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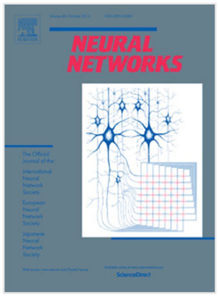

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Reaction times in visual search can be explained by a simple model of neural synchronization

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Abstract

We present an oscillatory neural network model that can account for reaction times in visual search experiments. The model consists of a central oscillator that represents the central executive of the attention system and a number of peripheral oscillators that represent objects in the display. The oscillators are described as generalized Kuramoto type oscillators with adapted parameters. An object is considered as being included in the focus of attention if the oscillator associated with this object is in-phase with the central oscillator. The probability for an object to be included in the focus of attention is determined by its saliency that is described in formal terms as the strength of the connection from the peripheral oscillator to the central oscillator. By computer simulations it is shown that the model can reproduce reaction times in visual search tasks of various complexities. The dependence of the reaction time on the number of items in the display is represented by linear functions of different steepness which is in agreement with biological evidence.

Keywords: visual search, reaction times, oscillatory neural network, synchronization

1. Introduction

Visual search is a type of perceptual task that involves an active scan of the visual environment for a particular object (the target) surrounded by other objects (the distractors). The task of visual search can be of various complexities depending on the saliency of the target relative to the distractors. This is reflected in the duration of time that the observer spends performing the search task, and in the number of errors that are made. A vast amount of experimental evidence has been obtained to characterize the mechanisms of visual selection both at the level of information processing by neural structures and of the algorithms that are consciously or subconsciously used by subjects in visual search experiments.

In the early experiments of Treizman and Gelade (1980) it was discovered that visual search tasks can be subdivided into several categories on the basis of their difficulty. Though later experiments have shown that there are no strict barriers between the categories (Nothdurft, 1999), the following three categories are considered as basic experimental paradigms (Wolfe, Palmer, & Horowitz, 2010):

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