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LANGUAGE

ERPs during auditory language comprehension in Williams syndrome: The effects of word frequency, imageability and length on word class

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Introduction

Williams syndrome (WMS) is a rare, genetically-based neurodevelopmental disorder resulting in moderate mental retardation (average IQ 55) and a distinctive neurocognitive profile. One of the most striking aspects of this syndrome is their preserved language processing coupled with poor non-linguistic processing. We investigated their on-line processing of auditory sentences to learn more about how the brain processes language in a population in which an ease of language use is paired with impaired general cognitive functioning.

Method

Thirty-eight normal adults and twenty-two adults with WMS participated in the study. Participants listened to eighty English sentences (1000 msec SOA), and pressed one of two buttons following each sentence to indicate whether the sentence made sense or not. Half of the final words of the sentences were highly expected given the preceding context, (e.g., "I have five fingers on my hand."), and the other half of the sentences ended in final words which were semantically anomalous (e.g., "I have five fingers on my moon."). Each of the words in the sentences were coded as to word class (content or function). Additionally, word length, imageability, and word frequency were coded as "low" or "high" for each word, each based on a median split within each of the word class categories.

Scalp electrical activity was recorded using tin electrodes in an elastic mesh cap (Electro-cap) from sites over anterior frontal (Fp1 and Fp2), frontal (F7 and F8), anterior temporal (50% of the distance from F7/8 and T3/4), temporal (33% of the distance from T3/4 to C3/4), parietal (50% of the distance between T3/4 and P3/4), and occipital (O1 and O2) regions of the left and right hemispheres, as well as from Cz and Pz (midline sites over central and parietal regions). In addition, the EOG was recorded to reject trials on which blinks or horizontal eye movement occurred.

Results

As reported previously, (Bellugi, et al., 1999; Mills, 1998; Neville, et al., 1993), participants with WMS had N400 components which were larger than controls, and the distribution of the N400s was bilateral, whereas the controls had N400s which were greater over the right hemisphere. For the controls, function words elicited an early left anterior negativity, and a later posterior negativity, the N400, was greater to content than to function words. The WMS participants did not reliably show either of these effects. In addition we also looked at ERPs based on imageability, frequency, and length because content words tend to be high in imageability, low in frequency, and long whereas function words which tend to be low in imageability, high in frequency, and short. Thus, it is possible that the ERP differences observed in response to word class might in fact be driven by differences in any of these three variables. Interestingly, although the WMS did not show ERP differences for word class, they did show larger-than-normal effects for frequency, length, and imageability, and in each case the WMS ERPs were in the same direction as controls. Importantly, ERPs for frequency, length, and imageability for both WMS and controls were different from ERPs elicited by word class. In conclusion, the ERP language profile of WMS seems to be one of less brain specificity. That is, when controls show asymmetries, WMS typically show bilateral activity. When controls show a front to back of the head pattern, WMS typically show equally large potentials over the whole head. Moreover, these data suggest that ERP differences to content and function words observed in normal controls may not be due to differences in frequency, length, or imageability, which are correlated with word class.

References

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