



## A rare trigger for photosensitive seizure: fireworks

Gürkan Gürbüz<sup>1</sup> · Özge Berfu Gürbüz<sup>2</sup>

Received: 3 January 2021 / Accepted: 26 February 2021 / Published online: 8 March 2021  
© Belgian Neurological Society 2021

### Introduction

Reflex epilepsy is a type of epilepsy involving seizures that occur with sensory stimulus. It occurs when the cortical and subcortical brain areas over-react to a physiological stimulus. Stimulus can be simple like flickering lights, hot water or complex like reading and listening to music. Photosensitive epilepsy is the most common form of reflex epilepsy [1].

Photosensitive epilepsy (PSE) involves seizures caused by visual stimulation. Patients usually experience their first seizure before the age of 20. This may be a myoclonia, eyelid myoclonia, or rarely a generalized tonic–clonic seizure (GTS), occurring following a photic stimulus. Photoparoxysmal responses (PPRs) occur on these patients' EEGs with photic stimulation. PPR is defined electrographically as 2–5 Hz spike, spike wave, or slow wave complexes exhibiting frontal dominance with intermittent photic stimulation (IPS). Pathophysiology of PSE is still unclear but visual cortical hyperexcitability is the most emphasized issue [2].

In differential diagnosis of PSE; juvenile absence epilepsy, Jeavons' syndrome, childhood epilepsies with occipital paroxysms, juvenile myoclonic epilepsy and progressive myoclonic epilepsies are included [3]. All these diseases have clinical and laboratory findings with photic stimulation and can be distinguished with EEG and history of the patient.

The most common examples of stimuli that trigger PSE are televisions, computers, and mobile phones, since the high flicker, high contrast and rapidly changing patterns in these can be strong enough to precipitate seizures.

While there are interesting reports of PSE being triggered by mobile phone flashes, known as “selfie epilepsy” in the literature, firework-triggered epilepsy has not previously been reported [4]. We report the case of a young girl who experienced a seizure after watching a firework show at night and was subsequently diagnosed with PSE, with the evaluation of clinical and laboratory findings.

### Case report

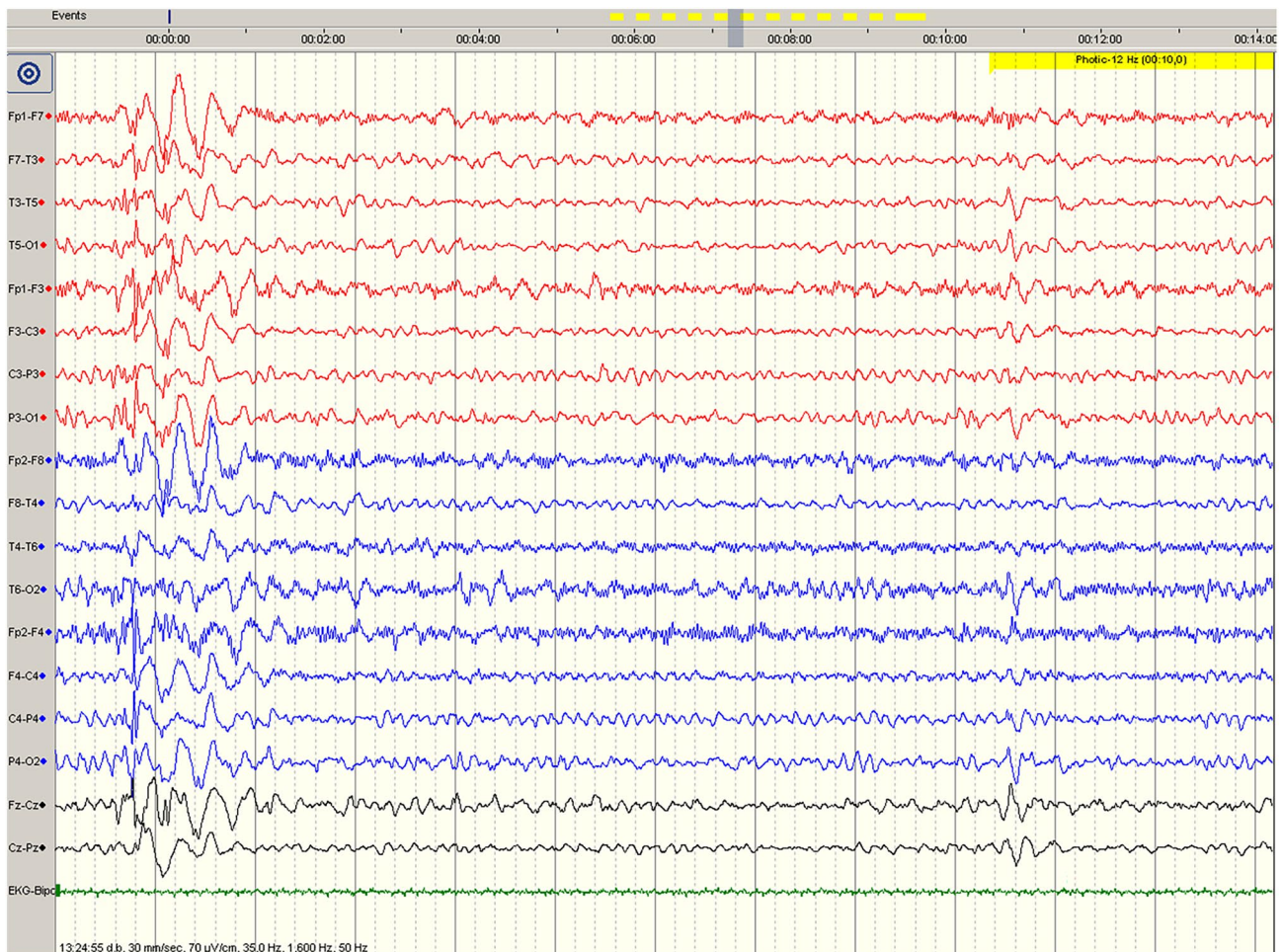
A 13-year-old girl presented to the emergency room due to first GTS. She described large and spectacular explosions toward the end of a firework show at a party being held in a garden on a dark night. The seizure took the form of numbness around the mouth and jerking of the upper extremities. She was unable to remember what happened after the jerks. After waking, following a brief period of confusion, neurological examination was completely normal. There were not other precipitators like menstruation, sleep deprivation, and infections. There were not neurological diseases or epilepsy in the patient's or in her family's history. She was using no medications other than NSAIDs for occasional migrainous headaches without auras. Brain magnetic resonance imaging (MRI) was normal. Standard 20-channel awake electroencephalography (EEG) revealed a 3–4 Hz generalized spike multispikes and slow wave activity, starting with 12 Hz IPS. This activity rarely manifests between the frequency transitions of the photic stimulation session (Fig. 1). Most activities after 12 Hz were accompanied by myoclonic muscle artifacts, reached the maximum amplitude at 18 Hz IPS (Fig. 2). Jerks were also noted in the arms at 18 Hz IPS. Due to the risk of generalized tonic–clonic seizure, IPS was not applied beyond 18 Hz. The background rhythm was normal, and no epileptic abnormality was observed in the remainder of the trace without IPS. Sleep-deprived EEG was also seen with normal background rhythm without epileptic activity. PSE was considered at diagnosis based on the existing findings. Protecting strategies such as wearing sunglasses, watching TV in a well-lit room, sitting as far as

✉ Gürkan Gürbüz  
drgurkangurbuz@hotmail.com

Özge Berfu Gürbüz  
berfukacar@hotmail.com

<sup>1</sup> Pediatric Neurology, Namık Kemal University, Tekirdağ, Turkey

<sup>2</sup> Family Medicine, Tekirdağ State Hospital, Tekirdağ, Turkey



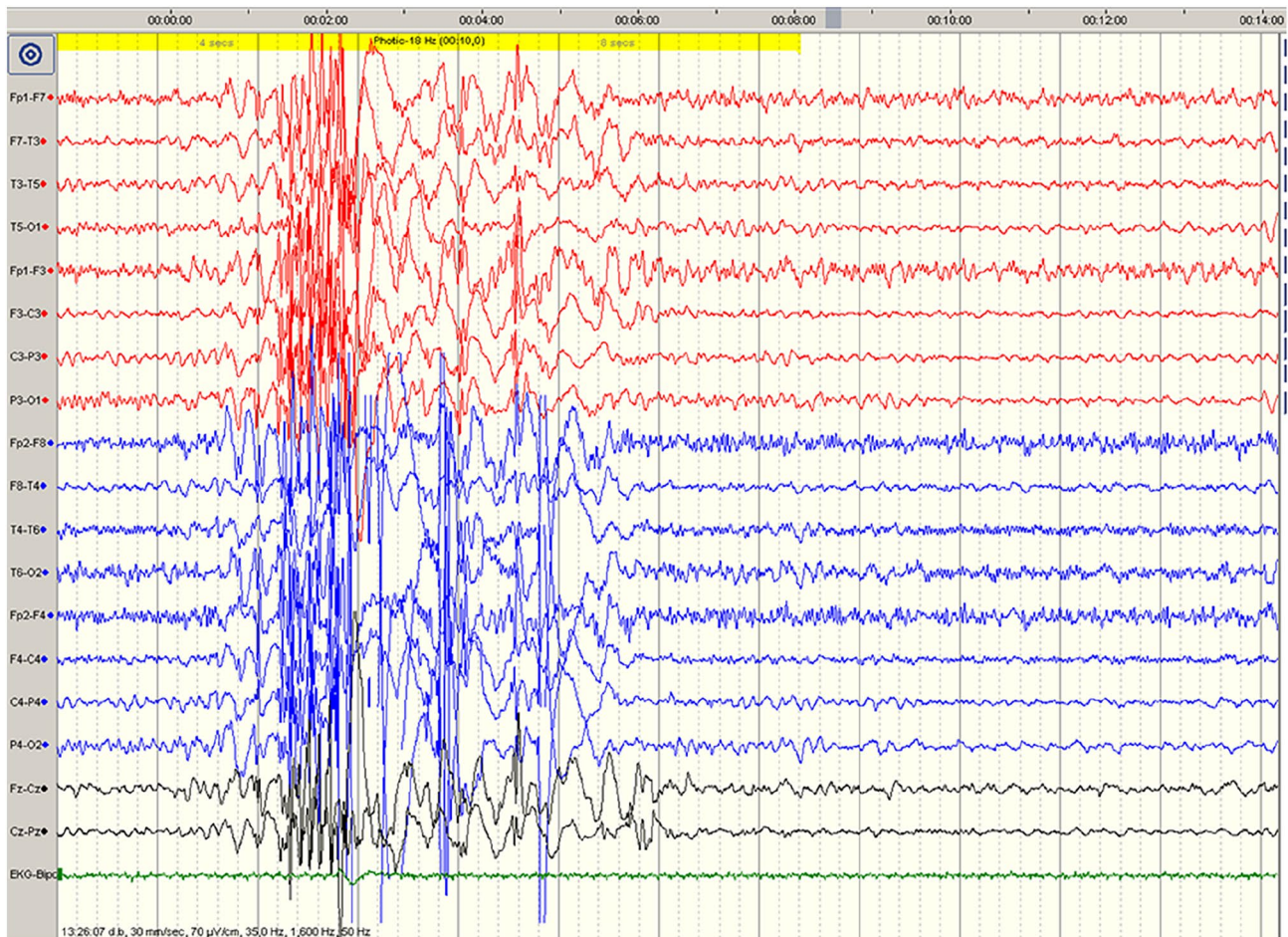
**Fig. 1** 3–4 Hz generalized spike multipike and slow wave activity starting with 12 Hz IPS were observed on EEG

possible, decreasing the brightness and avoiding very long periods were suggested. Levetiracetam therapy was started instead of valproic acid (VPA), considering the side effects that may occur in long-term VPA use. No seizures were observed at 6-month follow-up.

## Discussion

The prevalence in general population is low (1/4000); however, it is around 2–5% of all patients with epileptic seizures [5]. Since PSE can appear as “pure PSE” or it can accompany numerous diseases such as juvenile absence epilepsy, Jeavons’s syndrome, idiopathic photosensitive occipital epilepsy, progressive myoclonic epilepsy and juvenile myoclonic epilepsy (JME) [6]. It is important to question the blank stares for absence epilepsy, eyelid myoclonies for Jeavons syndrome and morning jerks when sleep-deprived for JME while taking the patient’s history, because all these diseases have photosensitivity [7]. Questioning the

incremental continuation or drug resistance of myoclonic seizures, neurodegeneration in brainstem and other neurological findings like ataxia is helpful in ruling out progressive myoclonic epilepsies (PME) such as Lafora disease, mitochondrial epilepsies and neuronal ceroid lipofuscinosis. In confusing cases, genetic screening can be helpful. Idiopathic photosensitive occipital epilepsy (IPOE) is a reflex focal epilepsy generally seen in late childhood. Seizures can be triggered by PS. Interictal EEG shows occipital focal spike waves and also generalized spike-wave activities. In IPOE, all seizures are triggered by PS, colorful visual auras often accompanied with conscious head and eye turning are the main features which makes difference from others. Beside this, generalized tonic–clonic seizures are rarely seen [8]. In our case, the diseases mentioned in differential diagnosis were questioned and pure photosensitive epilepsy was considered with the absence of blank stares, myoclonias without PS, visual auras and abnormal neurological examination. Also the epileptic activity in EEG came up at the time of, or right after, IPS which points out pure PSE.



**Fig. 2** The epileptic activity, accompanied by myoclonic muscle artifacts due to jerks, reached the maximum amplitude at 18 Hz IPS

In today's technological era, there is a TV in every home, as well as a game console, a computer, and a mobile phone owned by many adolescents. Although technology generally exists to make life easier, one of the most frequent neurological diseases to which it can lead is probably PSE. The seizures triggered by the "Pokémon" cartoon and the "Space Invader" arcade game were the first reported instances of PSE triggered by technological photic stimulation. The present case also indicates that on a dark night, firework illuminations can create an IPS effect at a sufficient distance, frequency and contrast, and can pass the epileptic threshold in susceptible individuals, thus resulting in seizure.

In PSE protecting strategies from stimuli such as using polarized sunglasses in sunny days, avoiding watching old type televisions (TV) with flickers and not playing video games when sleepy or fatigued is essential and commonly effective. Intensity and contrast of the image, duration of exposure and flicker frequency are important factors. Watching TV from 2 m distance is acceptable in a well-lightened room, view on a 100 Hz TV. If necessary, to approach the screen or other photic stimulator, patients have to cover one

eye with their hand cause monocular sight protects cortical hyperexcitation [1]. LCD and plasma TV screens have a transistor to keep all the pixels state, which prevents the manifestation of flickering. LCD TV screens are less likely to trigger a seizure than old-fashioned flickering TV screens [9].

Some patients place their adducted fingers in front of the sun and shake them to create a IPS effect and thus precipitate a seizure to deal with anxiety and stress. This is known as "self-induced epilepsy" and has also been reported in childhood [10].

In addition to the preventive strategies against PSE, positive results can be obtained with VPA therapy. However European Medicines Agency (EMA) has recommended strengthening the restrictions on the use of valproate due to the risk of malformations and developmental problems in children exposed to valproate in the womb [11]. Since our patient was an adolescent female, levetiracetam with fewer side effects was chosen rather than VPA. We know that seizures are generally controlled by managing precipitators. On the other hand, during the COVID 19 pandemic,

it was appropriate to initiate antiepileptic treatment, considering that increased exposure to electronic devices due to the increase in home stay and e-learning strategy of the education system. Our patient's seizures ceased entirely with levetiracetam, suggesting that levetiracetam may be preferable to VPA in PSE [12].

To the best of our knowledge, there are no previous reports in the literature of seizures triggered by fireworks, which have been used for entertainment and celebration for hundreds of years. Our case is unique in this respect. It may be life-saving to provide verbal and written warnings for susceptible individuals. Especially in places where fireworks are used, before video games and TV shows which involves high flicker.

## Conclusion

Fireworks can act as intermittent photic stimulants and can cause seizures in susceptible individuals. Verbal and visual warnings should be used before firework shows.

**Acknowledgements** The authors would like to thank the patient's family for their participation and help. Written informed consent was obtained from the guardian of patients for their anonymized information to be published in this article.

**Funding** The authors received no financial support for the research, authorship, and/or publication of this article.

## Compliance with ethical standards

**Conflict of interest** Authors declare that there is no conflict of interest.

## References

1. Okudan ZV, Özkara C (2018) Reflex epilepsy: triggers and management strategies. *neuropsychiatric disease and treatment. Neuropsychiatr Dis Treat* 14:327–337

2. Siniatchkin M, Groppa S, Jerosch B, Muhle H, Kurth C, Shepherd AJ, Siebner H, Stephani U (2007) Spreading photoparoxysmal EEG response is associated with an abnormal cortical excitability pattern. *Brain* 130:78–87
3. Taylor I, Marini C, Johnson MR, Turner S, Berkovic SF, Scheffer IE (2004) Juvenile myoclonic epilepsy and idiopathic photosensitive occipital lobe epilepsy: is there overlap? *Brain* 127(Pt 8):1878–1886
4. Brna PM, Gordon KG (2017) “Selfie-epilepsy”: a novel photosensitivity. *Seizure* 47:5–8
5. Quirk JA, Fish DR, Smith SJ, Sander JW, Shorvon SD, Allen PJ (1995) Incidence of photosensitive epilepsy: a prospective national study. *Electroencephalogr Clin Neurophysiol* 95(4):260–267
6. Striano S, Capovilla G, Sofia V et al (2009) Eyelid myoclonia with absences (Jeavons syndrome): a well-defined idiopathic generalized epilepsy syndrome or a spectrum of photosensitive conditions? *Epilepsia* 50(Suppl 5):15–19
7. Abanoz YG, Abanoz Y, Özkara Ç (2018) Ongoing photosensitivity in an elderly patient with jeavons syndrome. *Neurologist* 23(3):94–97
8. van Win OA, Barnes JG, Ferrier CF, Booth F, Prasad AN, Kasteleijn-NolstTrenite DGA (2020) A study of the significance of photoparoxysmal responses and spontaneous epileptiform discharges in the EEG in childhood epilepsy. *Epilepsy Behav* 107:107046
9. Sharma A, Cameron D (2007) Reasons to consider a plasma screen television—photosensitive epilepsy. *Epilepsia* 48(10):2003
10. Akbas Y, Oz Tuncer G, Serdaroglu A (2019) A rare self-induced reflex epilepsy: sunflower syndrome. *Acta Neurol Belg* 119(4):617–618
11. Tomson T, Marson A, Boon P, Canevini MP, Covanis A, Gaily E, Kälviäinen R, Trinka E (2015) Valproate in the treatment of epilepsy in girls and women of childbearing potential. *Epilepsia* 56(7):1006–1019
12. Kasteleijn-NolstTrenité DG, Marescaux C, Stodieck S, Edelbroek PM, Oosting J (1996) Photosensitive epilepsy: a model to study the effects of antiepileptic drugs. Evaluation of the piracetam analogue, levetiracetam. *Epilepsy Res* 25(3):225–230

**Publisher's Note** Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.