

# A Role for Phonological Information in Relative Clause Processing

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## Background

- Increased difficulty of **Object extracted relative clause (OR)** sentences compared with **Subject extracted relative (SR)** sentences is often attributed to **increased memory burden** in the harder sentences

OR: The reporter that the senator attacked admitted the error.  
SR: The reporter that attacked the senator admitted the error.

- Nature of memory burden unclear
  - Syntactic dependencies? (Lewis, 1996)
  - Thematic roles? (MacWhinney, 1987)
  - Discourse entities? (Gibson, 1998; Warren and Gibson, 2002)
  - Semantic representations? (Gordon, Hendrick & Johnson, 2001)

All of these accounts put locus of memory burden on semantic and/or syntactic representations and do not consider a role for **phonological information**

### Why phonological information?

- Phonological information may be used to maintain the serial order of words while processing of complex sentences (Baddeley, Eldridge and Lewis, 1981)

**Question:** Does phonological information play a role in the processing of sentences containing relative clauses?

## Experiments

**Goal:** Examine whether phonological information is used in the processing of OR and SR sentences by taxing the phonological system through the introduction of **phonological overlap**

### Materials

#### Experimental Sentences

Matched for length, frequency and plausibility

#### Experiment 1: Object Relative Sentences

##### OR with Phonological Overlap

The preacher that the teacher fought caught the athlete  
(Comprehension question: Did the teacher fight the preacher?)

##### OR without Phonological Overlap

The preacher that the runner feared caught the athlete  
(Comprehension question: Did the runner catch the athlete?)

#### Experiment 2: Subject Relative Sentences

##### SR with Phonological Overlap

The preacher that fought the teacher caught the athlete  
(Comprehension question: Did the teacher catch the athlete?)

##### SR without Phonological Overlap

The preacher that feared the runner caught the athlete  
(Comprehension question: Did the runner fear the preacher?)

Overlap and Non-Overlap sentences differed at only two words

### Participants & Procedure

Participants: 104 native speakers of English in each experiment.

#### Self-Paced Reading Paradigm

- Sentences read one word at a time
- Yes/no comprehension question followed each sentence
- 24 experimental and 96 filler items

### Predictions

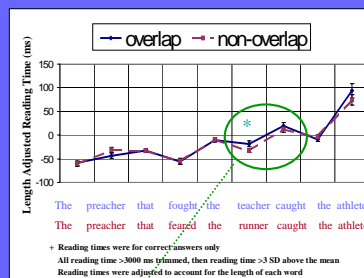
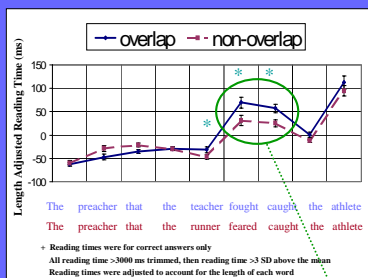
- Phonological overlap will produce processing difficulties in the form of increased reading times at points of overlap, reduced comprehension and increased question answering time
- More difficult OR sentences may exhibit larger effect of overlap compared to SR sentences

## Results

### Experiment 1 - Object Relatives

### Experiment 2 - Subject Relatives

### Word-By-Word Reading Times



**Result:** OR sentences show an effect of phonological overlap at both the embedded and main verbs whereas SR sentences show this effect only at the embedded noun, yielding a significant three way interaction between sentence type, overlap condition and word position

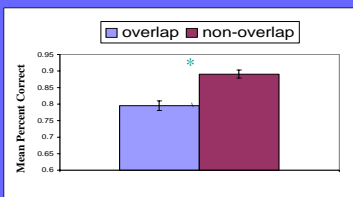
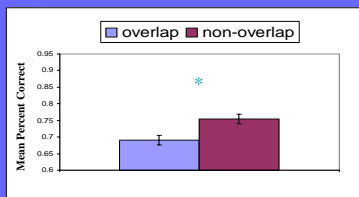
Word Position 6  
Embedded Verb/Noun

**Result:** Difference in reading time between overlap and non-overlap sentences for OR sentences only marginally larger than SR sentences ( $F(1,206) = 3.394, p = 0.067$ )

\*Word Position 7  
Main Verb/Noun

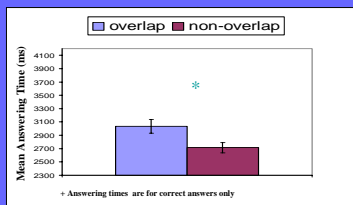
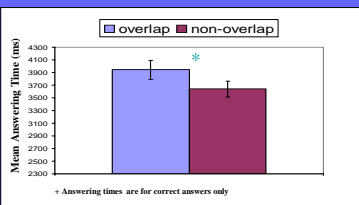
**Result:** Difference in reading time between overlap and non-overlap sentences significantly larger for OR sentences but not for SR sentences ( $F(1,206) = 3.934, p = 0.049$ )

### Comprehension Accuracy



**Result:** SR comprehension significantly higher than OR, but accuracy declined in overlap conditions for both sentence types; no interaction of sentence type and overlap

### Question Answering Time



**Result:** OR question answering time significantly longer than for SR sentences, significant effect of overlap on answering time in both sentence types, and no interaction of overlap and sentence type.

## Two Main Results

### A. Phonological information affects comprehension

- Reading times longer for **Overlap** vs. **Non-Overlap** sentences for both relative clause constructions
- Comprehension worse and question answering time longer for **Overlap** vs. **Non-Overlap** sentences

### B. Differences between SR and OR sentences

- Overall **SR** sentences easier than **OR** sentences
  - Better comprehension
  - Shorter question answering time
  - Shorter reading times
- Smaller effect of phonological overlap on reading times in **SR** than **OR** sentences

## General Discussion

Current memory-based accounts do not make explicit predictions about the effects of phonological overlap in the processing of OR and SR sentences.

- However, there may be ways that each model could be modified to incorporate a phonological component

### A. Why should phonological information matter?

- Phonological overlap leads to poorer memory in verbal working memory tasks (Conrad and Hull, 1964).
- Phonological information is a part of lexical representation in the context of word recognition, overlap leads to competition
  - e.g., TRACE (McClelland and Elman, 1986) and triangle (Harm and Seidenberg, 1999) models.

### Some possible consequences:

#### 1. For Semantics

Phonological interference could lead to reduced semantic activation, impairing thematic role assignment, development of discourse representation (e.g. Gibson, 1998; Warren and Gibson, 2002)

#### 2. For Parsing

Phonological information might be used to maintain serial order of words (Baddeley, Eldridge & Lewis, 1981)

Parsing of OR sentences requires maintenance of multiple nouns before each is assigned a predicate. Maintaining the order of these nouns is critical to correct assignment

### B. Why were there differences in OR vs. SR reading times as a function of the phonological overlap manipulation?

#### Two possibilities:

- OR sentences are simply more difficult than SR sentences, hence are more susceptible to increased demands on memory induced by phonological overlap
- Overlapping words were adjacent (XXYY) in OR sentences but interspersed (XYXY) in SR sentences:

OR: The preacher that the teacher fought caught the athlete

SR: The preacher that fought the teacher caught the athlete

The (XXYY) pattern may simply create more interference, independent of sentence difficulty.

## Conclusion

1. There is a role for phonological information in the processing of relative clause constructions

2. Models of sentence comprehension need to incorporate phonological information in addition to semantic, syntactic and discourse representations

#### References

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Please address questions/comments to Dan Acheson: