The role of statistical learning in speech processing of dogs as evidenced by awake fMRI

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Introduction

Human infants are tuned to spoken language from birth and use **computational strategies** to detect the statistical and prosodic patterns in a language input[1].

In contrast there is a limit to language capacity in non-human species, which is especially apparent in vocabulary acquisition[2]. Although, there is behavioural evidence for statistical learning in some mammals[3,4], the neural basis of this ability is not known in non-human species.

Dogs live in the **same language environment** as humans, they attend to spoken words and process them similarly to humans, as evidenced from neuroimaging studies[5,6]. Consequently, the aim of the present study is to investigate if a **neural attunement to statistical regularities** in language can be observed in dogs, similarly to humans [7-10].

Methods

Stimuli: Two sets of 12 syllables forming two conditions – equal frequency, different transitional probabilities (TP, the conditional probability of one syllable following the other):

Word: **daropi**golatu**pabikutibudo**golatu**daropitibudo**

TP 1 0,3 1 1

Random: **pefimunovukabafugivikogabanokagifimukope**

TP 0,09 0,09 0,09 …

Subjects: 18 fMRI trained family dogs (8 males, mean age 5,5 yrs)

Acquisition details: Sparse sampling, 8 channel coil, 32 transverse slices, acquisition matrix 80 × 58; TR=7700 ms, including 1700 ms acquisition and 6000 ms silent gap; TE=12 ms; flip angle=90°

Data preprocessing SPM12 (realignment, manual coregistration, normalization to an in-house template, smoothing 4mm FWHM)

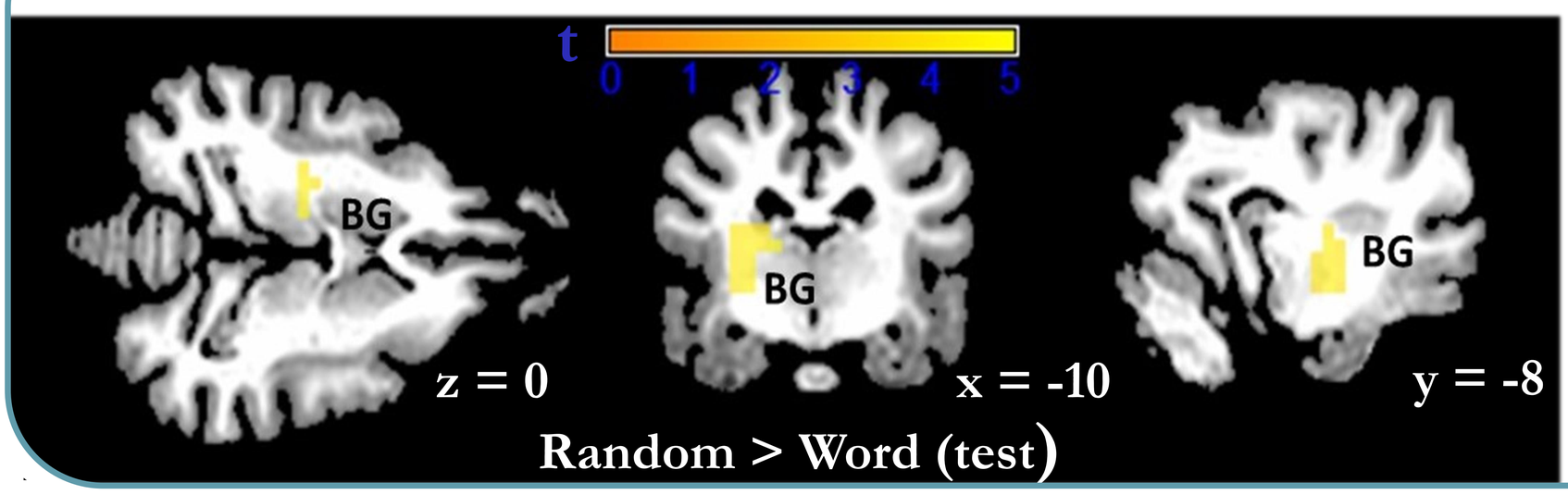
Procedure: 3 sessions following each other immediately

Baseline fMRI	Exposition	Test fMRI
3 blocks per condition	10 blocks per condition	3 blocks per condition
5 blocks of silence	no silence	5 blocks of silence
~5 mins	2 x 8 mins	~5 mins

Comparisons:

1. Pre vs post exposition
2. Word vs Random condition

Results



No difference between the word and random condition in the **baseline** fMRI measurement.

Stronger response for the random than for the word condition in the **test** fMRI measurement in the **left basal ganglia**.

Activity rendered on a template dog brain. Cluster size threshold: $p_{FWE}<.05$

Conclusions

- Similarly to rats [4] and cotton top tamarins[3], dogs can quickly (~20 mins exposure) learn and extract statistical regularities found in a linguistic input.
- In dogs this ability seems to be mediated by the basal nuclei, which are known to support sequence learning[11].
- This mechanism is different from that found in humans, where statistical language learning predominantly involves language processing areas (superior temporal gyrus, inferior frontal gyrus and ventral premotor cortex) [7-10] .

References

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