

Disruption of Reciprocal Coordination by a Medial Frontal Stroke Sparing the Corpus Callosum

Benzi M. Kluger, MD* and Kenneth M. Heilman, MD†

Abstract: Aleksandr Luria described several tests of higher motor function, including the “reciprocal coordination” test of bimanual coordination. Although these tests are commonly used to assess frontal lobe function, their specific neuroanatomic underpinnings are not completely understood. We describe a man with a medial frontal stroke sparing the corpus callosum with a defect in Luria’s reciprocal coordination test but otherwise intact motor abilities, including other tests of higher motor function.

Key Words: reciprocal coordination, bimanual coordination, supplementary motor area, stroke, Aleksandr Luria

(*Cog Behav Neurol* 2007;20:230–231)

Aleksandr Luria¹ described several tests of higher motor function, including the imitation of hand positions, sequential motor programming (the “fist-edge-palm” test), and bimanual coordination. In Luria’s “reciprocal coordination” test, the patient has both hands palm down on a horizontal surface. The test is started by closing 1 hand in a fist with the other hand remaining open. The patient is then asked to repeatedly and simultaneously reverse the configurations of the hands, so that the fist is opened and the open hand closed into a fist. Luria¹ localized dysfunction on this task to either the anterior corpus callosum or combined lesions of “pre-motor and postcentral regions” of a single hemisphere. We describe a man with a medial frontal stroke sparing the corpus callosum with a defect in the reciprocal coordination test but otherwise intact motor function.

CASE REPORT

A 72-year-old right-handed man presented to our emergency department with left lower extremity weakness. Our initial examination was notable for 3/5 weakness of the left lower extremity and increased deep tendon reflexes in that extremity but otherwise intact strength, sensation, and cranial

nerve function. An magnetic resonance imaging (MRI) performed the day after admission revealed an acute stroke in the right mesial frontal lobe sparing the corpus callosum (Fig. 1). This lesion is centered in the supplementary motor area (SMA) with minimal involvement of the anterior cingulate and complete sparing of the corpus callosum. Posteriorly, this lesion extends to involve the leg area of Brodmann’s area 4 and a small portion of anterior Brodmann’s area 7. MR and computed tomographic angiography demonstrated a completely occluded right internal carotid with distal reconstitution, suggesting that that this was an embolic event.

Further testing revealed that the patient had normal cognition and he performed well on the Mini-Mental Status Examination (29/30) and the Frontal Assessment Battery² (18/18). He was completely right-handed on the Edinburgh Handedness Inventory (score of 36).³ On his initial assessment, he demonstrated an ideomotor apraxia in his left hand including spatial impairments when pantomiming transitive acts. However, these deficits had resolved when he was reassessed 72 hours later. This assessment included tests of limb kinetic apraxia (Purdue pegboard and coin rotation tasks), transitive and intransitive gestures, and bimanual tasks (eg, using a knife and fork). On Luria’s tests of higher motor functions, the patient performed well bilaterally on Luria’s fist-edge-palm test, the manual crossed response inhibition test⁴ and imitating hand positions. However, the patient demonstrated persistent difficulties in performing Luria’s reciprocal coordination test. When attempting reciprocal hand formations, his contralesional hand consistently lagged behind his ipsilesional hand. Although this was not formally timed, we would estimate this lag time to be approximately half a second. This deficit was still present 1 week later when the patient was discharged from our service.

DISCUSSION

To our knowledge, this represents the first report of a medial frontal lesion without callosal injury disrupting the reciprocal coordination task. This location is consistent with other data from animal lesion and human functional imaging studies, implicating the SMA as a critically important locus in bimanual coordination.⁵ Although there was minimal direct anterior cingulate cortex (ACC) involvement, the stroke did involve white matter tracts proximate to the ACC. This is relevant as cingulate motor areas are also involved in bimanual coordination and may be important in modulating other motor areas (M1 and SMA).⁶ Interestingly, Luria’s task proved more sensitive to this lesion than other tests of bimanual praxis, possibly because many of these tasks do not involve concurrent and reciprocal movements but rather use one hand as a stabilizer for the actions of the other.

Received for publication May 24, 2007; accepted July 4, 2007.

From the *Department of Neurology, University of Florida College of Medicine; and †The Malcom Randall Veterans Affairs Hospital, Gainesville, FL.

Disclosure: The authors report no conflicts of interest.

Reprints: Dr Benzi M. Kluger, MD, Department of Neurology, University of Florida College of Medicine, Box 100236, Gainesville, FL 32610-02366 (e-mail: benzi.kluger@neurology.ufl.edu).

Copyright © 2007 by Lippincott Williams & Wilkins



FIGURE 1. MRI coronal flair, demonstrating right mesial frontal stroke with sparing of the corpus callosum.

Stephan et al⁷ reported 2 patients with medial frontal lesions who had difficulty with bimanual tasks. The first of these patients had an astrocytoma involving the ACC (10-mm anterior to 20-mm posterior to the AC line) with no corpus callosum or SMA involvement. Interestingly, this patient had severe difficulty with bimanual praxis and both simultaneous and alternating bimanual tasks. Although performance on the reciprocal coordination test was not reported, we assume that this patient would likely have performed poorly on this test. The second patient had a slightly more anteriorly situated astrocytoma within the ACC (20-mm anterior to the AC line) with some involvement of both the corpus callosum and SMA. This patient predominantly had difficulty with alternating movements (rotating arms or legs), but had intact bimanual tapping and praxis on formal examination.

Although Luria did not specify the exact loci of “postcentral regions” in his text, data from clinical lesions

and functional imaging have shown the primary somatosensory cortex and posterior parietal cortex (PPC) may be involved in a network mediating bimanual function.^{8,9} Although there was some injury posterior to the central sulcus, these lesions were restricted to the anterior cerebral artery circulation and were medial to lesions expected to directly disrupt bimanual motor function. However, Serrien et al⁹ used functional MRI (fMRI) to demonstrate that the PPC functions within a network, including the SMA to mediate bimanual movements. It is thus possible that the posterior medial white matter damage in this patient also contributed to his deficits by disturbing PPC-SMA communication.¹⁰

Despite improved imaging methodologies, our knowledge of the localizing value of bedside tests of higher motor and cognitive functions remains an important clinical and research tool.¹¹ This is particularly true in terms of understanding many neurodegenerative conditions, which affect these functional networks but do not demonstrate focal lesions on routine imaging studies.¹²

REFERENCES

1. Luria AR. *Higher Cortical Functions in Man*. 2nd ed. New York: Consultants Bureau; 1966.
2. Dubois B, Slachevsky A, Litvan I, et al. The FAB: a Frontal Assessment Battery at bedside. *Neurology*. 2000;55:1621–1626.
3. Oldfield RC. The assessment and analysis of handedness: the Edinburgh inventory. *Neuropsychologia*. 1971;9:97–113.
4. Crucian GP, Heilman KM, Junco E, et al. The crossed response inhibition task in Parkinson's disease: disinhibition hyperkinesia. *Neurocase*. In press.
5. Carson RG. Neural pathways mediating bilateral interactions between the upper limbs. *Brain Res Rev*. 2005;49:641–662.
6. Wenderoth N, Debaere F, Sunaert S, et al. The role of the anterior cingulate cortex and precuneus in the coordination of motor behaviour. *Eur J Neurosci*. 2005;22:235–246.
7. Stephan KM, Binkofski F, Halsbad U, et al. The role of the ventral medial wall motor areas in bimanual co-ordination. A combined lesion and activation study. *Brain*. 1999;122(pt 2):351–368.
8. Gerloff C, Andres FG. Bimanual coordination and interhemispheric interaction. *Acta Psychol*. 2002;110:161–186.
9. Serrien DJ, Nirkko AC, Lovblad KO, et al. Damage to the parietal lobe impairs bimanual coordination. *Neuroreport*. 2001;12:2721–2724.
10. Schmahmann JD, Pandya DN, Wang R, et al. Association fibre pathways of the brain: parallel observations from diffusion spectrum imaging and autoradiography. *Brain*. 2007;130(pt3):630–653.
11. Bhimani AA, Hlustik P, Small SL, et al. Complex motor function in humans: validating and extending the postulates of Alexandr R. Luria. *Cog Behav Neurol*. 2006;19:11–20.
12. Fama R, Sullivan EV. Motor sequencing in Parkinson's disease: relationship to executive function and motor rigidity. *Cortex*. 2002;38:753–767.