

Re-examining the role of working memory in bilingual sentence processing

Filiz Çele^{1,2} and Ayşe Gürel¹

¹Boğaziçi University, ²Kadir Has University

contact: filiz.cele@boun.edu.tr

Psycholinguistic research on sentence processing has shown that bilinguals process complex and temporarily ambiguous sentences in the second language (L2) less accurately and more slowly than monolinguals do. It has been suggested that this difference results from the variation in working memory (WM) capacity (Harrington & Sawyer, 1992; Juffs & Harrington, 1995). However, findings are inconsistent as regards the role of WM capacity in online sentence processing (Juffs, 2004; 2005; Felser & Roberts, 2007; Dussias & Piñar, 2010). One concern with previous research studies is that they measured the WM capacity using a single WM task (e.g. Reading Span). Conway et al. (2005) argue that no single test is a perfect measure of the construct it is meant to represent.

We examined the relationship between the WM capacity and online processing of complex *wh*-questions in L2 English by testing 30 Turkish-English bilinguals and 31 native English speakers on an online grammaticality judgment (OGJ) task and two WM measures: the Automated Reading Span (ARSPAN) and Automated Arithmetic Span (AOSPAN) tasks (Unsworth, et.al., 2005). The Turkish participants also took an ARSPAN test in Turkish to determine whether or not WM is language-independent. The OGJ task focused on long-distance grammatical (1a-e) and ungrammatical *wh*-extractions (2a-e) in English presented in two conditions: the full-sentence, and the self-paced word-by-word reading condition (Just et al, 1982).

The results reveal a strong positive correlation between the ARSPAN and AOSPAN tasks in the native English group ($r = .768^{**}$) ($p < .01$) and the bilingual group ($r = .753^{**}$) ($p < .01$). This supports the findings of Turner & Engle (1989), and Unsworth et al. (2005), and suggests that both the ARSPAN and AOSPAN tasks are strongly related to each other and are valid indicators of WM capacity. There was also a strong positive correlation between the ARSPAN in Turkish and in English ($r = .619$; $p < .01$), which suggests that the WM capacity is a language-independent construct (Osaka & Osaka, 1992). The results from the OGJT given in both conditions reveal that the bilinguals were significantly less accurate and slower on grammatical *wh*-extractions than English monolinguals. With respect to accuracy on ungrammatical *wh*-extractions, no significant difference was observed between the two groups, except for *wh*-extractions with *that*-trace violation. The Turkish-English bilinguals were significantly less accurate and slower than English monolinguals. No significant correlation was observed between WM measures and accuracy scores and RTs for grammatical and ungrammatical *wh*-extractions in the OGJ task. This suggests that the difficulty in online judgment of (un)grammatical *wh*-extractions is not due to the limitation in WM capacity. These findings support the Separate Sentence Interpretation Resource Theory (Waters & Caplan, 1996a; 1996b), which suggests separate WM resources dedicated to sentence processing.

Examples for wh-dependencies:

Grammatical wh-sentences:

1. a. What does the woman think the plumber stole from the garage? (Object extraction/ finite clause)
- b. What does the inspector think that the boy stole from home? (Object extraction/ finite clause with *that*)
- c. Who does the manager expect to meet at work this morning? (Object extraction /nonfinite clause)
- d. Who does the woman think stole the bicycle in the garage? (Subject extraction/ finite clause)
- e. Who does the manager expect to meet the job applicants today? (Subject extraction/ nonfinite clause)

Ungrammatical wh-sentences:

2. a. *Who did Alison go to work after she took to school? (Adjunct Island)
- b. *What does James believe the fact that Alison saw at work? (Complex Noun Phrase Island)
- c. *What does Jane visit the architect who designed for her friend? (Relative Clause Island)
- d. *Who does the teacher believe a story by amuses the children? (Subject Island)
- e. *Who do the police believe that attacked the man last night? (*That*-trace)

References

- Conway, A. R. A., Kane, M. J., Bunting, M. F., Hambrick, D. Z., Wilhelm, O., & Engle, R. W. (2005). Working memory span tasks: A methodological review and user's guide. *Psychonomic Bulletin & Review*, 12, 769-786.
- Dussias, P.A., & Piñar, P. (2010). Effects of reading span and plausibility in the reanalysis of *wh*-gaps by Chinese-English second language speakers. *Second Language Research*, 26, 443-472.
- Felser, C., & Roberts, L. (2007). Processing *wh*-dependencies in English as a second language: A cross-modal priming study. *Second Language Research*, 23, 1-28.
- Juffs, A. (2004). Representation, processing, and working memory in a second language. *Transactions of the Philological Society*, 102, 199-225.
- Juffs, A. (2005). The influence of first language on the processing of *wh*-movement in English as a second language. *Second Language Research* 21, 121-51.
- Juffs, A. & Harrington, M. (1995). Parsing effects in second language sentence processing: subject and object asymmetries in *wh*-extraction. *Studies in Second Language Acquisition* 17, 483-516.
- Harrington, M., & Sawyer, M. (1992). L2 working memory capacity and L2 reading skills. *Studies in Second Language Acquisition* 14, 25-38.
- Osaka, M. & Osaka, N. (1992). Language independent working memory as measured by Japanese and English reading span tests. *Bulletin of the Psychonomic Society* 30, 89-287.
- Turner, M. L., & Engle, R. W. (1989). Is working memory capacity task dependent? *Journal of Memory and Language*, 28, 127-154.
- Unsworth, N., Heitz, R. P., Schrock, J. C., & Engle, R. W. (2005). An automated version of the operation span task. *Behavior Research Methods*, 37, 498-505.
- Waters, G. S., & Caplan, D. (1996a). The measurement of verbal working memory capacity and its relation to reading comprehension. *The Quarterly Journal of Experimental Psychology*, 49A, 51-79.
- Waters, G.S., & Caplan, D. (1996b). The capacity theory of sentence comprehension: Critique of Just and Carpenter (1992). *Psychological Review*, 103, 761-772