The Neural Basis of Program Comprehension

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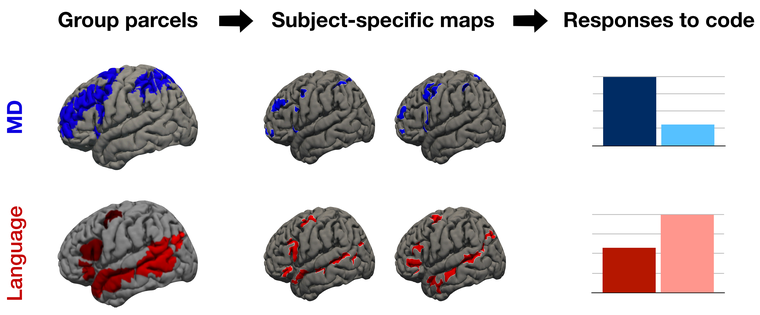
Objective

We use fMRI to evaluate the role of the **Multiple Demand (MD) System** and the **Language System** in computer program comprehension.

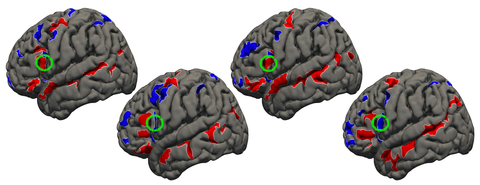
MD System: responds during math, logic, and spatial reasoning tasks

Language System: responds to linguistic input

Method: Functional Localization



Functionally localizing networks of interest allows us to distinguish between them in spite of intersubject variability



Green circles indicate anatomically identical locations that encompass a part of the language system (top) or MD system (bottom)

Experiment 1 - Python

Code problems

```
big_num, small_num = 64, 16

if big_num % small_num == 0:
    print(1)
else:
    print(0)
```

Sentence problems

You are given two numbers 64 and 16. If the remainder when the first number is divided by the second number is 0, you perform one good deed. Otherwise, you perform no good deeds. How many good deeds will you perform?

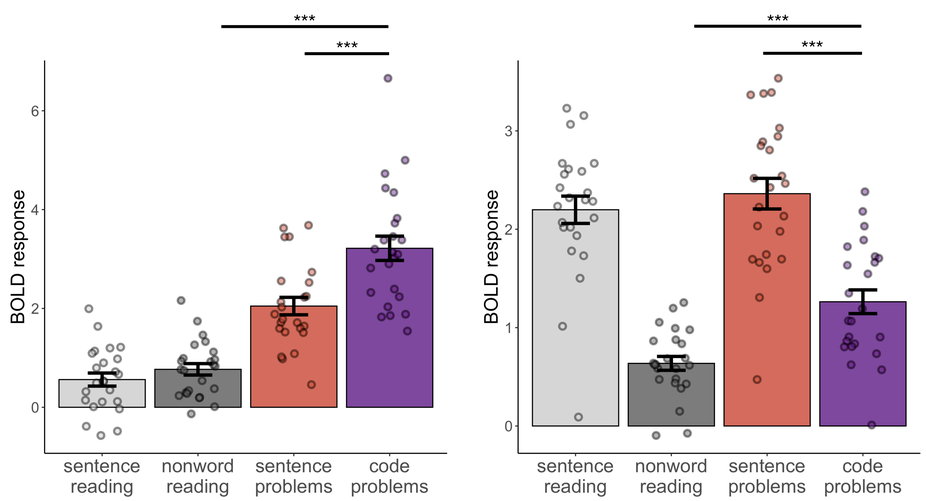
```
filename = "alphabet.java"
modified = filename.split(".")

print(modified[-1])
```

A file is named "alphabet.java". You split the name at the dot character. What is the last part of resultant split?

24 participants (13 women); data preprocessed in SPM.

Experiment 1 Results

Both Systems Respond to Python Code



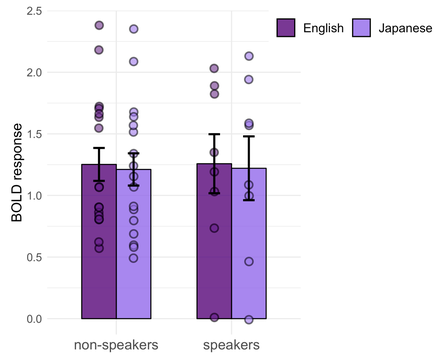
The language system response is not driven by single words

English identifiers

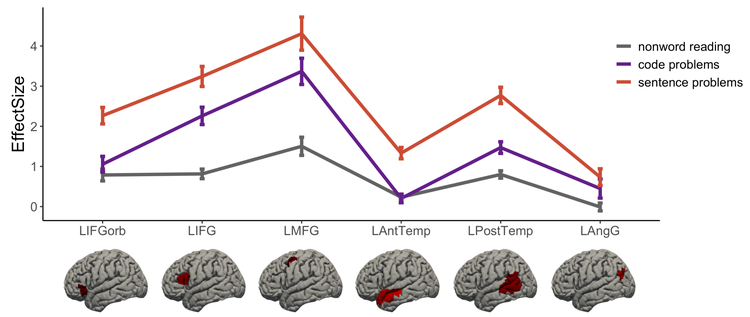
```
height = 5
weight = 100
bmi = weight / (height*height)
print(bmi)
```

Japanese identifiers

```
sincho = 5
taiju = 100
keisu = taiju / (sincho*sincho)
print(keisu)
```



The same regions respond to code and sentence problems



Experiment 2 - ScratchJr

Code problems

Sentence problems

Kitten walks right, jumps, and then walks left.

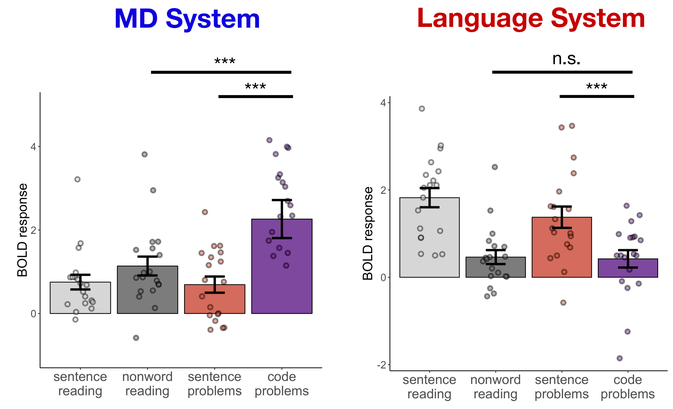
Did the instructions match the video?

1 - yes 2 - no

21 participants (13 women); data preprocessed in SPM.

Experiment 2 Results

Only the MD System Responds to ScratchJr



Conclusion

- The **Multiple Demand System** responds to both Python and ScratchJr code.
- The **Language System** only responds to Python code, and its response might be task-dependent.
- Studying programming in the brain can shed light on the functions performed by preexisting neural systems.

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