

Classifying cognitive states associated with reading single words and two-word sentences.

Svetlana V. Shinkareva, Robert A. Mason, Vicente L. Malave, Tom M. Mitchell, Marcel A. Just

Objective

How are individual nouns encoded and represented in the brain? How does the representation change when nouns are combined with a verb in a two-word sentence?

The goal of this work was to identify cognitive state associated with reading a single word or a sentence. In addition, we examined whether we could correctly identify the propositional elements based on the brain activity due to reading a proposition.

Methods

Participants were presented with four nouns, eight two-word sentences, and two verbs, with seven repetitions each. Participants were instructed to think of the same properties consistently at each presentation of a word or a sentence. Functional images were recorded on a Siemens 3T Allegra scanner.

Each stimulus was presented for 3s, followed by a 7s rest period, during which the participants were instructed to fixate on an X displayed in the center of the screen. There were 6 additional presentations of fixation, 21s each, distributed across the session to provide a baseline measure of activation. Stimuli were presented in a pseudo randomized order within each of the three blocks - nouns, sentences, and verbs.

We applied machine learning methods to classify cognitive states associated with nouns, verbs, and two-word sentences (Mitchell et al., 2004). We used several feature selection methods and Gaussian Naive Bayes classifier. Classification accuracy was evaluated using cross-validation technique.

Results and Discussion

We were able to distinguish cognitive states when subjects were reading nouns, verbs, or two-word sentences with a classification accuracy that was well above chance. The highest classification accuracies were obtained for distinguishing individual verbs and the two noun categories. Training the classifiers on sentences we were able to predict the noun and the verb component with accuracies above chance. This suggests that it might be easier to extract verb meaning from the sentences than the noun meaning.

Conclusions

These results indicate that it is possible to use machine learning techniques to classify cognitive states associated with reading propositional elements and propositions.

References and Acknowledgements

Mitchell, T. M., Hutchinson, R., Niculescu, R. S., Pereira, F., Wang, X., Just, M. A., & Newman, S. D (2004). Learning to decode cognitive states from brain images. *Machine Learning*, 57: 145-175.

This research was supported in part by a grant from the Keck Foundation.