Interhemispheric cooperation for face recognition but not for affective facial expressions

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Received 16 January 2002; received in revised form 14 August 2002; accepted 2 September 2002

Abstract

Interhemispheric cooperation can be indicated by enhanced performance when stimuli are presented to both visual fields relative to one visual field alone. This “bilateral gain” is seen for words but not pseudowords in lexical decision tasks, and has been attributed to the operation of interhemispheric cell assemblies that exist only for meaningful words with acquired cortical representations. Recently, a bilateral gain has been reported for famous but not unfamiliar faces in a face recognition task [Neuropsychologia 40 (2002) 1841]. In Experiment 1 of the present paper, participants performed familiarity decisions for faces that were presented to the left (LVF), the right (RVF), or to both visual fields (BVF). An advantage for BVF relative to both LVF and RVF stimuli was seen in reaction times (RTs) to famous faces, but this bilateral advantage was absent for unfamiliar faces. In Experiment 2, participants classified the expression (happy or neutral) of unfamiliar faces. No bilateral advantage was seen for expressions, although a right hemisphere superiority was seen in terms of higher accuracy for LVF and BVF trials relative to the RVF. Recognition of famous faces (but not of facial expressions) require access to acquired memory representations that may be instantiated via cortical cell assemblies, and it is suggested that interhemispheric cooperation depends on these acquired cortical representations.

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Keywords: Hemispheres; Asymmetry; Face recognition; Emotion

1. Introduction

The cerebral hemispheres develop specialisations for a number of tasks [19,33]. For instance, language processing has been attributed to the left hemisphere (LH), whereas face processing has been related to right hemisphere (RH) function [40]. However, whereas traditional models tended to stress an absolute “dominance” of the LH or RH for a particular task, more recent work has emphasized that tasks should be considered as composed of separable task components [32], and that relative rather than absolute specialisation exists for a number of tasks [45]. This leads to the important question as to if and how the two hemispheres collaborate in cognitive processing [20].

One possibility to test hemispheric interaction is to present stimuli tachistoscopically either unilaterally to the left (LVF) or right visual fields (RVF), or to present the same stimuli simultaneously to both fields (BVF) [13]. The anatomy of primary visual pathways provides that LVF and RVF stimuli project directly to the RH and LH, respectively. Thus, unilateral stimuli initially project to only one hemisphere, but bilateral stimuli project to both hemispheres simultaneously. Many studies demonstrated better processing in the bilateral condition compared to the best unilateral condition. This effect (also called bilateral advantage or bilateral gain) has been found for words [16,27,28,30] and famous faces [25]. In contrast, it has never been seen for meaningless pseudowords [30] or unfamiliar faces [25]. A bilateral advantage has been first observed in lexical decision, where participants discriminate between words and pronounceable pseudowords in a series of letterstrings by speeded keypress responses. A consistent finding in this task is that words but not pseudowords lead to a robust bilateral advantage [27–30]. Moreover, in a split-brain patient with complete commissurotomy in whom any (cortically mediated) interaction between the hemi-
superior to unilateral trials. A pattern in which performance for bilateral trials is always
perception seem to be lateralized to the RH[40,42,44,48],
candidate stimulus, because although many aspects of face
considerations led us to propose the following hypotheses. If interhemispheric cooperation depends on
whether recognition involves an acquired cortical representa-
tion, we would predict a bilateral gain for famous but
not unfamiliar faces in the familiarity task. In addition, we
would not expect a bilateral advantage for faces in an
expression task. In contrast, if interhemispheric cooperation
depends on whether or not the stimulus is an informative
target stimulus for a particular task, one would expect a
bilateral gain for affective but not for neutral expressions in
an expression task.

spheres was unlikely, the bilateral advantage was absent
[29]. These findings indicate four major theoretically important
processing characteristics of the two hemispheres: First, re-
dundant information facilitates processing, but only for
previously learned stimuli (such as words or famous faces). Second, facilitation also occurs when information is divided
across hemispheres, supporting the notion of hemispheric
cooperaeKion rather than independence. Third, hemispheric
cooperaeKion after bilateral presentation of a stimulus reflects
cortical representation of that stimulus over both hemisph-
ers. Fourth, the lack of a bilateral advantage in split-brain
patients suggests that this bihemispheric representation
includes excitatory connections via the corpus callosum
[4,29,36].

Several models have been proposed to explain the bilateral
advantage. First, a bilateral advantage might reflect a sim-
ple “horse race” between two independently operating hemi-
spheres, in which the hemisphere specialised for a certain op-
eration “wins the race” [49]. Accordingly, this would cause
a pattern in which performance for bilateral trials is always
superior to unilateral trials for all kinds of stimuli (for dis-
Kussion [26]). Thus, a horse race model fails to account for a
bilateral advantage seen for some stimuli but not for others.
A neurocognitive model can better account for this dif-
ferential bilateral advantage. Based on Hebb’s theory [18],
it has been held that words are cortically represented by
strongly connected cell assemblies (CAs). CAs may be dis-
tributed across both hemispheres [35], in line with findings
of relative rather than absolute specialisation of the LH for
language processing [45,53]. If a word is represented by a
CA that is distributed across both hemispheres, there will
be strong excitatory connections across the corpus callosum
within this CA. If stimulated with only one copy via input
through one hemisphere, the CA activation is relatively slow
and less efficient than when stimulated with two copies via
input through both hemispheres. This would explain a bilat-
eral advantage for meaningful words. At the same time, no
bilateral advantage should be seen for novel pseudowords
which are relatively meaningless, and which are not thought
to be represented by cortical CAs.

Although the bilateral gain has been mainly investigated in
language studies, it should be possible to extend this ac-
count to the processing of other stimuli. Faces seem a good
candidate stimulus, because although many aspects of face
perception seem to be lateralized to the RH [40,42,44,48],
both hemispheres contribute to it [10,11,46]. We have
recently demonstrated a bilateral advantage in a face recog-
nition task [25]. Participants performed familiarity judg-
ments for famous and unfamiliar faces flashed to either the
RVF, LVF, or BVF. A significant bilateral advantage was
obtained for famous but not for unfamiliar faces. These
results extend earlier findings beyond the verbal domain,
and suggest that interhemispheric cooperation may depend
on the recognition of stimuli for which a cortical represen-
tation has been acquired. Alternatively, interhemispheric
cooperation might depend on the recognition of stimuli
which are particularly meaningful or informative (e.g.
“target” stimuli, such as words in lexical decision, or famous
faces in face familiarity decision).

The aim of the present study was to extend our initial find-
ings on interhemispheric cooperation in face processing, by
comparing two different face processing tasks (face recogni-
tion versus recognition of facial expressions). In Experiment
1, participants performed familiarity judgements for famous
and unfamiliar faces presented to either the RVF, LVF, or
BVF. In Experiment 2, we presented unfamiliar faces with
different expressions (either happy or neutral), and the task
was to recognise the expression displayed. 1 The recognition of
facial expressions, just like facial identification, is thought
to rely more on the RH than the LH [48]. Also, happy ex-
pressions can be regarded as informative target stimuli in
this task, just like famous faces can be regarded as infor-
mative target stimuli in a familiarity task. However, we rea-
soned that the recognition of expressions does not require
the contact with a learned cortical representation in the same
way as recognition of face identity does.

Identification of a face clearly requires the contact with an
acquired memory representation, and one that is likely stored
cortically, presumably in inferior temporal areas [12,47]. It is
also more difficult to store and identify faces from other-race
faces [50]. In contrast, the ability to recognise facial expres-
sions is thought to be innate and universal across cultural
and racial borders [14]. Humans easily recognise expres-
sions of someone they have never seen before, suggesting
that recognition of expression does not require access to an
acquired cortical representation. Instead, recognition of
facial expression may be mediated by phylogenetically older
limbic mechanisms, in particular the amygdala [1] or basal
ganglia [9].

We used a neutral and an expressive condition, rather than two dif-
different expressions, in order to make the task more similar to the face
familiarity decision in Experiment 1. Specifically, we reasoned that rela-
tive to neutral faces happy faces would operate as relatively informative
“target” stimuli, just like familiar faces would operate as relatively in-
formative “target” stimuli relative to unfamiliar faces. Reaction time in
a two-choice discrimination or recognition task depends on the criteria
set by participants [37], and based on the above reasoning we predicted
faster RTs for those stimuli that participants regard as targets (i.e. faster
RTs for famous than unfamiliar faces in Experiment 1, and faster RTs
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