

Video game-induced reflex seizures via a smartphone

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ABSTRACT

Reflex seizures are consistently evoked by a specific afferent stimulus or by patient activity. Patients experiencing reflex seizures when playing a game on a mobile phone are rarely reported. We describe a boy with reflex seizures after prolonged exposure to the game, *Cut the rope*, on his mobile phone. The video-EEG documented electroclinical events characterized by distal myoclonic jerks of the upper limbs, in combination with irregular, diffuse spike-and-wave and polyspike-and-wave discharges on EEG, followed by a tonic-clonic seizure. Playing video games on mobile phones may potentially induce reflex seizures, similar to other commonly used platforms such as docking stations connected to video screens.

Key words: reflex seizure, video game, epilepsy, video-EEG

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VIDEO ONLINE

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Reflex seizures (RS) are objectively and consistently evoked by specific external or internal *stimuli*, including stress, lack of sleep, and mental activity, such as mathematical calculations, table games (card games, checkers, or Baduk), thinking, or decision-making. A combination of different *stimuli* could be necessary to evoke seizures, as cognitive and praxis skills may overlap, as documented for RS triggered by playing table or video games [1-3].

Cut the rope is a touch-screen video game in which the player has to pick up candy "with his fingers" to feed a monster and collect three scattered stars. If the candy falls without going into the monster's mouth, the game is over. This game therefore also requires a combination of cognitive tasks (reasoning and selecting the best strategy), including manual skill and speed and good visual-motor function.

There are several reports of epilepsy induced by cognitive tasks, but few reports of seizures evoked by a specific combination of cognitive and praxis skills via a mobile phone [4]. We describe a boy experiencing RS induced by prolonged exposure to the video game, *Cut the rope*. This report highlights that playing video games on mobile phones may potentially induce RS, similar to other commonly used platforms such as docking stations connected to video screens.

Case study

A 17-year-old boy was referred to the epilepsy clinic due to a tonic-clonic seizure upon awakening, after prolonged sleep deprivation while playing the video game *Cut the rope* on his mobile phone. The seizure lasted approximately five minutes and spontaneously resolved.

Medical history

Family history was unremarkable for seizures, epilepsy and neurological disorders. The patient's delivery was uncomplicated, with spontaneous birth and a normal neonatal period. Cognitive, fine, and gross motor development were unremarkable.

Video-EEG

Prolonged polygraphic recording (14 EEG and six EMG channels) with simultaneous video was performed. Both resting and sleep EEG were unremarkable. Intermittent photic stimulation (IPS) and visual patterns (P) during the performance of cognitive tasks (calculation, reading) was performed without effect. The boy was invited to play several different video games, previously installed on his mobile phone, for 30 minutes with no effect. Finally, the game *Cut the rope* was tested and, after 10 minutes, an abrupt electroclinical event occurred consisting of irregular, diffuse spike-and-wave and polyspike-and-wave discharges, clinically related to the myoclonic jerks of the upper limbs (figure 1, video sequence 1), followed by a convulsive seizure.

Treatment and outcome

Valproate (500 mg/day) was prescribed, and the patient accepted to avoid playing *Cut the rope* if he could still regularly use his smartphone for other activities, including other video games. At the 52-month follow-up visit, he was seizure-free, and his last EEG was unremarkable.

Discussion

RS occur in nearly 5% of epilepsy patients, and detecting seizure precipitants is important because trying to avoid them is the cornerstone for treatment. There are no specific antiseizure medications for RS and the therapy depends on the type of epilepsy related to the RS [5, 6]. Since RS are described based on the stimulus that may cause them, the supposed provoking stimulus can be tested during a standard EEG recording to verify the consequence for the patient and make the final diagnosis [7].

Epileptic seizures related to playing video games have been known since the early 1980s. Video games are played by people of almost all ages on TV monitors or, nowadays, on small hand-held devices. Given that

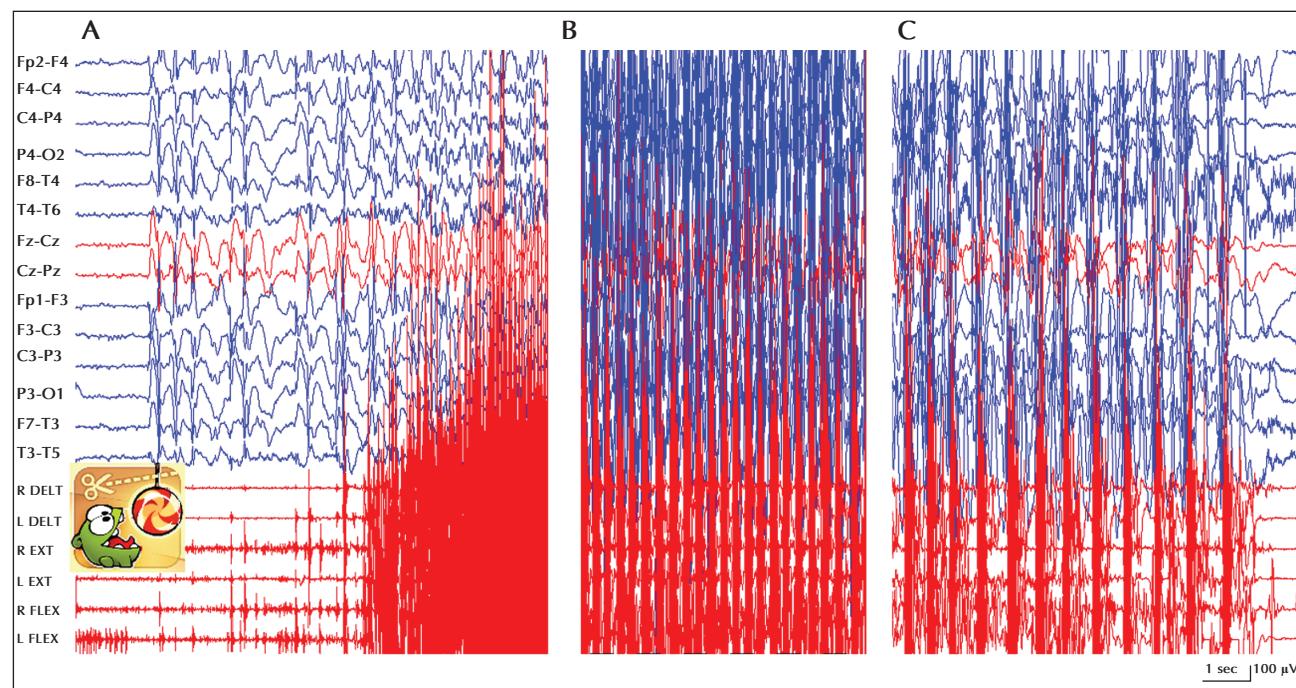


Figure 1. Ictal EEG recordings showing irregular, diffuse spike-and-wave and polyspike-and-wave discharges correlating with myoclonic jerks, involving the upper limbs, eventually resulting in a tonic-clonic seizure.

oscillating electronic screen devices can produce flickering and vibrating patterns [8], games played on mobile phones or tablets at a distance of less than one meter would be expected to have the same potential harmful effects as games played on TV monitors. However, so far, there is only one previously reported case of smartphone-induced RS. Watson and colleagues [4] described a 44-year-old woman experiencing seizures while texting on her mobile phone. She had a history of unrecognized reading epilepsy, and texting which requires a high level of concentration and attention was responsible for seizure precipitation. Interestingly, a peculiar EEG pattern, the texting rhythm (TR), was activated. TR, first suggested by Watson *et al.* [4] and comprehensively investigated by Tatum *et al.* [9], is a reproducible, stimulus-evoked, frontocentral predominant monomorphic burst of 5-6-Hz theta waves, lasting from 2 to >10 seconds, consistently induced by active text messaging [9, 10] or playing video games [11] using a smartphone or other electronic devices, hence the definition "texting and gaming rhythm".

TR is very similar to the Cigánek rhythm, a theta-band activity predominantly arousing in the vertex head region during periods of mental concentration or drowsiness [12]. Initially misinterpreted as being linked to temporal lobe epilepsy [12], Cigánek's theta rhythm is now considered a rhythmic activity of uncertain significance. Since then, different descriptions of theta rhythms related to cognitive tasks with varied locations have been reported.

In general, paroxysmal theta rhythm is evoked by a broad range of cognitive tasks in normal subjects linked to decision making, mental effort, attention, and concentration.

An electronic screen game study in patients without sensitivity to electronic games showed changes in epileptiform spike activity in some brain areas, such as the right supplementary motor area (execution of movement) and the left perisylvian (organization of praxis activity during the game) and medial temporal lobe (emotional loading) [7].

Italiano *et al.* [13] suggested that unilateral frontoparietal activation (usually occurring during thinking tasks) is not sufficient to recruit a critical mass of the cerebral cortex; hence, bilateral parietal activation may be required to induce seizures. Moreover, they also stated that praxis activates hyperexcitable cortical pathways beyond parietal cortices and beyond the network, subsuming spatial thought alone (sensorimotor areas). This hypothesis could explain why both triggers are needed.

Following the concept of "system epilepsy", seizures are the result of genetic or acquired hyperexcitability of a network. A specific stimulus for each area is required to activate a network [14]; the peculiarity of

our case with such a specific trigger seems to support this concept.

Several factors may lead to the occurrence of a seizure while playing a video game, including photosensitivity, emotional factors, lowering of the seizure threshold by fatigue or sleep deprivation, and specific cognitive activities, such as decision-making and hand movements. Piccioli *et al.* [3] showed *Super bomberman II*, a video game requiring fast action and geometrical components, to be the most provocative video game. In our case, a relationship between cognitive tasks and hand movement was likely to be involved in the physiopathology of epilepsy. Indeed, the patient was tested with different types of triggers, such as simple mental calculations and reading. These patterns were ineffective, whereas playing *Cut the rope*, requiring the combination of cognitive and praxis skills, induced generalized epileptiform discharges, followed by a clinical event. In this patient, no other bursts occurred playing other video games, supporting the clear-cut correlation with the contingent trigger, namely the *Cut the rope* video game.

Although we cannot exclude that other complex tasks, more directed to praxis induction (e.g., writing, written calculation, doing a puzzle, Rubik's cube, Tower of London, or any other tasks cognitively guided by hands), could have induced a seizure in this patient, playing *Cut the rope* was the only provocative factor reported by him. This may be related to the simultaneous involvement of different mechanisms, linked to pattern stimulation, emotional or cognitive excitement/tension, proprioceptive stimuli (movement/praxis) associated with fatigue, insomnia, and playing games for a long time, eventually leading to large-scale neuronal activation [15].

We are not aware of any other patient reporting this specific video game as a trigger for seizures, either from our cohort or from the literature. Moreover, this is one of the first reports, pointing out that playing video games on mobile phones may potentially induce RS, similar to docking stations connected to video screens. Multicentre cohort studies will be needed to fully assess the provocative potential for seizures of small hand-held devices and differences between video games, as we cannot exclude that other video games, not tested in this case, could have precipitated a seizure in our patient. ■

Supplementary material.

Summary slides accompanying the manuscript are available at www.epilepticdisorders.com.

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Ethical standards.

This study was performed following the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments. Parents gave written informed consent.

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Legend for video sequence

Myoclonic jerks involving the upper limbs, associated with irregular, diffuse spike-and-wave and polyspike-and-wave discharges during playing *Cut the rope* on a smartphone.

Key words for video research on www.epilepticdisorders.com

Phenomenology: generalized seizures

Localisation: not applicable

Syndrome: reflex epilepsy

Aetiology: idiopathic

TEST YOURSELF

(1) Are video game-induced seizures more common in males or females?

- A. Females
- B. Males
- C. Same frequency in males and females
- D. This is still unclear

(2) Which epilepsy type is more likely to be associated with video game-induced seizures?

- A. Symptomatic focal or generalized epilepsy
- B. Catamenial epilepsy
- C. Idiopathic (genetic) generalized epilepsy
- D. Childhood absence epilepsy

(3) Which is the most effective treatment approach for reflex seizures?

- A. Valproate
- B. Valproate and clobazam
- C. Avoidance of the trigger(s)
- D. No treatment is required for reflex seizures

Note: Reading the manuscript provides an answer to all questions. Correct answers may be accessed on the website, www.epilepticdisorders.com.
