

Visual ERP repetition effects to novel objects predict word fast-mapping ability
in 20-month-olds

K Borgström, J v K Torkildsen, M Lindgren

Vocabulary development between 18 and 24 months shows enormous individual variability (Fenson et al., 1994). Although the causes of individual differences are many and complex, one factor that has been found to predict productive vocabulary at this age is the ability to receptively fast map a novel word to a novel object (Torkildsen et al., 2009; Torkildsen et al., 2008). In other words, productive vocabulary is dependent on effective receptive processing of novel words and their referents. Previous research has demonstrated this link using ERP measures of word processing during learning, and later mismatch responses (N400) to incongruous word and object pairings. We wanted to investigate if efficiency of visual object processing could also be predictive of subsequent measures of successful fast mapping.

A sample of 20 months old children ($n = 38$) contributed data in an ERP experiment showing pictures of fantasy objects paired with auditory presentations of pseudowords. Familiar words and objects were also included as a control. The experiment contained 30 items of each stimulus type, divided into 10 independent presentation blocks. During a learning phase each picture was presented five times together with the same label, always with other interleaving pictures/words, and the picture was presented 1000 ms before onset of the word stimulus. In a test phase directly following the learning phase, the same pictures were presented with a label that was incorrect but equally familiar. The semantic incongruity effect as measured by N400 amplitude was used as an index of successful fast mapping, and this was related to a negative central (Nc) response to the picture stimuli, modulated by repetition.

EEG data was recorded with Electrical Geodesic's (EGI) HydroCel Geodesic Sensor Nets (HCGSN) with 128 channels. To test the relationship between ERP responses and vocabulary, the children were divided into two groups based on productive vocabulary size. Repeated-measures ANOVAs were carried out to test the statistical effects of differences in ERP waveforms, and productive vocabulary group was entered as a between-subjects factor. The relation between ERP effects was tested with a linear regression model.

The sample as a whole did not produce a significant N400 incongruity effect to newly

learned pseudowords, regardless of vocabulary size, although the effect was present in the real word condition. However, the size of the Nc repetition effect to fantasy object pictures was found to predict the size of the N400 amplitude difference between congruous and incongruous pseudoword presentations, $r = 0.462$, $p = 0.004$, and in fact, when grouped according to their repetition difference scores, a group of 11 children with the biggest amplitude difference due to repetition showed a significant N400 incongruity effect to the pseudowords, $F(1,10) = 5.69$, $p = 0.038$. The results suggest that the ability to successfully fast map novel words to novel objects is not only related to efficient word processing but also dependent on efficient processing of the visual object information.

References

- Fenson, L., Dale, P. S., Reznick, J. S., Bates, E., Thal, D. J., & Pethick, S. J. (1994). Variability in early communicative development. *Monographs of the Society for Research in Child Development*, *59*(5), v-173. doi: 10.2307/1166093
- Torkildsen, J. v. K., Friis Hansen, H., Svangstu, J. M., Smith, L., Simonsen, H. G., Moen, I., & Lindgren, M. (2009). Brain dynamics of word familiarization in 20-month-olds: Effects of productive vocabulary size. *Brain and Language*, *108*(2), 73-88.
- Torkildsen, J. v. K., Svangstu, J. M., Friis Hansen, H., Smith, L., Simonsen, H. G., Moen, I., & Lindgren, M. (2008). Productive vocabulary size predicts event-related potential correlates of fast mapping in 20-month-olds. *Journal of Cognitive Neuroscience*, *20*(7), 1266-1282. doi: 10.1162/jocn.2008.20087