Code Comprehension for Looping Programs

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COGS-Q 370 Final Project

Background

- Computer programs are important!
- The way that programs are written affects ease of understanding
  - Variable names should reflect function
  - Don’t include unused code
  - Whitespace in Python programs
- Ease of understanding is important for collaboration
- Top-Down and Bottom-Up models of comprehension
- Use of working memory as vocabulary size increases

More Background…

- Loops: Parts of a program where code is repeatedly executed until some condition is satisfied
- Lists: Ordered sequence of values in a program
  - [1, 2, 6, 7]
- Research Question: How does the number of loop iterations affect code comprehension?
  - Does this effect vary for different sorts of programs?

Method

- Independent Variables
  - List length: { 1, 5, 10, 20 }
  - Program used - 12 options, 3 types
- Dependent Variables
  - Accuracy
  - Response time
- Programmed web app using jsPsych
- Subjects asked to predict output of program

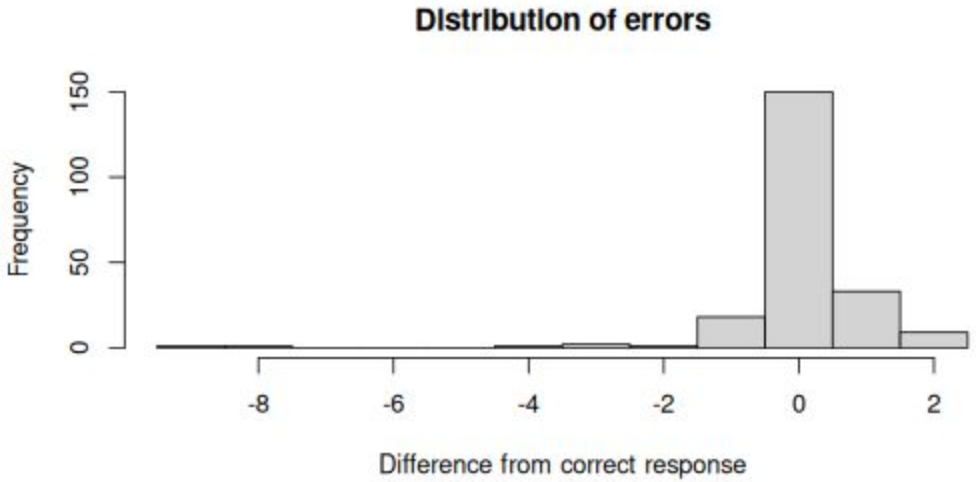
```
# Example of hard
ls = [3, 3, 9, 2, 8]
a = 0
i = 0

while i < len(ls):
 if ls[i] % 2 == a % 2:
   a = a + 1
 i = i + 1

print(a)
```

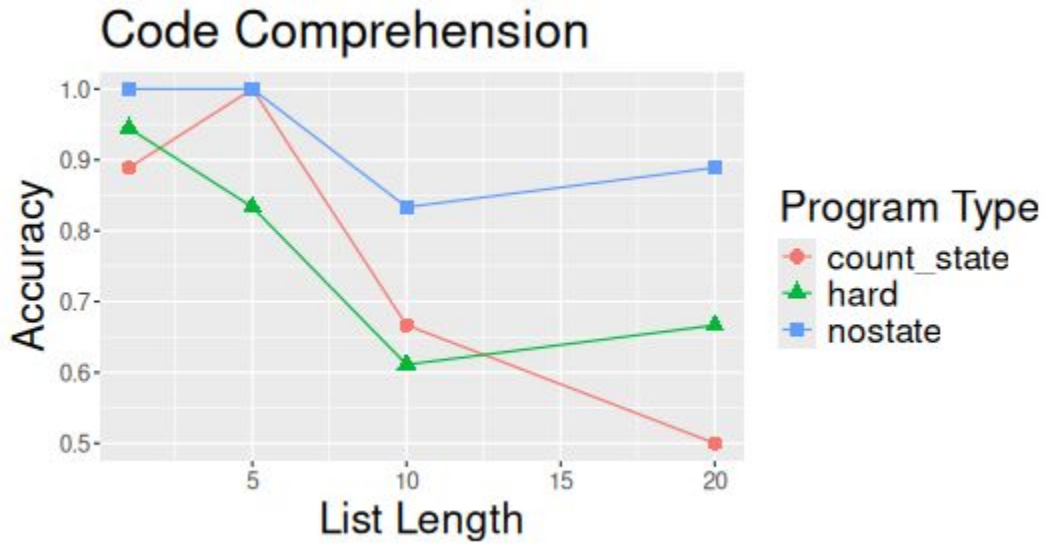
```
# Example of count_state
ls = [3, 3, 9, 2, 8]
a = 0
b = 0
i = 0

while i < len(ls):
 if ls[i] < a:
   b = b + 1
 a = ls[i]
 i = i + 1

print(b)
```

```
# Example of nostate
ls = [3, 3, 9, 2, 8]
a = 0
i = 0

while i < len(ls):
 if ls[i] % 2 == 0:
   a = a + 1
 i = i + 1

print(a)
```

Accuracy

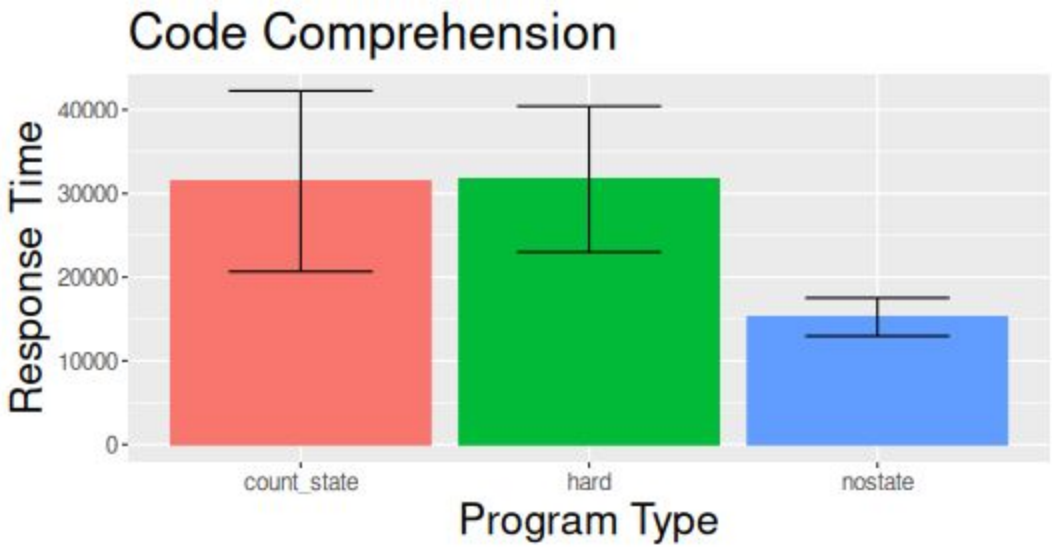
- 77.3% of errors were “off-by-one”
- Program type and list length affect accuracy ($p < 0.05$)
- Interaction effect ($p < 0.2$)

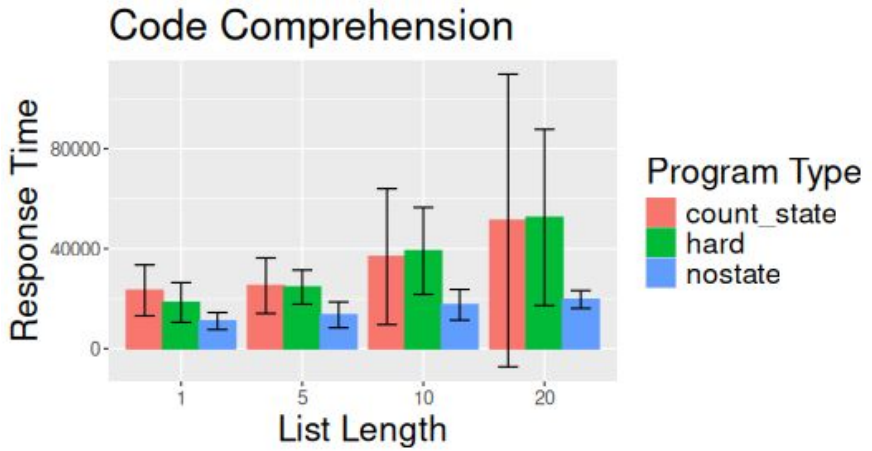




Response Time

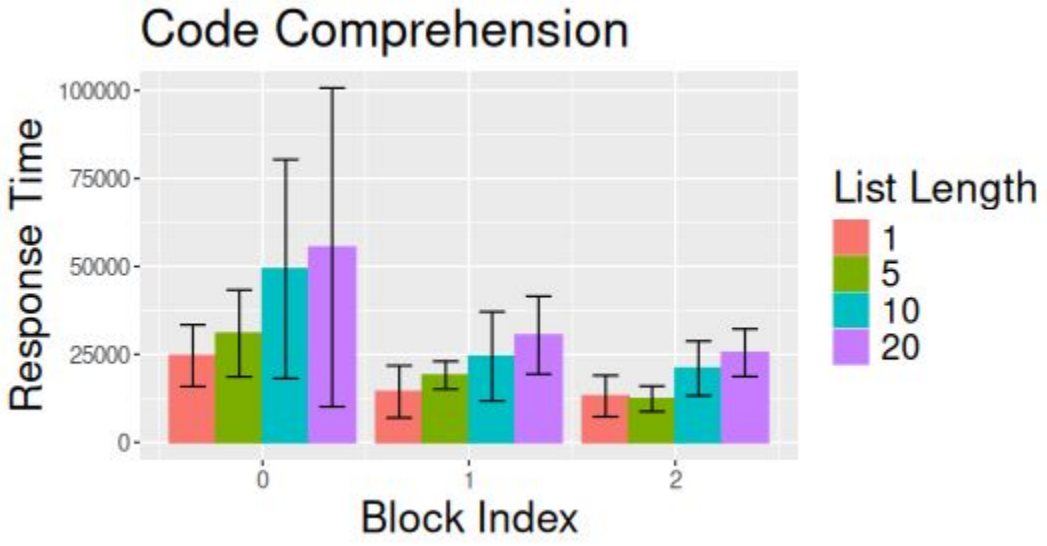
- Main effect of program type and list length ($p < 0.05$)
- No significant interaction effect
- Response time not correlated with accuracy

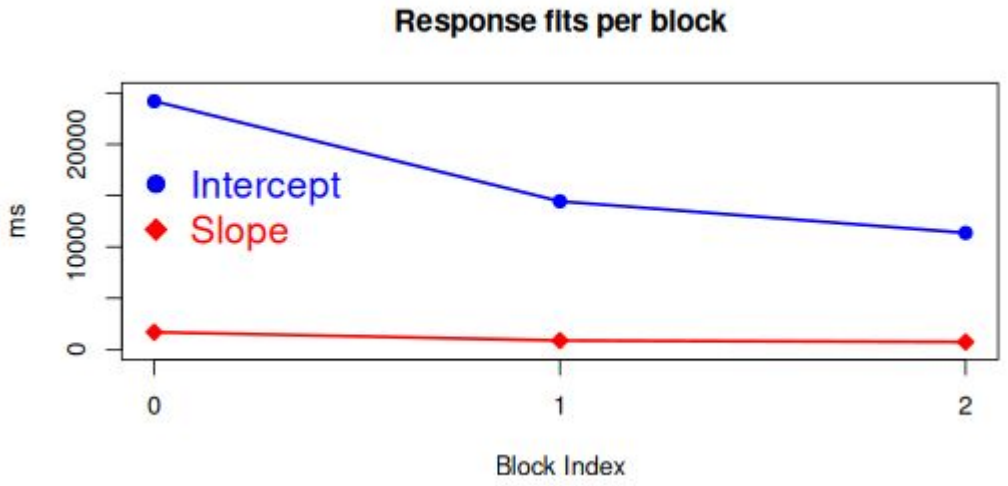




Learning

- Significant effect of block on response time ($p < 0.05$), but not on accuracy
- Intercept decrease indicates improvement at recognition





Discussion

- Response time increases with list length
- Recognition of program templates - developing schema?
- Accuracy and response time don’t correlate
  - Mistakes purely due to increased chance of calculation error
  - Error rates higher for program types with more variables
- Next steps (sorta kinda hypothetically)
  - More varied program structures (nested loops)
  - More information about learning rate for experienced vs. inexperienced programmers
  - Effects of increased size of non-list data structures
  - Higher order functions