A Computational Framework for Theories of Negative Priming

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Summary

Negative priming (NP) is characterized by longer reaction times when responding to stimuli which have been actively ignored recently. Over the last 20 years, various theoretical accounts of NP have been proposed. However, empirical evidence does not unambiguously favor one theory. We develop a general model for stimulus-based action selection that incorporates mechanisms relevant to selective attention, i.e. feature detection, feature binding, semantic representation, action planning and episodic memory and executive control. Reaction time differences in various priming conditions emerge by an interplay of the components of the model. We describe how the model represents different paradigms of NP.

Paradigms

In NP experiments subjects respond to a target and ignore a distractor.

Continuous Stimulus Presentation

Activation of the feature “green” which defines the target. The corresponding shape is activated via binding connectively leading to an activation of the target object in semantic space.

Semantic layer: Threshold adapts towards the mean of the two major activations. For more than two strong activations the threshold exceeds all of them allowing thus for further accumulation of perceptual evidence.

After response all activations enter short-term memory (m) and decay there with time scale τm. The dissimilarity of memory trace and perceptual input and the activation of the features determines retrieval strength vs. It is the typical number of objects in the experiment. The result is inverted and weighted by the sum of feature activations and normalized by the total number of features. The binding strength b adapts with τf towards a maximum strength if p = 1 or to 0 for no input.

Between trials, αm (dashed line) is active; during stimulus presentation some actions are activated by input from semantic layer and retrieval. If only one action is super-threshold it is executed. The Central Executive chooses a mapping of super-threshold semantic representations onto the fixed points λ of the dynamics of the action layer.

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Computational Results

Reaction times in a simulated experiment with 40 trails in the word-picture comparison paradigm with an RSI = 1500ms:

Conclusions and Outlook

The interdisciplinary project aims at integrating experimental paradigms into a comprehensive model.

The model includes perception, attention, memory, semantic representations and action selection.

The model can be used to interpret EEG data from NP experiments.

Parameters can be adjusted for a representation of specific theories.

Complex features can be represented by the topology of the feature layer.

Cognitive aging can be introduced by stochasticity of the dynamics.

Application of the model as a controller for autonomous robots.

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