Available online at www.sciencedirect.com
SCIENCE DIRECT®
Behavioural Brain Research 158 (2005) 269–275
BEHAVIOURAL BRAIN RESEARCH
www.elsevier.com/locate/bbr

Research report

Hemispheric lateralization of spatial attention in right- and left-hemispheric language dominance

A. Flöel[a,b,*], A. Buyx[b], C. Breitenstein[b], H. Lohmann[b], S. Knecht[b]

[a] *Human Cortical Physiology Section, National Institute of Neurological Disorders and Stroke, NIH, 10 Center Drive, Building 10, Bethesda, MD 20892-1430, USA*
[b] *Department of Neurology, University of Münster, Germany*

Received 30 March 2004; accepted 7 September 2004
Available online 27 October 2004

Abstract

Hemispheric lateralization of the neural systems supporting language and spatial attention most commonly dissociate in healthy individuals. However, the reverse pattern with association of language and attention within the right hemispheres has also been observed. We investigated in 75 healthy volunteers (37 right-handed, 38 left-handed) if language and spatial attention may associate not only in individuals with an atypical pattern of language lateralization, but also in subjects showing the standard, i.e. left-hemispheric dominance for language. Hemispheric lateralization of cerebral perfusion was determined with functional transcranial Doppler ultrasonography during a visuospatial attention, and a word generation task. We found that language and visuospatial attention associated within the left hemisphere in five subjects and within the right hemisphere in eight subjects. We conclude that all combinations of cerebral lateralization for language and attention may exist in the healthy brain.
© 2004 Elsevier B.V. All rights reserved.

Keywords: Functional Doppler ultrasonography; Word generation; Landmark Task; Handedness; Right-shift theory

1. Introduction

Neuroimaging and neuropsychological research indicate that spatial attention and language are subserved by large-scale cognitive networks that involve both hemispheres, the epicenters of which are lateralized to one hemisphere [3,27,29]. Therefore, it is common to refer to right-hemispheric dominance for attention [16,26,38]. Recent studies have reported that between 48% and 82% of stroke patients suffer from neglect after right-hemispheric stroke, and 65% after left-hemispheric stroke [5,34], but it is not known to which degree this dominance varies in the general population [4]. Activation studies of representative cohorts of healthy subjects are lacking. Lateralization of brain functions is of clinical significance, because differences in the side and the extent of attentional lateralization determine the susceptibility to attentional deficits after unihemispheric lesion, similar to what is known about the language system [23].

The relationship between lateralizations for language and attention has not yet been thoroughly addressed, possibly because activation studies on attention generally do not report lateralization for language [9,15,28,38]. Dissociation of language and attention between the hemispheres is believed to be the most common principle of cerebral organization [17]. However, other patterns may occur: rare lesion studies inform us about patients, who, after unihemispheric stroke, suffer from both aphasia and hemineglect [1,12,18,31,36]. In a previous activation study, we demonstrated in healthy subjects that lateralization of language and spatial attention into different hemispheres is not an invariable characteristic of human brain organization. Even in the absence of brain pathology, the same hemisphere can be dominant in control of both language and spatial attention [13].

* Corresponding author. Tel.: +1 301 496 9986; fax: +1 301 402 7010.
E-mail address: floela@ninds.nih.gov (A. Flöel).

0166-4328/$ – see front matter © 2004 Elsevier B.V. All rights reserved.
doi:10.1016/j.bbr.2004.09.016

However, in the earlier study, we did not find subjects in whom both functions were lateralized to the left hemisphere. The relatively small subgroup of 20 subjects of a highly selected group might have prevented us from observing left-hemispheric association of functions in our previous study. It remained therefore unresolved if subjects with the standard, i.e. left-hemispheric pattern of cerebral language dominance, can lateralize attention to the same hemisphere.

In the present investigation, we tripled the overall sample size, and investigated if language and spatial attention may associate not only in subjects with an atypical pattern of language lateralization, but also in subjects showing the standard, i.e. left-hemispheric dominance for language (hypothesis I). We then asked if the quantitative distribution of lateralization patterns (particularly the percentage of right-hemispheric language dominant subjects who have left-hemispheric attentional dominance) would be consistent with predictions of genetic models of cerebral lateralization (hypothesis II).

2. Methods

2.1. Subjects

Seventy-five healthy subjects (41 women; mean age 26 ± 6.3 years, range 18–56 years) completed the study. Originally, 86 subjects were included. However, 11 subjects had to be excluded because of severe artefacts during recording ($n = 4$), lack of cooperation with task requirements ($n = 2$), or lack of a trans-temporal bone window ($n = 5$). There were no obvious differences between included and excluded subjects with respect to age, handedness, gender, or occupation. Participants were recruited from the local medical school or through newspaper advertisement. To maximize the number of subjects with atypical pattern of hemispheric lateralization [2,22], particularly non-right-handed individuals were recruited. Subjects were excluded if information based on a standardized questionnaire suggested neurological disorders, particularly asphyxia or kernicterus, head trauma, loss of consciousness, epileptic seizures, meningitis or encephalitis, or delayed or abnormal language development. Subjects were also excluded if they had failed to complete the equivalent of a high school degree ('Realschulabschluss' or 'Abitur' in Germany). A standardized questionnaire was used to screen subjects for the number of foreign languages spoken fluently, the number of languages was assumed to indicate linguistic talent. Academic achievement, i.e. a university qualification, was chosen as an additional indicator of linguistic proficiency [35]. Furthermore, subjects were asked about artistic activities. They had to report whether they were actively involved in music, painting, or sculpture. Such activities were taken to reflect artistic inclination and, by inference, artistic ability. Some authors perceive artistic ability as a faculty complementary to verbal ability as being subtended to the right hemisphere [32]. No differences were found for any of the items between subjects with a typical and those with an atypical pattern of lateralization.

All subjects were native German speakers and had normal or corrected-to-normal vision. Handedness was assessed with the Edinburgh Handedness Inventory [30]. Thirty-six subjects (48%) were classified as strongly left-handed (handedness score −100 to −70), 35 subjects (47%) as strongly right-handed (handedness score 70–100) and 4 subjects (4%) as ambidextrous (handedness score −69 to 69).

The study was approved by the local ethics committee, and each individual gave written informed consent. Task and testing procedures were in accordance with institutional guidelines. All subjects were examined with two different tasks probing attention (visuospatial and tactile), and a language task (letter-cued word generation (WG)). During performance of each of the three tasks, hemispheric lateralization of cerebral perfusion was determined with functional transcranial Doppler ultrasonography (fTCD). All tasks were conducted in one session in 55 subjects, and in three separate sessions in 20 subjects. Only data from the visuospatial and the word generation task will be reported here (incomplete fTCD files for the tactile task, due to technical problems). Number of sessions had no effect on the dependent variables. Therefore, data were pooled across all subjects. Task order was randomized across subjects.

2.2. Tasks

2.2.1. Landmark (LM) Task

To assess spatial attention, the Landmark Task, which is frequently used in the assessment of visuospatial neglect [16], was administered (see Fig. 1 for the experimental set-up). Five seconds after a cueing tone, a horizontal line was presented for 10 s on a computer screen (visual angle 9.3°). The horizontal line was bisected by a vertical line either in the exact middle or deviating to the right or the left by 0.1° or 0.2°. During the 10-s period, subjects had to silently decide if the horizontal line was bisected in the middle, slightly to the left, or slightly to the right. Task compliance was ensured by having subjects report the decision verbally (middle, left, or right) after a second auditory signal at the end of the

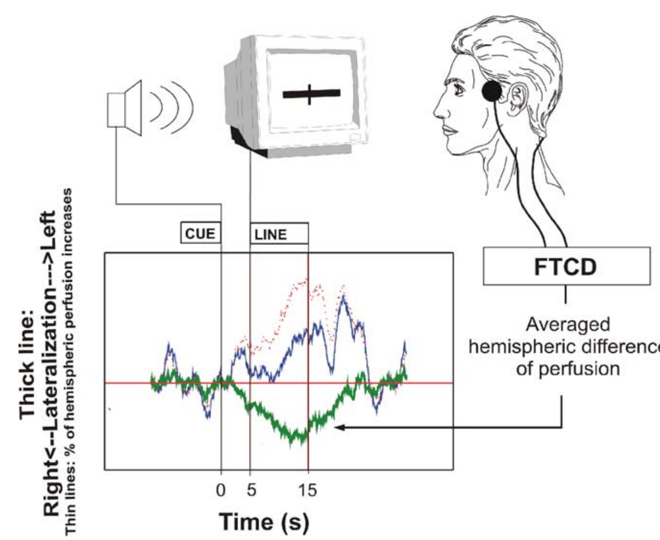

Fig. 1. (Top) Experimental set-up for the Landmark (LM) Task. Subjects wore bitemporal Doppler ultrasound probes and were seated in front of a computer screen displaying a bisected line. (Bottom) Averaged perfusion differences (thick lines) from the left (thin lines) and the right (thin perforated lines) MCAs as assessed with functional transcranial Doppler ultrasonography (fTCD) in a single subject. First cuing tone at 0 s, LM Task from 5 to 15 s, response from 15 to 20 s, second cueing tone at 20 s.

Download English Version:

https://daneshyari.com/en/article/9406792

Download Persian Version:

https://daneshyari.com/article/9406792

Daneshyari.com