

Different modality number-words and digits prime semantic number representations differentially

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It is a debated question to what extent representation of numerical information is language and modality dependent. In order to investigate the effects of different-type linguistic codes and presentation modality on the retrieval of numeric information, in this study we introduced a new paradigm. Participants were presented with trials consisting of 3 numbers. The first member of a pair (S1) was either a visually shown Arabic numeral, a written number word or an acoustically presented number word. In all conditions the second member of a pair (S2) was a visually shown Arabic digit. Subjects' task was to add S1 and S2 as fast as possible and to decide if the number shown as the third number (S3) was the correct result of the addition or not. S3 was correct in 50% of the cases. Our main interest lied in investigating the effect of the retrieval of the first number on brain activity as revealed by the ERPs to the second number. 12 right-handed young adult university students out of whom 6 was female participated in the experiment (22.6 years). Electric brain activity was recorded at 18 electrodes placed according the international 10-20 system. Digital recording was performed with a sampling rate of 250 Hz. An online filter set to 0.10-30 Hz was used. The baseline was the -100 - 0 ms interval.

Lateralization differences between processing of digits and number-words were found (Figure A.) The modality of S1 affected the amplitude of the parietal N1 peaking at 170 ms and the following interval (180-220 ms), as well as the amplitude of the LPC between 340-440 ms, mainly parietally ($p < 0.01$). We call this effect the ERP numeral-modality effect (NME; Figure B.). The distribution of the ERPs was identical in all conditions. The most plausible explanation for this phenomenon is that sources (generators) of brain activity were the same in all conditions but their level of activation differed. We assume that the end result of the processing of S1 converged on the same number representation independent of presentation format, though the activation level of the involved neural codes differed as a function of the surface-format of the presentation. On base of similarity to semantic priming effects (N400) we conclude that heard number words were the most successful to activate (prime) number representations, while written number words activated these the least. Activation level caused by Arabic numerals was intermediate between the two other conditions. The proposed priming effects were justified in a follow-up behavioral study. Our results also contribute to the debate regarding current number processing models.

Figures. (A) Different N1 to digits and number-words (N1-R). **(B)** Numeral-modality effects (NME-N1 and NME-LPC). *Legend of both figures:* A: Arabic digits; H: Heard number-words; W: Written number words.

