

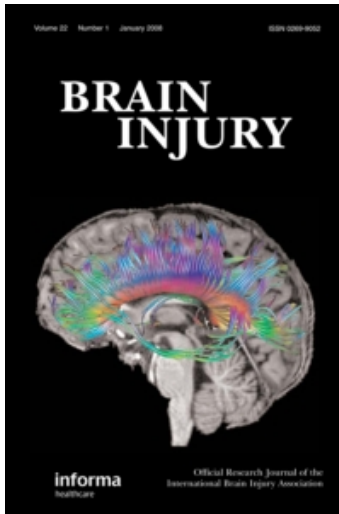
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Right sided weakness with right subdural hematoma: Motor deafferentation of left hemisphere resulted in paralysis of the right side[†]

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Abstract

Background: A right handed man with trauma to the head was admitted with headache and seizures. A severe right sided weakness was noted after a blunt trauma to the right side of his head.

Methods and results: MRI of brain revealed a right-sided subdural hematoma and a normal left hemisphere and downstream motor pathways. **Bimanual simultaneous drawing and manual reaction times indicated that the patient was right hemispheric in laterality of his major hemisphere.**

Conclusion: The right sided weakness in this patient was due to temporary transcallosal disconnection (diaschisis) of the minor hemisphere (left, in this case) from the excitatory signals arising from those structures of his major hemisphere devoted to movements occurring on nondominant side, transmitted via the corpus callosum to his left hemisphere. This case draws attention to disparity between neural and behavioral handedness (laterality of major hemisphere versus that of the preferred hand). **Drawing longer lines by the left hand in simultaneous bimanual tasks** and a slower simple reaction time to central visual stimuli by the ostensible dominant hand permitted lateralization of the major hemisphere to the right. Thus, the neurally nondominant side (right) lagged behind the dominant (left) by an interval equal to interhemispheric transfer time.

Keywords: *Laterality of seizure onset, major hemisphere, minor hemisphere, neural handedness, brainedness, diaschisis, deafferentation*

Case Report

The patient was a 76 year old right handed man who was admitted to hospital following four seizures in the previous month. These began after hitting his head on a car door two weeks prior to the onset of his symptoms. He did not lose consciousness in the event and had continued to function as usual with occasional headaches. His past history was remarkable for chronic obstructive lung disease, rheumatoid arthritis and atherosclerotic heart disease, receiving appropriate medications over the past several years. On arrival to our hospital the level of Dilantin, prescribed in the emergency room of another facility,

was subtherapeutic. Subsequent to admission, two more grand mals occurred on the floor, characterized by tonic extension of left arm and leg followed by clonic jerking of the same limbs, together with muscles on the right side. He remained conscious through these violent attacks though his speech, which was interrupted during the seizures, was severely slurred for several minutes after the attacks. Following the seizures, the plantar responses were extensor bilaterally; 'majestic' on the left. Intravenous phenytoin was used to terminate these seizures. Several minutes after one of these seizures witnessed by the author he walked slowly with fairly good

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[†]Dedication

This article is dedicated to the memory of my beloved sister Farkhodeh Derakhshan (Pakravan), Melbourne, Australia.

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balance, requiring moderate support. The right sided weakness and pyramidal signs gradually disappeared completely towards the end of the first week of hospitalization.

Carotid Doppler studies were normal. Diffusion weighted imaging (DWI) of the brain showed a thin isodense subdural hematoma over the right hemisphere accentuated over the occipital region (Figure 1). There was no evidence of displacement of hemispheres and no involvement of cerebral peduncles. The patient's neuropsychological performances, consisting of writing and clock drawing with either hand, improved over the hospital stay. **Samples of his last bimanual simultaneous drawings are represented in Figure 2.** A manual reaction time study after hospitalization, using a custom made software with a central 'go-signals,' in blocks of 60 trials at regular intervals, showed faster responses by the left hand compared to the right (right hand, 451 ms; left hand, 401 ms). **In bimanual drawing tests the patient drew longer lines and larger designs with his left hand compared to the right (Figure 2).** His immediate postictal EEGs were marked by drowsiness with occasional asymmetry due to excess of slow activity over the right hemisphere. This abnormality was absent in the EEG obtained after recovery.

Discussion

Although not commonly known, strict simultaneity in performance by both hands is impossible. Furthermore, while engaged in an activity such as bimanual aiming one and the same hand will lead in initiating and terminating the task [1–3]. These observations are inconsistent with the common belief that movement of each arm is controlled by the contralateral hemisphere (exemplified in canonical Poffenberger paradigm). On the other hand, precise timing of cortical events have documented that all commands are initiated in the same hemisphere 'irrespective of acting hand' [4–6] and that our handedness is a rough (i.e. statistical) reflection of the laterality of motor control as defined in this article and previous writings [5, 6].

In daily life, evidence pointing to the laterality of the major hemisphere (command center) may be obtained by drawing two lines or shapes with both hands at the same time. Invariably, the performance of one hand will be longer or larger than that of the other; because the hand contralateral to the major hemisphere has a wider excursion than the opposite. This is because the nondominant hand is a callosum-width farther away from the command center, located in the major hemisphere with which we speak [5, 6]. There is evidence indicating that

unconscious timing of a motor activity in the human mind begins from the issuance of a related command in the major hemisphere [7]. For example, of the 40 right handed participants in an experiment involving perception of size, 31 (~80%) of the blindfolded participants overestimated the size of a disc in their left hands (as the larger disc) while manipulating the similar size discs between thumb and index fingers. The remainder judged the relative size of the objects in the opposite direction [9]. This laterality indexed asymmetry in spatial judgment has been confirmed recently [10]. According to the circuitry under discussion, the disparities between the avowed handedness and hemispheric dominance for action in the population studied [9] reflected the discrepancy between the laterality of the major hemisphere and the behavioral handedness; indicating nonhomogeneity of the populations studied. Clinically, this disparity is manifested in occurrences of crossed aphasia among the dextrals; i.e. those right handed subjects who become aphasic following a lesion of the right hemisphere [11]. **Further support for directionality in callosal traffic underpinning laterality of motor control (including speech) comes from the fact that lesions of the anterior callosum lengthen the asynchrony between the hands [12–14]. Similarly, total disruption of callosal connectivity is associated with complete paralysis of the left side of the body in those who are left hemispheric in laterality of their command center [15, 16].**

While we have a choice in selecting a preferred hand, an event often long forgotten, we have no choice as to laterality of the hemisphere with which we speak.

The unique case described in this article raises the issue of the laterality of symptoms in a lifetime right hander. **What was the underlying mechanism that sustained seizures and right sided paralysis, findings that were opposite to those expected in a true right hander?** Results of bimanual simultaneous drawing and the reaction time data indicated that the patient was only a right hander ostensibly (behavioral handedness), as he was right hemispheric in laterality of his major hemisphere (referred to here as neural handedness).

Several laboratory techniques may be used to determine a person's laterality of major hemisphere, all subject to criticisms as to reliability, invasiveness, cost and availability in a community hospital [5, 8, 17, 18]. For example, movement related suppression of alpha and beta waves in EEG, indicating hemispheric engagement while performing a task, have been observed to occur over both hemispheres when moving the left hand and on the left side alone with moving the right [19]. This resulted in a call for revision of the canonical views on laterality

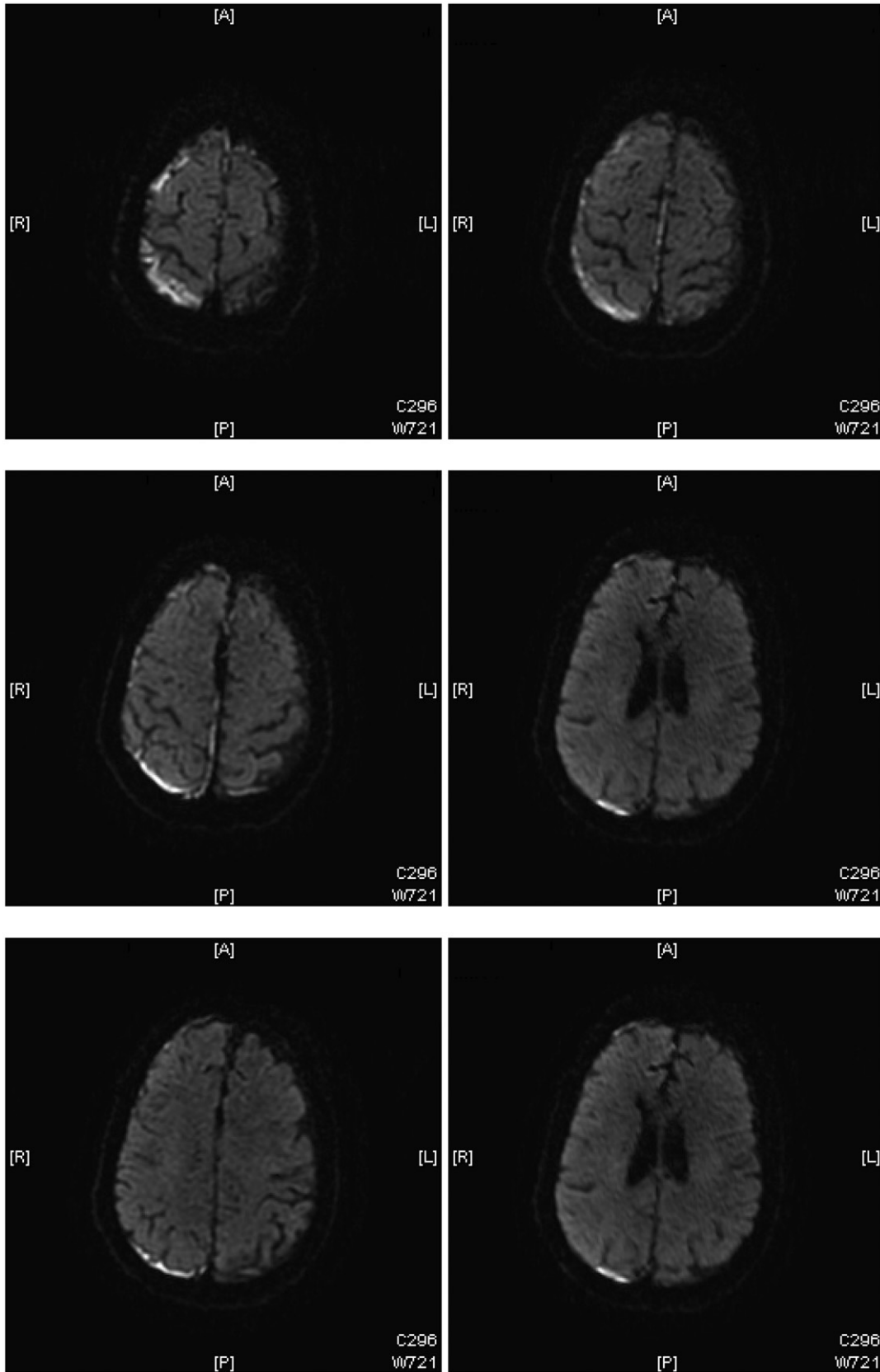


Figure 1. Axial views of DWI of the brain showing presence of subdural hematoma over the right hemisphere.

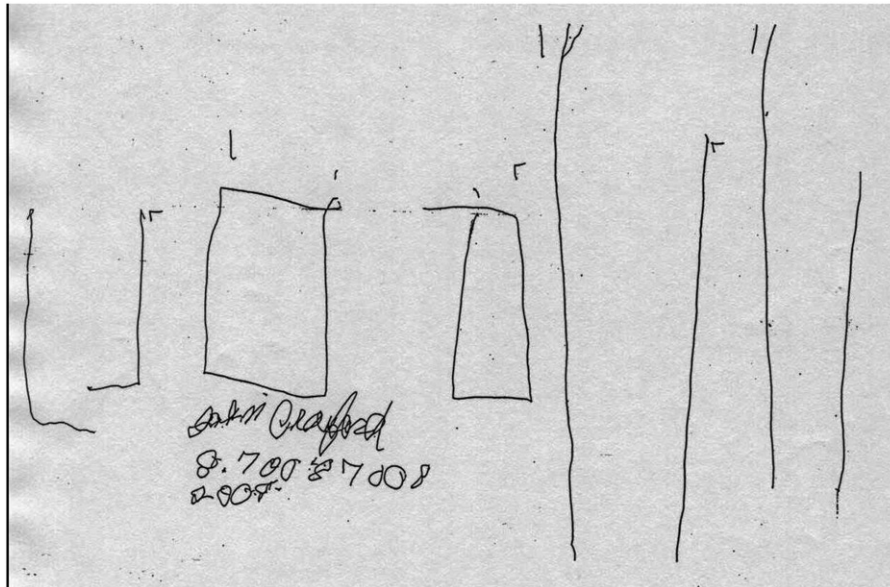


Figure 2. Repeated attempts at simultaneous bimanual vertical line and shape drawing with right (r) and left (l) hand. The larger/longer figures drawn by the left hand suggest a faster speed in the neurally dominant side of the body in this patient.

of motor control by Crone et al. (p. 2294). Clinically, the discrepancy in a person's hand preference and his or her laterality of motor control, is manifested in crossed aphasia (mentioned above) and nonaphasia; the latter consisting of a syndrome in which lifetime right handed patients retain their ability to speak despite having sustained paralysis on their ostensibly dominant side after an insult involving the left hemisphere [20, 21].

The present case is an instance of such paradoxical appearances, featuring a normal appearing left hemisphere that became temporarily deafferented from the excitatory influences arising from dominant right hemisphere. However, the unexpected reversed asymmetry witnessed in his bimanual simultaneous drawings (Figure 2) at once indicated that he was truly a right hemispheric person in laterality of his major hemisphere, despite a lifetime claim to right handedness [8].

Conclusion

Paralysis ipsilateral to a hemispheric lesion is usually considered an ominous sign, portending herniation of the temporal lobe (Kernohan notch). However, evidence in this case indicated the absence of midbrain notch and normal appearance of the left hemisphere. Physiological data, in the form of wider excursions by the left hand in bimanual simultaneous drawings tasks, indicated that the patient's dominant hemisphere (command center) was on the right side despite his life long claim to right handedness.

It is concluded that the temporary paralysis ipsilateral to the right hemisphere in this patient was the result of deafferentation (diaschisis) of the nondominant left hemisphere from the excitatory influences arising from his major hemisphere on the right. This case supports earlier calls for revision of our current views on the laterality of motor control and provides for a noninvasive and inexpensive method in ascertaining the laterality of a person's major hemisphere (neural handedness) regardless of their behavioral handedness.

Declaration of interest: The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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