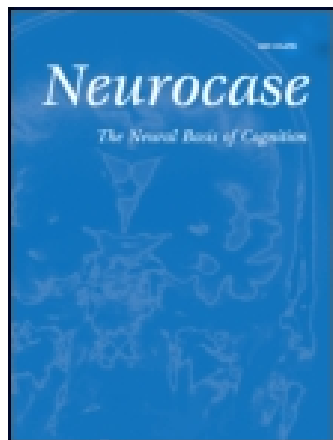


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Publisher: Routledge

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Neurocase: The Neural Basis of Cognition

Publication details, including instructions for authors and subscription information:
<http://www.tandfonline.com/loi/nncs20>

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Published online: 05 Apr 2013.

To cite this article: Fred Ovsiew (2014) The Zeitraffer phenomenon, akinetopsia, and the visual perception of speed of motion: A case report, *Neurocase: The Neural Basis of Cognition*, 20:3, 269-272, DOI:

[10.1080/13554794.2013.770877](http://dx.doi.org/10.1080/13554794.2013.770877)

To link to this article: <http://dx.doi.org/10.1080/13554794.2013.770877>

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The *Zeitraffer* phenomenon, akinetopsia, and the visual perception of speed of motion: A case report

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The *Zeitraffer* phenomenon is the altered perception of the speed of moving objects. A single case is reported using the subject's own description of a transient alteration of the visual perception of motion. The literature on the subject is reviewed. The *Zeitraffer* phenomenon probably arises from dysfunction of brain networks subserving visual perception of speed. It shares characteristics with akinetopsia, the loss of visual ability to perceive motion.

Keywords: Akinetopsia; Visual perception; Time Perception.

The *Zeitraffer* phenomenon is the experience of perceived acceleration of motion, initially described in a series of German-language case reports beginning in 1919 (Tonkonogy & Puente, 2009). Although the word refers to an early photographic device that accelerates motion by time-lapse photography, in some instances deceleration of motion or the combination of acceleration and deceleration has been designated by this term (Tonkonogy & Puente, 2009).

Here I report a man with the illusory experience of decelerated motion. A 39-year-old right-handed professional man developed several days of unaccustomed headache. During this time, he carried on all his usual activities. "On the 3rd or 4th day, I turned on the shower and sat in the tub to let the water stream massage my scalp. After what I recall to be a fairly short time, perhaps 10 minutes, I had the feeling that I couldn't stand up if I tried. The best way I could describe it, from memory, was a lethargy and loss of coordination. I vividly remember looking up at the showerhead and having the perception that time had slowed. The water stream from the showerhead separated into droplets as they moved away from the head (that was normal and real) and I recall seeing the

drops seemingly hang in mid-air but I don't recall them stopping. The effect was very similar to the way the bullets traveled in the Matrix movies, minus the trails that the special effects crew added behind the bullet. I don't recall any trails behind the water droplets, though that may be a failure of my memory. I remember the scene being very clear. I noted to myself at the time that I could see every droplet clearly when you'd normally perceive the streams as more of a blur of movement. I can't remember if I saw them speed back up afterward though I have a vague notion that they did while I was looking. I can't say for sure if I'm imagining that though. My memory is unclear after the clarity of the effect faded. As I think about it, it seems a good way to describe it is that the water droplets went into sharp focus as they slowed down, but I'm unclear how the event resolved itself. I'm pretty sure I didn't black out/lose time but I was alone in the house at the time. I don't recall the water being cold when I left the tub but my recollection of the details after the event are less clear than before and during." By the following day, he was feeling better, but he saw a doctor who ordered a head CT scan. This showed a large right temporal hematoma. Subsequent MRI (Figure 1) showed a hematoma in

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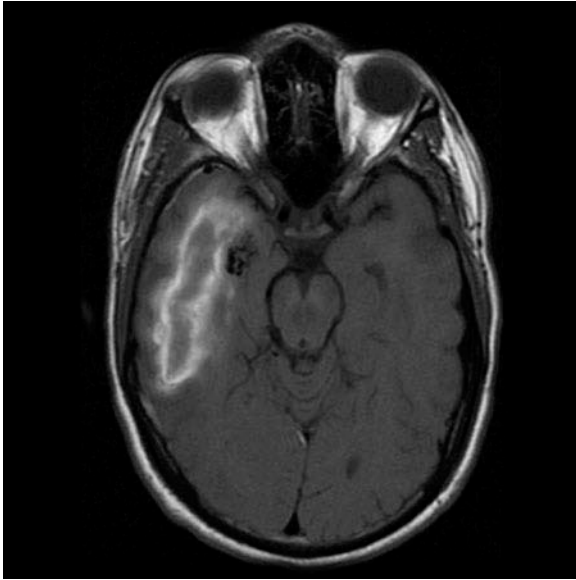


Figure 1. Acute-phase T1 MRI showing right temporal hematoma.

the right temporal lobe measuring 7.3 cm \times 2.3 cm \times 2.8 cm. A small subdural hematoma was also present. No mass effect was evident. Conventional and MR angiography showed bleeding from a right temporal arteriovenous malformation as well as unruptured carotid aneurysms. He did well over the next days without immediate surgical intervention. About a month later, he underwent resection of the arteriovenous malformation and aneurysmal clipping with good results. Several months later, he presented with seizures marked by briefly clouded consciousness; these were subsequently controlled by an antiepileptic drug.

He returned to work in his previous occupation without difficulty. He and his wife reported that prior to the illness, he had been quiet and withdrawn; after the intracranial bleed, he became more outgoing and talkative. Both considered that the alteration was favorable; no disinhibition or impropriety was reported. Chronic-phase MRI showed an area of encephalomalacia in the anterior right temporal lobe. Neuropsychological assessment 5 years later showed mild variability on measures of attention and processing speed. Nonverbal memory and reasoning and visuospatial skills were normal.

This man bled into his right temporal lobe from an arteriovenous malformation. Initially, he had only headache, but as eloquently described above,

he later experienced an episode of altered perception of motion. Given the temporal profile of the episode and the subsequent development of epilepsy, the episode may have been a seizure originating from the right temporal lobe. Alternatively, altered cerebral blood flow related to his immersion in warm water, with peripheral vasodilation, could account for transiently altered brain function. It is also possible that the visual environment did not elicit the abnormal perceptual phenomenon until the patient encountered the fast-moving water.

In the existing case reports, focal brain injury underlay many cases of the *Zeitraffer* phenomenon. Mullan and Penfield considered illusory acceleration or deceleration of movement in epilepsy as an “illusion of comparative interpretation” (Mullan & Penfield, 1959). They alluded to three cases but described only one (case 10), a patient with a right-hemisphere focus and the ictal experience of “a movie going slow motion.” Another patient mentioned by Penfield and his colleagues under this rubric experienced a sound like machinery going faster (case 22), but this is not an alteration in the visual perception of speed of motion.

Cutting reviewed the case reports and emphasized a striking preponderance of right-hemisphere damage (Cutting, 1997, 2011). Apart from the Penfield reports (which he considered to show six cases, all related to right-hemisphere foci), he found seven reports of the *Zeitraffer* phenomenon, all associated with right-hemisphere injury. A different review found two additional reports with right-hemisphere damage (but did not find three of the right-hemisphere cases included by Cutting), and three with diencephalic damage, four with nonlocalizable disease, and two (including a newly reported case) with left-hemisphere damage (Binkofski & Block, 1996).

Critchley remarked that a perceived increase of the speed of moving objects can occur in migraine and explicitly designated this as the *Zeitraffer* phenomenon (Critchley, 1986, p. 202). He had earlier alluded to this phenomenon in relation to altered time sense in posterior lesions, without offering any specific lateralization or localization (Critchley, 1953, p. 353). Conversely, Sacks described as a migrainous phenomenon “cinematographic vision,” in which motion is experienced as “a rapidly-flickering series of ‘stills,’ as in a film run too slowly” (Sacks, 1992, p. 74).

Perception of motion is subserved by cells in area V5 of extrastriate visual cortex, at the occipital-temporal border just below the superior temporal sulcus (Anderson, Holliday, Singh, & Harding, 1996). Neurons in V5 (or its analog in the monkey, area MT) are selectively tuned for speed of moving visual stimuli, and V5 is believed to play a role in perception of speed (Liu & Newsome, 2005; Priebe, Lisberger, & Movshon, 2006). In addition, left or bilateral V5/MT and the right posterior parietal cortex play a role in temporal processing of visual stimuli (Buetti, Bahrami, & Walsh, 2008).

Defective perception of speed of moving objects (akinetopsia) can occur with lesions in area V5 of either hemisphere (Barton, 2011), and illusory motion can occur with epileptic discharges from V5 (Laff, Mesad, & Devinsky, 2003). Beckers and Homberg produced transient akinetopsia by transcranial magnetic stimulation of V5 in human subjects (Beckers & Homberg, 1992). They did not correlate subjective experience with psychophysical findings. The subjective experience of fragmentary and transient akinetopsia has been described in terms indistinguishable from those used for the *Zeitraffer* phenomenon with decelerated motion (Cooper et al., 2012). One patient described by Cooper et al. had a right posterior stroke and saw movements as “freeze frames . . . in slow motion.” Another had a left posterior stroke and saw moving objects “jump from one location to the next.” In the patient at hand, the lesion did not appear to involve posterolateral temporal cortex directly, though mass effect from the hematoma or disconnection of V5 from temporal cortex cannot be excluded. Diaschisis, an alteration in function in V5 produced by dysfunction in areas connected to it, can also be considered as a possible cause of the abnormal phenomenon.

Cutting (1997, 2011) asserted that the *Zeitraffer* phenomenon derived from a disturbance of the experience of time as personally relevant; in his formulation personal relevance is the general characteristic of right-hemisphere functioning. A different set of cases seems to evince the personal relevance of time, patients described under the rubrics of “loss of time orientation” and “thalamic chronoataraxis” (Kumral, Gulluoglu, & Dramali, 2007; Lee, Chu, Kim, & Roh, 2010). These patients have an isolated inability to assess the passage of time or maintain orientation to date and time of day. Such cases have thalamic lesions often involving the anterior nucleus and mamillothalamic tract (Masdeu,

2011). They do not show right-lateralization of lesions.

The *Zeitraffer* phenomenon is likely to be due to dysfunction in areas subserving visual perception of speed of motion. The degree to which it is a lateralized phenomenon remains uncertain, as indeed does the lateralization of akinetopsia (Barton, 2011), but the apparent preponderance of right-hemisphere injury is striking. The relation between deficits demonstrated psychophysically and the subjective experience of the sufferer has seldom been explored. Possibly injury on either side of the brain can produce similar objective deficits that are experienced differently depending on the hemisphere involved. If so, a left-hemisphere symptom corresponding to the deficit experienced in categorical terms, as against the personal relevance of the defective world of right-hemisphere injury, may be awaiting description. Also still puzzling is what determines the distinction between perceived acceleration and perceived deceleration of motion. Only further study of additional cases will answer the remaining questions.

Another feature of this case merits mention. This man experienced an alteration of personality in a favorable direction as judged by himself and his wife. Such benefit from brain injury, though counter-intuitive, occurs occasionally with a wide range of pathologies (Ovsiew, 1997).

Manuscript received 24 October 2012

Revised manuscript received 18 January 2012

First published online 4 April 2013

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