Executive function and the asymmetry between children’s language production and comprehension

Malathi Thothathiri and Whitley Lucio
Department of Speech and Hearing Sciences, The George Washington University, Washington, DC

Introduction

Production lags behind perception in a number of domains, including language development. Children less than 3 years of age demonstrate grammatical knowledge in comprehension tasks [1,2,3]. Yet, children’s production of grammatical structures does not mature until 4 to 5 years [4,5,6].

The asymmetry is consistent and persistent (e.g., it is seen in adult second language acquisition), and the reasons likely go beyond simple task difficulty.

What additional processes are required for production over comprehension? We investigated one possible mechanism – the requirement to flexibly sequence words during production. Children’s executive function abilities including inhibition and flexibility are known to develop slowly. We tested two predictions that arise from this hypothesis:
1. Children will have greater difficulty in flexibly sequencing words during production than comprehension.
2. This difficulty will decrease with age.

Methods

34 English-speaking children (17 Male, 5.8 - 7.10. Mean age = 6.7). Each completed two closely matched production and comprehension tasks.

Production task: Name aloud two pictures as they appear on the screen, from left to right, using the form “X and Y”. Comprehension task: Listen to a pre-recorded “X and Y” phrase and selected the noun in one phrasal position for two trials and then asked the child to produce a noun in the phrase.

Data from 10 children were excluded (bilingual, did not know English labels for the stimuli, low accuracy, experiment error). Analyses are reported for the remaining 24 children (12 male. 12 got production task first).

Results

Data from 10 children were excluded (bilingual, did not know English labels for the stimuli, low accuracy, experiment error). Analyses are reported for the remaining 24 children (12 male. 12 got production task first).

Production Results

Accuracy: equal for consistent and inconsistent trials (86.67%). RTs: slower to name pictures during inconsistent (1267.27 ms) than consistent (1169.22 ms) trials. F(1,23)=6.05, p<.03.

Age-dependent effects: Median-split into two groups (<79 months and >80 months).

Comprehension Results

Accuracy: equivalent for consistent (87.92%) and inconsistent (85.83%) trials. RTs: No effect of condition. F<1, p>.6.

No age-dependent effects.

Comparison between Production and Comprehension

Because raw RTs are necessarily different in the two tasks, we computed a normalized interference score that has been used previously with frontal cortex patients (Thothathiri et al., 2010).

Normalized interference score = (Inconsistent RT – Consistent RT)/Filler RT * 100.

Discussion

We argued from first principles that lack of sequencing flexibility during development might constrain sentence production more than comprehension. Using two closely matched tasks and measures that specifically index sequencing flexibility, we found that children showed a significant reaction time cost when they had to flexibly change word order during production but not comprehension. Further, the reaction time cost effect during production decreased with age.

These results support the idea that increasing sequencing flexibility – potentially corresponding to increasing frontal maturation – might allow older children to produce different word orders in ways that surpass the speech of younger children.

Future studies could extend these results to other ages and language structures, and examine the relation between developing executive function and flexibility during language production.

References


Not just task sensitivity difference

1. Can detect RT differences between conditions with comprehension task: primed trials (consistent and inconsistent) faster than filler trials.
2. Can detect RT differences between individuals with comprehension task: correlated with production RTs.

We thank Rachel Crane for piloting an earlier version of this study, Rita Purcell-Robertson for enabling testing in the Loudon County public schools, and the staff, parents and children at Cedar Lane Elementary School for their enthusiastic support and participation.

Please contact malathi@gwu.edu for more information.