Journal of Neurolinguistics 24 (2011) 96–112

Contents lists available at ScienceDirect

Journal of Neurolinguistics

journal homepage: www.elsevier.com/locate/jneuroling

Long-term recovery from acquired childhood aphasia and changes of cerebral blood flow

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ARTICLE INFO

Article history:
Received 12 June 2010
Received in revised form 31 August 2010
Accepted 3 September 2010

Keywords:
Childhood aphasia
Long-term recovery
Cerebral blood flow
Standard Language Test of Aphasia

ABSTRACT

In this study, we investigated the mechanism of functional reorganization underlying long-term functional recovery from acquired childhood aphasia. We followed a 9-year-old boy with aphasia from 3 months to 10 years and 5 months after his stroke. The patient's language ability was assessed five times by the Standard Language Test of Aphasia (SLTA) and regional cerebral blood flow (rCBF) was measured four times with 99mTc-ECD and a fully automated quantitative image analysis system. The patient showed continuous improvement of language throughout this period. Overall rCBF peaked at the time of the 2nd measurement (at the age of 12 years and 2 months) and then gradually decreased to the 4th measurement (at the age of 20 years and 2 months). However, there were several patterns of significant relative dominance of rCBF in one cerebral hemisphere compared with the other hemisphere. The Broca and supplementary motor areas showed consistent right hemisphere dominance throughout the study period, but Wernicke's area showed left hemisphere dominance in the early stage (comparison between the 1st and 2nd measurements or the 2nd and 3rd measurements), followed by right hemisphere dominance in the late stage (comparison between the 3rd and 4th

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0911-6044/$ – see front matter
doi:10.1016/j.jneuroling.2010.09.001

measurements). In the primary auditory area, right hemisphere dominance was only seen in the late stage (comparison between the 3rd and 4th measurements). These findings suggest that both hemispheres are involved in the long-term recovery of children from aphasia, but the location of functional reorganization varies depending on the ROIs studied and the stage after the onset.

1. Introduction

It has been recognized that the prognosis of acquired aphasia is better in children than in adults, and with children showing recovery that is faster and more complete (Cranberg, Filley, Hart, & Alexander, 1987; Lenneberg, 1967; Satz & Bullard-Bates, 1981). The main factors that are considered to influence the prognosis of childhood aphasia are the age at onset, cause, severity and bilaterality of lesions, and type of aphasia. According to Loonen and van Dongen (1990), these variables often are interrelated and the outcome is determined by complex interactions between a number of factors.

To investigate the underlying mechanisms of functional reorganization in patients with acquired childhood aphasia (ACA), Martins and Ferro (1991) followed-up 29 aphasic children with an age range of 1.8 months–15 years for at least six months to assess the effects of a number of variables, and concluded that recovery from aphasia was more dependent upon the existence of intact areas in the left hemisphere than upon language shift to the nondominant hemisphere. The study performed by Martins and Ferro (1992) also suggested that recovery from aphasia depends much more upon the integrity of the left posterior language area than upon hypothetical age-related plasticity. On the other hand, recent functional brain imaging studies have emphasized the role of the contralateral hemisphere in functional reorganization of language after brain damage. Chiu Wong et al. (2006) investigated 16 children between 8 and 12 years old at 3 years after severe traumatic brain injury by using single photon emission computed tomography (SPECT), and they found a strong positive association between perfusion of the right frontal regions and language ability (discourse abstraction), with higher perfusion linked to better discourse outcomes and lower perfusion linked to poorer outcomes. In another study, Staudt et al. (2002) performed functional magnetic resonance imaging (fMRI) in five young adults with congenital right hemiparesis, and investigated the anatomical correlates of language processing in the right hemisphere. They concluded that the occurrence of left hemisphere lesions early in life can lead to language reorganization in the undamaged right hemisphere.

In our previous study (Kojima, Mimura, Auchi, & Kato, 2009), we followed the recovery of a 9-year-old boy with aphasia from 2 to 16 months after traumatic head injury. The patient's language ability was assessed four times by the Standard Test of Aphasia (SLTA) and regional cerebral blood flow (rCBF) was also measured four times with a fully automated quantitative image analysis system. The patient showed rapid improvement of language during this period, and there was significant relative dominance of rCBF in the left cerebral hemisphere compared with the right hemisphere throughout the study period, especially in the paracentral and temporo-parietal regions. From these findings, we proposed that the left cerebral hemisphere rather than the right hemisphere plays a major role in the early recovery of children from aphasia. However, we did not have any evidence about the detailed process of long-term functional recovery from childhood aphasia.

In the present study, we followed a 9-year-old boy (the same age as the patient in our previous study) with acquired childhood aphasia due to cerebrovascular accident (CVA) for more than 10 years after the onset by the same monitoring protocol as used in the previous study (Kojima et al., 2009). The patient underwent assessment of language five times and cerebral perfusion four times during the follow-up period. Recovery of language ability and changes of regional cerebral blood flow (rCBF) were analyzed to assess the possible neural mechanisms underlying long-term recovery from aphasia. In addition, to investigate the dominant hemisphere in this patient, we performed the dichotic listening task.