## Introduction

Sentences with early closure syntax (EC; Table 1 sentences 1-2) are associated with increased processing demand because the noun following the subordinate verb (*dance* and *watch*) tends to be initially interpreted as its direct object (DO; Frazier & Clifton, 1996). This results in the correct interpretation for late closure sentences (LC; Table 1, sentence 3), but not for early closure sentences (1 & 2), in which the initial analysis is incorrect and requires revision.

Lexical information such as verb subcategorization biases can affect processing of EC sentences because they provide cues that influence the likelihood of an EC interpretation. Subcategorization biases are the relative frequency with which verbs appear in different argument structure frames. Many verbs can appear in more than one argument structure, for example, *play* is used transitively in *The boy played a game* and intransitively in *The boy played*. An intransitively biased subordinate verb (as in 2) may support an EC interpretation, because it is less likely to take a DO. In contrast, a transitively biased subordinate verb (as in 1) reduces the likelihood of an EC interpretation because it is likely to take a DO. Several studies of written language have demonstrated that readers initially pursue the DO interpretation regardless of subcategorization bias (e.g., Van Gompel & Pickering, 2001, but c.f. Adams, Clifton, & Mitchell, 1998). However, recovery from misanalysis is faster when lexical information supports the EC interpretation, suggesting that such cues influence the ease of reanalysis (Van Gompel & Pickering, 2001). It is important to note that these effects only emerge in the absence of punctuation, and that a comma following the subordinate verb eliminates garden path effects. In the auditory modality, prosody fulfills a function similar to punctuation in written texts. Prosodic contours that mark the phrase boundary after V1 reduce garden path effects in EC sentences relative to contours that do not clearly mark phrase boundaries (Kjelgaard & Speer, 1999).

The present study used self-paced listening (SPL), an auditory analog of self-paced reading, to investigate whether prosody and transitivity bias interact to produce garden path effects similar to those observed in reading studies.

## Methods

### *Participants*

Twenty-one native English-speaking, non-brain damaged college students (age range=18-24, mean=20) participated in the study.

### *Procedures & Stimuli*

Fifteen sentence pairs containing EC syntax were developed (Table 1). One member of each pair contained a transitively biased subordinate verb with a post-verbal NP (NP2) that was a plausible DO (Table 1, sentence 1). The second member contained an intransitively biased verb with a post-verbal NP that was an implausible DO (Table 1, sentence 2). The sentence pairs were identical except for the subordinate verbs, which were matched for frequency using Francis and Kuçera (1980). All stimuli were followed by true/false comprehension probes.

The stimuli were recorded by a female speaker in both cooperating and neutral prosodies (Kjelgaard & Speer, 1999). The intonational contour of cooperating prosodies increased expectations of EC structure by prosodically marking the clause boundary after the subordinate verb. For the neutral prosody, neither of the possible clause boundaries was marked. Sentences were broken into segments consisting of short phrases using SoundEdit (Dunn, 1994) and then entered into PsyScope (Cohen, MacWhinney, Flatt, & Provost, 1993) to create the SPL experiment. In SPL, participants paced themselves through each sentence one phrase at a time by pressing a button interfaced with a computer. The button box collected response accuracy and reaction times for each button press.

The stimuli were randomly assigned to 4 lists such that each version appeared in only one list. These were combined with 63 filler sentences so that the experimental items comprised less than 20% of the items in each list. There were 15 filler sentences with LC syntax, to guard against development of expectations for EC or LC syntax. The remaining fillers were unrelated and unambiguous structures. All participants were tested on all four lists in separate testing sessions, with order of list presentation counterbalanced across participants.

## Results

*Listening times (LTs):* LTs for the critical segments (NP2 and the main verb) were analyzed in separate 2-way ANOVAS (transitivity x prosody). For NP2, there was a significant interaction of transitivity and prosody, $F(1, 20) = 20.29$, $p<.001$. When the subordinate verb (V1) was intransitive, LTs for NP2 were longer in the neutral prosodic condition. In contrast, when V1 was transitive, LTs for NP2 were longer in the cooperating prosodic condition.

There was also a significant interaction of transitivity and prosody for the main verb (V2), $F(1, 20)=4.54$, $p<.05$. For neutral prosodies, LTs were longer when V1 was transitively biased, suggesting that NP2 was initially interpreted as the DO, with resolution of the ambiguity delayed until V2. There were no significant differences in the cooperating prosodic condition.

*Comprehension probes*: There were no significant effects for response accuracy. Judgment response times showed a near-significant effect of transitivity, $F(1,20) = 4.21$, $p=.053$), with participants taking longer to make judgments about sentences with transitive (984 msec) compared to intransitive (871 msec) subordinate verbs.

## Conclusion

The results suggest that prosody interacts with transitivity during resolution of EC ambiguities, and that prosodic cues function similarly to commas in disambiguation of this structure. Cooperating prosodies cued participants to pursue an EC interpretation. When this conflicted with a plausible DO, processing load increased immediately and transiently. When the prosodic structure did not support the EC interpretation, lexical effects were found at NP2 following intransitively biased subordinate verbs and at the main verb following transitively biased subordinate verbs. Taken in isolation, the results from the neutral prosodic condition are consistent with those reported by Van Gompel and Pickering (2001), who suggested that subcategorization biases did not influence the initial interpretation but did influence ease of reanalysis. However, when the results from the cooperating prosodic condition are considered, the data suggest that these effects may reflect resolution of conflicting prosodic and lexical cues.

This work will be extended to people with aphasia in order to investigate whether people with disordered sentence processing use prosody, subcategorization bias, and lexical pragmatic information in the same ways as non-brain damaged populations. The ultimate goal of this work is to understand both disordered and non-disordered sentence comprehension in order to facilitate development of effective tools to diagnose and treat impairments of sentence comprehension.

References

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Table 1: Examples (slashes depict segmentation for self-paced listening)

| | | |
|---|---|---|
| 1. | Early closure (transitive bias) | While / the parents / watched (V1) / the child (NP2) / sang (V2) / a song / in the kitchen. |
| 2. | Early closure (intransitive bias) | While / the parents / danced / the child / sang / a song / in the kitchen. |
| 3. | Late closure | While the parents watched a movie, the child sang a song in the kitchen. |
| 4. | TF probe | The parents danced together. |

Table 2: Listening Times (msec)

| | *Cooperating Prosody* | | *Neutral Prosody* | |
|---|---|---|---|---|
| | NP2* | V2 | NP2* | V2* |
| Transitively biased verb | 421 | 397 | 399 | 463 |
| Intransitively biased verb | 388 | 398 | 429 | 382 |

*$p<.05$