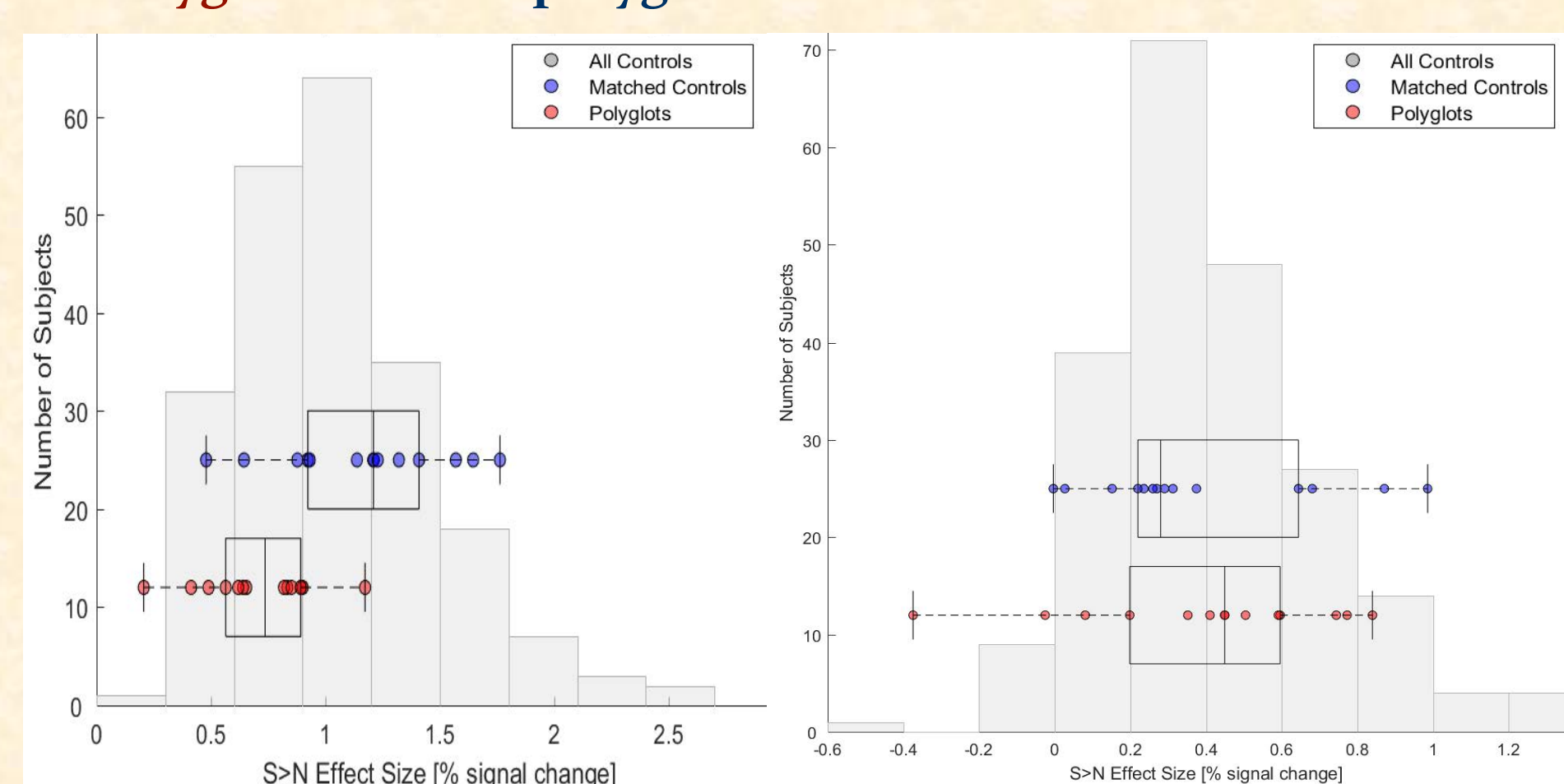
Sentences condition									
A	RUSTY	LOCK	WAS	FOUND	IN	THE	DRAWER	+	
Nonwords condition									
DAP	DRELLLO	SMOP	UP	PLUD	KAV	CRE	REPLODE	+	
Each word/nonword presented for 350 ms									300 ms

Functional Measures of Interest

Response Magnitude	Effect size for a relevant contrast: -Sentence > Nonwords -Take top 10% of voxels Extract the response in a left-out portion of the data
Region Volume	The number of voxels for a relevant contrast at a certain significance threshold (p<.001,unc.)
Lateralization	(Nvoxels LH - NvoxelsRH) / (Nvoxels LH + Nvoxels RH) 1 = Left Lateralized -1 = Right Lateralized 0 = No Dominance

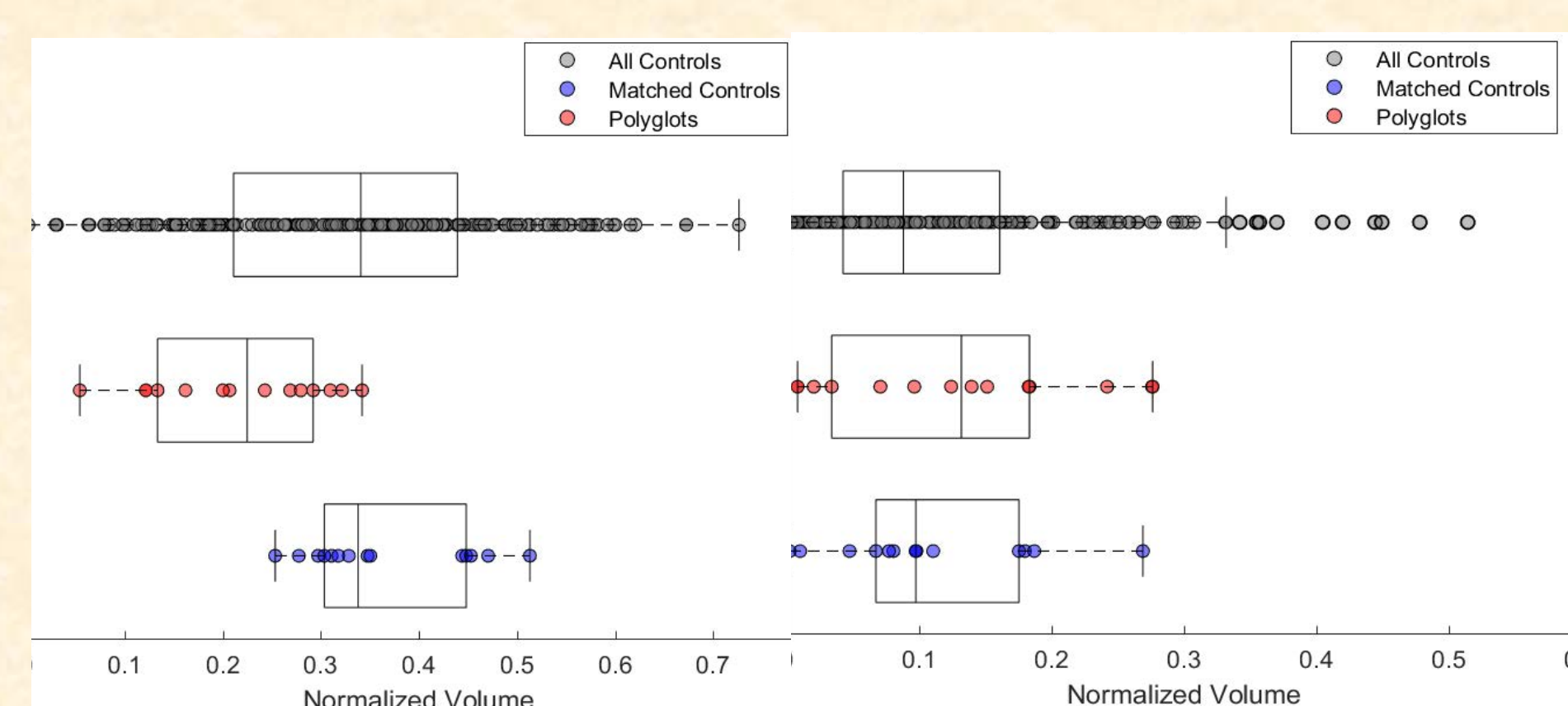
Results – Study 1

Figure 2. Effect sizes in the LH & RH Language Network of **Polyglots** vs. **Non-polyglots**.



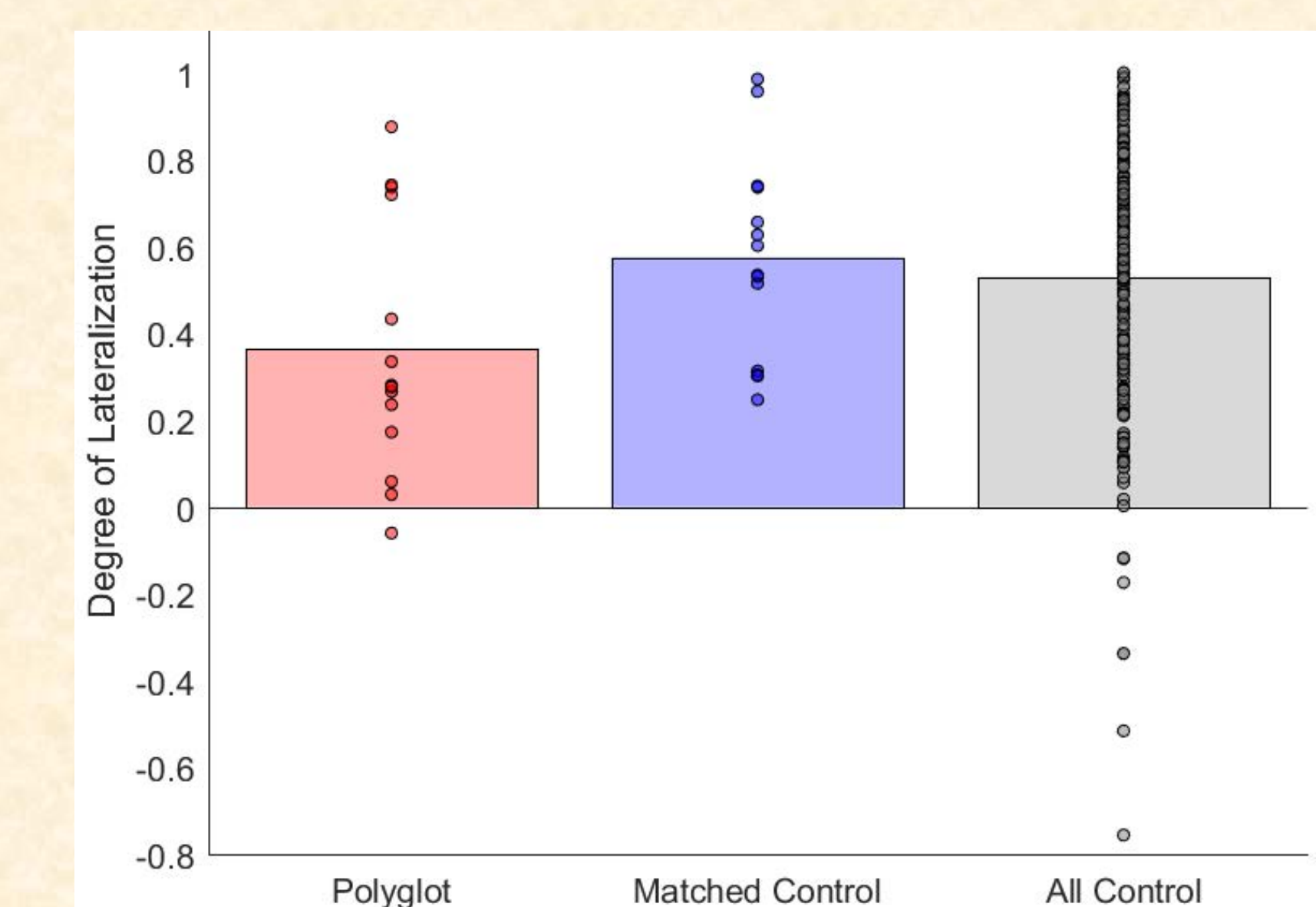
Reduced response magnitudes in the LH Language Network in polyglots

Figure 3. Region volumes in the LH and RH Language Network of **Polyglots** vs. **Non-polyglots**.



Reduced region volumes in the LH Language Network in polyglots

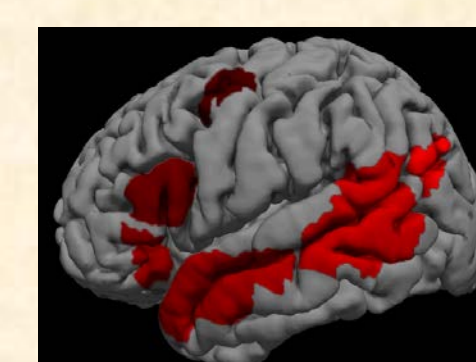
Figure 4. Volume-based degree of lateralization in the Language Network of **Polyglots** vs. **Non-polyglots**.



Reduced lateralization for language in polyglots

Study 2 – How are multiple languages represented in polyglots' brains?

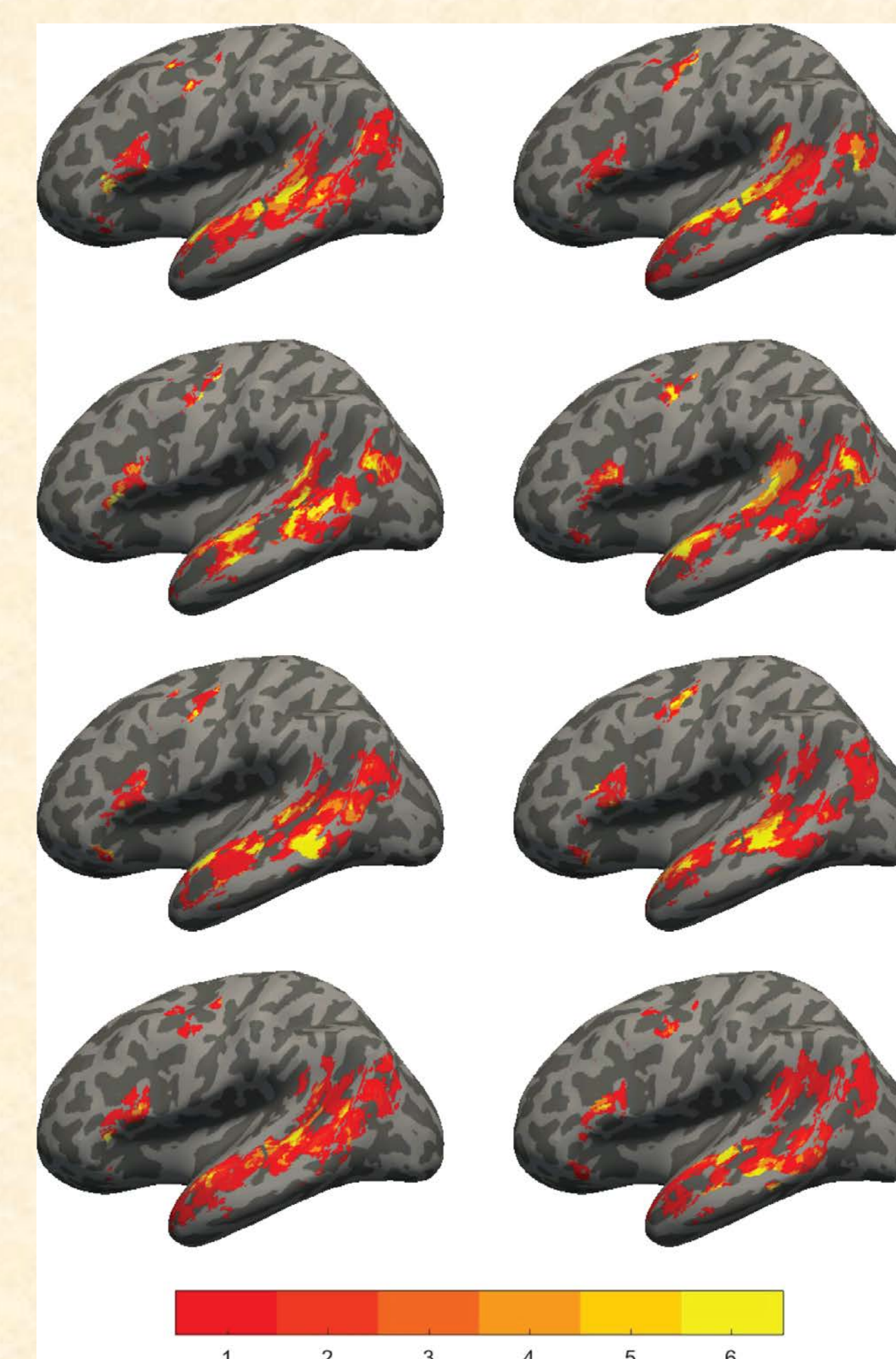
- Multi-language Listening Task
- Passively listened to speech excerpts and scrambled speech in native (L1), non-native familiar (L2-4), cognate unfamiliar (L5-6), and non-cognate unfamiliar languages (L7-8)



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Results – Study 2

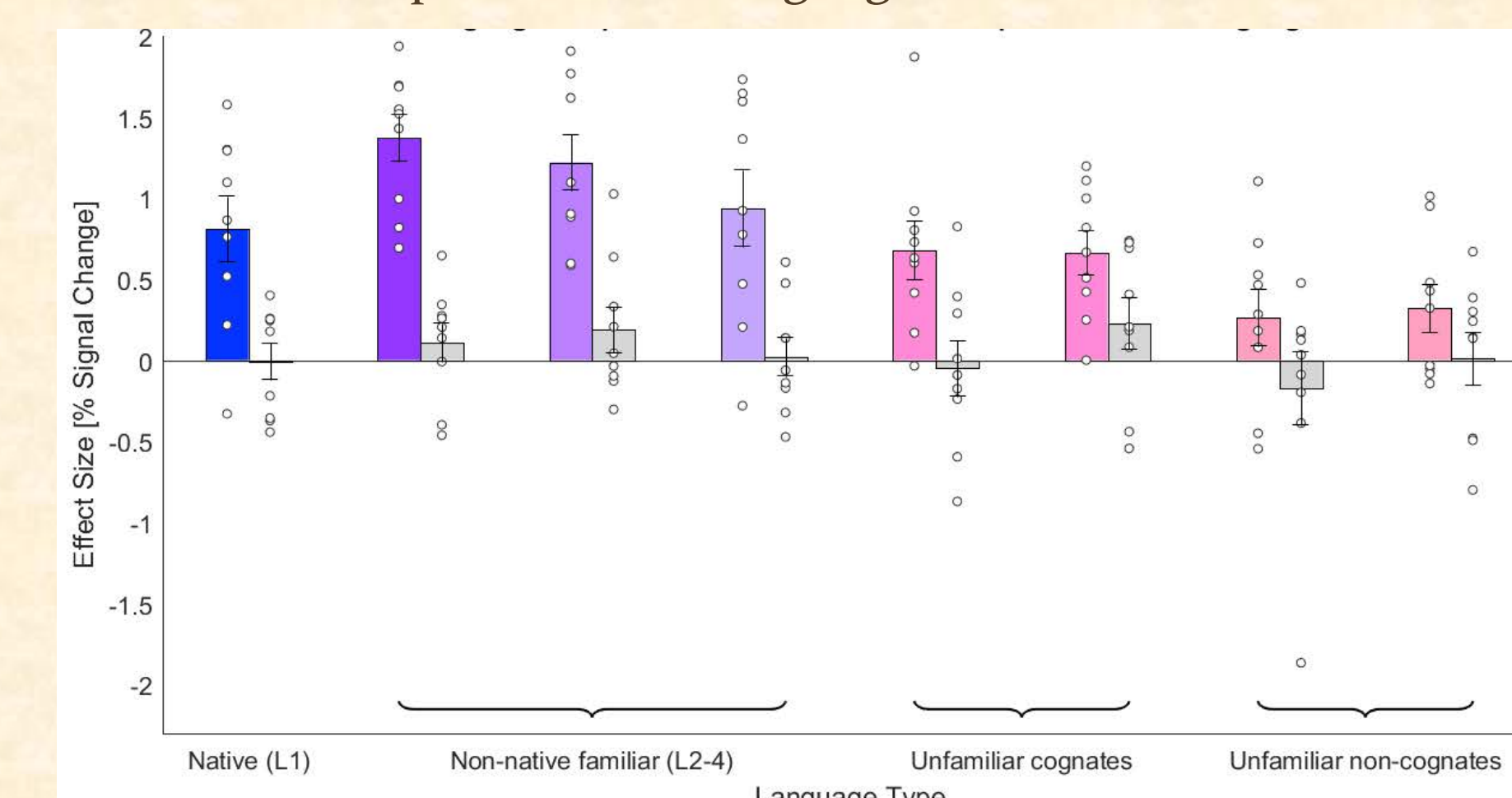
Figure 5. Sample individual maps for the Intact>Scrambled contrast in L1-L6



Different languages activate highly overlapping areas within the language network

Results – Study 2 (continued)

Figure 6. Responses of the LH Language Network to Intact and Scrambled speech across languages.



Responses to speech scale with proficiency, decreasing from L2 to L8

Response to L1 is lower than responses to L2-L4

Discussion:

- **Q1:** Polyglots have a smaller language network and they activate it to a lesser degree (more efficient organization?).
- Language processing is more efficient as a result of learning multiple languages.
- Alternatively, polyglots process language more efficiently from the start.
- Reduced language lateralization may characterize both linguistic impairment (greater RH activity; Kleinmans et al., 2008; Tesink et al., 2009) and linguistic giftedness (reduced LH activity).
- **Q2:** Different languages activate highly overlapping areas in the brains of polyglots (a common neural circuitry?).
- With decreasing proficiency, polyglots can extract progressively less linguistic information from the speech signal, hence, scaling down of responses with a decrease in familiarity with languages.