Available online at www.sciencedirect.com
SCIENCE DIRECT
Cognitive Brain Research 24 (2005) 436 – 441
COGNITIVE BRAIN RESEARCH
www.elsevier.com/locate/cogbrainres

Research Report

Configural and analytical processing of familiar and unfamiliar objects

Behrad Noudoost[a,b,*], Mehdi Adibi[b], Ali Moeeny[a,b], Hossein Esteky[a,b]

[a]School of Cognitive Sciences, Institute for Studies in Theoretical Physics and Mathematics, Tehran, Iran
[b]Laboratories for Brain and Cognitive Sciences, Shaheed Beheshti University of Medical Sciences, Tehran, Iran

Accepted 15 February 2005
Available online 31 March 2005

Abstract

Configural processing could develop for non-face visual objects as one becomes familiar with those objects through repeated exposure. To explore the role of familiarity in object recognition, we studied the effect of adaptation to a visual object (adapting stimulus) on the identification performance of other objects (test stimulus) while adapting and test stimuli were exactly the same, shared parts or were completely different. We used a subset of English alphabets (p, q, d and b) as familiar objects and an unfamiliar set of symbols constructed from same parts but with different configurations. Adaptation to a member of each set led to a lower identification performance for that object in a crowding paradigm. Adaptation to each member of the unfamiliar set resulted in decreased identification performance for the same object and those members of the set that shared parts with the adapting stimulus. But no such transfer of adaptation was observed for the familiar set. Our results support the notion that processing of object parts plays an important role in the recognition of unfamiliar objects while recognition of familiar objects is mainly based on configural processing mechanisms.

Theme: Sensory systems
Topic: Visual psychophysics and behavior

Keywords: Configural processing; Face recognition; Identification performance

1. Introduction

Recognition of faces using configural or part-based processing has been studied widely [19]. The term "configural processing" has been used with different meanings by different authors and refers to at least three different processes in the face recognition literature: (1) sensitivity to first-order relations like the existence of two eyes and a nose above a mouth. Congruent with this definition, dramatic decreases in behavioral performance [19] and brain activation [14] due to face inversion have been shown; (2) sensitivity to second-order relations such as distance among parts of a face [5]; (3) holistic processing where face is processed as a whole or a gestalt [25]. The common notion in these reports is that configural processing refers to any process that takes into account the spatial relations of features of an object (first-order relational processing). It is contrasted with part-based processing which is also called featural or analytical processing.

Recently, Baker et al. [3] investigated the effect of training discrimination of unfamiliar objects on the response properties of the macaque inferotemporal neurons. They reported that some inferotemporal neurons were engaged in a configural process for trained objects while contributing to the coding of another untrained set of unfamiliar objects in a part-based manner. They proposed that purely configural and analytical processing of visual objects are the two extremes of a singular continuum and the selection of a processing strategy for each object is a consequence of the degree of familiarity with that object [4]. This conjecture is in line with the results of other studies arguing for more involvement of configural processing of visual objects in

* Corresponding author.
E-mail address: behrad@ipm.ir (B. Noudoost).

0926-6410/$ - see front matter © 2005 Elsevier B.V. All rights reserved.
doi:10.1016/j.cogbrainres.2005.02.012

people who were experts in recognition of non-face stimuli [10]. Converging evidence from psychophysical [6], ERP [21] and neuroimaging studies [7,8] has emerged.

The notion that first-order relational processing is unique for faces has received major objections. For example, it has been shown that first-order relational processes for other categories of visual objects may occur as the objects become familiar [3]. Structural theories of object recognition assume faces to be a special case of visual objects and treat other objects with structural descriptions. Emergence of first-order relational processing for other object categories as a result of factors such as familiarity would challenge these theories. In this study, we investigated first-order relational processing of letters in comparison with an unfamiliar set of stimuli.

Lack of a general consensus on a definition for object "parts" and what determines the complexity of objects in a visual image constrains attempts to compare the degree of holistic processing for familiar vs. unfamiliar visual objects. Any such comparison would only be valid if familiar and unfamiliar objects were composed of the same parts.

Using adaptation to tap various mental or neural process has a long history in the cognitive sciences [15]. Lack of a good definition for shape space has restricted the use of adaptation to investigate the processes involved in visual object recognition. But some recent studies have demonstrated the effects of adaptation in face recognition [16,24].

Assuming that common components are processed by common processing units, here we used two sets of visual objects made from a common set of components. One set with a familiar configuration of components and the other set with an unfamiliar arrangement. Adaptation to familiar objects should lead to decreased accuracy in identification of that object but not any other configuration of the same parts provided that a first-order relational processing is used.

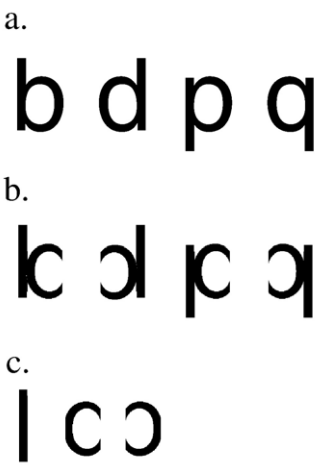

Fig. 1. Stimuli set. (a) Familiar set, (b) unfamiliar set, (c) three simple shapes used to construct the stimulus set.

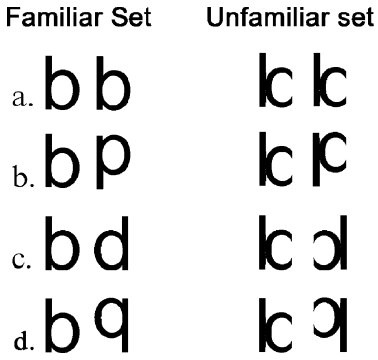

Fig. 2. Relationship between stimulus "b" and the other members of the familiar set and an exemplar similar relation between members of the unfamiliar set: (a) Same stimulus; (b) same parts but with different configuration; (c) different parts I; (d) different parts II.

2. Methods

2.1. Stimuli

Two sets of familiar and unfamiliar stimuli (Fig. 1a, b) were constructed from a set of three simple segments (Fig. 1c). The familiar stimuli consisted of letters b, d, p and q and the unfamiliar set consisted of artificial stimuli made up from components of the same letters (Fig. 1b). Within each set, any two members could have one of three possible relations: (1) same part stimuli: constructed from same parts but in different configurations (Fig. 2b); (2) different part stimuli type I: constructed from different components with same relative configuration (Fig. 2c); (3) different part stimuli type II: constructed from different components in a different configuration (Fig. 2d). As shown in Fig. 2b and c, our "different part" stimuli have a common part (a vertical bar) and a non-common part (c shape curve) that make them different.

2.2. Experimental paradigm

In the first experiment (non-adapted condition), target stimulus was presented in the middle of an array of five stimuli. This array was presented at 12° above a fixation point. In each trial, any of these five stimuli were selected randomly from members of one of stimuli sets (familiar or unfamiliar). Each stimulus subtended 0.75° × 0.50° of visual field and was placed 0.25° apart from neighboring stimuli. Array of stimuli were presented for 100 ms. Subjects were instructed to maintain fixation and identify the stimulus located at the center of the stimuli array by pressing one of four keys on the computer keyboard. They were asked to report their best guess even if they could not recognize the central stimulus. Instructions were given before each session. Experiments were performed in a dimly lit room. Each subject sat through a total number of 400 trials.

In the second experiment (adapted condition), an adaptation phase preceded the identification task. In this adaptation phase, a grid of 750 stimuli, each 0.75° × 0.50° in size, were presented for 60 s. Subjects were asked to maintain fixation