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Abstract—Rare reflex epilepsies are a clinical curiosity but may also give insight into neurocognitive processes. The authors present a patient whose seizures were precipitated by drawing but not by writing. This dissociation complements previous reports on selective impairment of writing. EEG revealed a focus in the right frontal lobe with parietal spread. This is in accord with current cognitive and neural network models of drawing.

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Written language may have its origin in drawings, e.g., cave paintings and cuneiform scripts, including pictograms. Both skills are unique to humans: no other primate is able to write or draw. Although writing and drawing are alike in motor action, they do differ. Writing is heavily linked to the language system, and during ontogeny, this skill is learned and trained to become an internalized, automatized process. The number of graphemes in written language is fixed. Drawing also may serve communication but shows unlimited expression and is not linked to language and linguistics *per se*.

The occurrence of selective deficits in writing but not drawing supports the idea of separate modules involved in writing and drawing.¹

In reflex epilepsies, seizures are precipitated by specific stimuli, such as stroboscopic light, or even higher-level cognitive activity (for a historical overview, see reference 2). Several cases of epilepsy induced by reading, writing, or speaking have been reported.^{3–5} Such cases not only give greater insights into the mechanisms of epilepsy, but also yield fur-

ther understanding of the neurologic organization of this cognitive activity and its relationship to other functions.

We describe a patient in whom only drawing triggered seizures, supporting the dissociation between language and drawing.

Case report. *Case history.* A 19-year-old fashion design student was presented to the emergency department of our hospital. While engaged in a drawing assignment, he repeatedly experienced short-lasting twitches in both arms and subsequently lost consciousness. Fellow students saw him stretching both arms before falling to the ground. He did not respond, and shook all limbs for 2 minutes. History revealed previous “special sensations” with twitching of the arms since high school while constructing graphs during math class. He never had these sensations during other activities. When he recently became a student in fashion design, he experienced similar problems when he was drawing. Although he was left-handed (0.18, Edinburgh Handedness Inventory), he later underwent a functional MRI⁶ indicating normal, left hemisphere dominance for language (figure E-1; go to the *Neurology* Web site at www.neurology.org). Physical examination results, including vision, were unremarkable. Visual acuity was normal, as were perception and motor ability. Brain MRI scans, including a high-resolution T1, T2, and a fluid-attenuated inversion recovery (FLAIR) scan, showed no abnormalities (video E-1, A through C). Laboratory investigation results were normal. There was no family history of epilepsy.

EEG. A standard EEG (MicroMed, Treviso, Italy; sample frequency 1,024 Hz, filters 0.1 to 70 Hz) that included eye closure, hyperventilation, and intermittent photic stimulation (2 and 30 Hz) was normal. There were no spontaneous interictal epileptiform discharges during 7.5 hours of video-EEG recording. However, when asked to draw, spike and wave discharges immediately occurred. These coincided with myoclonic jerks in both arms and disorientation afterward, with inability to resume drawing for 10 to 30 seconds. Several specific functions were assessed with neuropsychological tests during EEG (tables 1 and E-1).

Tests included spontaneous drawing, copying, and drawing figures from memory (the Rey–Osterrieth complex figure [figure E-2] and the Benton Visual Retention Test) using either hand and foot; writing tasks; and specific tests of higher cognitive function. Except for writing with either foot, no test other than related to drawing elicited any EEG or clinical abnormalities (table 1 and video E-2). Writing (video E-3) or other higher cognitive activities, such as calculation, speaking, reading, and recollection of events, showed no EEG alterations (figure 1). In addition, describing complex figures or scenes such as the “Cookie Theft Picture” did not elicit abnormalities (table E-1). Spike and waves were elicited,

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Table Stimuli, tasks, and EEG correlates*

Stimulus/task	EEG findings								
	Self-report	Myoclonus	Arrest	Paroxysms	Generalization	Focal	Latency, sec	Isolated SW	Series SW
Drawing†									
Spontaneous freehand drawing	+	+	+	+	+	+	34	+	++
Complex figure of Rey–Osterrieth (copying)	–	–	–	–	–	–	–	–	–
Complex figure of Rey–Osterrieth (immediate recall)	+	+	+	+	+	+	16	+	+
Complex figure of Rey–Osterrieth (delayed recall)	–	?	–	+	+	+	21	+	–
Drawing + arithmetic (dual tasking)	+	+	+	+	+	+	4	+	+
Benton Visual Retention Test (copying)	+	+	+	+	+	+	4	+	+
Benton Visual Retention Test (10-second delay)	–	?	+	+	+	+	21	+	
Benton Visual Retention Test (copying)—right hand	+	+	+	+	+	+	220	+	–
Benton Visual Retention Test (10-second delay)—right hand	+	+	–	+	+	+	27	+	++
Drawing (with mouse on computer)	–	+	–	+	+	+	164	+	–
Mental drawing	–	?	?	+	+	+	80	+	–
Drawing simple repetitive (sawtooth)	–	–	–	–	–	–	–	–	–
Drawing complex repetitive figure	+	+	–	+	+	+	3	+	–
Drawing (with right hand, test)	–	–	–	+	–	+	–	–	–
Drawing (with right hand, figures)	+	+	+	+	+	+	10	+	–
Drawing (while standing upright)	+	+	+	+	+	+	3	+	++
Drawing with left foot	+	+	+	+	+	+	71	+	–
Drawing with right foot	–	?	+	+	+	+	83	+	+
Drawing (eyes closed)	–	?	–	+	+	+	21	+	+
Drawing (maze)	–	–	–	+	+	+	51	+	–
Drawing (numbers)	–	–	–	–	–	+	–	–	–
Writing†									
Copying text (normal paragraph)	–	–	–	–	–	–	–	–	–
Copying text (single words, no syntax)	–	–	–	–	–	–	–	–	–
Copying single letters (no syntax, no semantics)	–	–	–	–	–	–	–	–	–
Writing (upright position)	–	–	–	–	–	+	–	–	–
Writing with left foot	–	–	–	+	+	+	16	+	–
Writing with right foot	–	–	–	–	–	+	–	–	–

* See table E-1 for complete overview of tasks.

† For writing and drawing, the patient used his left hand, unless otherwise specified.

SW = spike and wave forms.

however, by copying figures, by drawing them from memory, and even by imagining himself drawing (imagery) but not by visualizing static pictures or remembering episodes such as his last holiday. Drawing a simple, repeating “sawtooth” pattern also did not evoke myoclonic seizures; however, drawing a more complex meander of alternating squares and triangles did (figure E-3).

When he used his nondominant hand to draw, the same EEG abnormalities occurred, whereas writing with his right hand did not evoke any epileptic activity. Interestingly, EEG signs of epilepsy were observed, albeit less pronounced, when the patient used his left or right foot to write.

Analysis of EEG spike propagation showed right frontal and right parietal lobe involvement. To this end, six spike and waves were averaged that were the first of a series of spike and waves

after induction by drawing. Filters were set at 0.5 to 140 Hz, which gave flat baselines in all channels. Using MicroMed software, sequential amplitude maps were generated of the initial spike (duration 60 milliseconds) of the averaged complex at intervals of 5 milliseconds, starting on the rising slope of the spike (figure 2).

Discussion. This case can be categorized as a form of highly selective reflex epilepsy induced by drawing. Brenner and Seelinger⁷ described a case of drawing-induced seizures, but their patient also experienced seizures spontaneously and while calculat-

Figure 1. EEG recordings showing a normal pattern for an awake and alert adult. The upper pane shows the spontaneous asymmetrical discharges observed when our patient was drawing.

ing. They did not test whether writing was also a seizure trigger. Sudden impairment of drawing may represent some form of acute constructional apraxia, which refers to the inability to assemble, build, or draw.⁸

Dissociations between writing and other higher functions have already been described. In lesional "ideational agraphia," a patient is unable to write but still has the ability to produce relatively good drawings.¹ A recent article described a patient whose epilepsy was selectively triggered by writing but not by drawing.⁵ Our case complements these observations and therefore supports a double dissociation between drawing and writing. This double dissociation is surprising given the close relationship between the two skills. The observation that drawing a

simple sawtooth pattern did not evoke epilepsy in our patient whereas drawing a more complex repeating pattern did, suggests that complexity or acquired automated skill may account for differences in drawing and writing. This may also explain why writing with either foot also elicited EEG paroxysms. Writing efforts with a foot resemble drawing in that the mapping of images to motor output is not automated (cf. using the nonlexical route in the pronunciation of nonwords in the dual route model of word naming). This is in accord with the development of writing skills, in which cultural emphasis, hemispheric specialization, handedness, and automatization play a role. Writing is automatized and relies on a lateralized brain language network, whereas disruption of the automated aspect may turn writing to drawing,

Figure 2. Amplitude maps of drawing-evoked spike and wave complex after averaging of six spike and waves (filters 0.5 to 140 Hz).

relying on a more extended, probably less lateralized neural substrate.⁹

Current cognitive models propose three combined systems underlying the process of drawing: visual perception, visual imagery, and graphic production, which includes planning and action programming.^{8,10} In our patient, the inability to draw cannot be attributed to disturbed visual perception or motor response, because these processes themselves did not evoke any epileptic response. Visual imagery and aspects of planning and action programming are more likely triggers of his epilepsy.⁸

A functional imaging study on drawing showed bilateral parietal and premotor activation.⁹ Although left-handed, our patient was left-hemisphere dominant for language. We therefore assume that his other functions have the same, normal hemispheric distribution as well. EEG analysis of the induced epileptic spikes in our patient suggests early right frontoparietal network involvement in drawing. The epileptogenic focus and the spread of the epilepsy suggest that although both hemispheres may be involved in drawing, the right hemisphere may well be indispensable for this function.

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