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Cortical processing during smartphone text messaging☆

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ABSTRACT

Objective: The objective of this study was to report the EEG features of text messaging using smartphones.
Methods: One hundred twenty-nine patients were prospectively evaluated during video-EEG monitoring (VEM) over 16 months. A reproducible texting rhythm (TR) present during active text messaging with a smartphone was compared with passive and forced audio telephone use, thumb/finger movements, cognitive testing/calculation, scanning eye movements, and speech/language tasks in patients with and without epilepsy. Statistical significance was set at $p < 0.05$.
Results: Twenty-seven patients with a TR were identified from a cohort of 129 (93 female, mean age: 36; range: 18–71) unselected VEM patients. Fifty-three out of 129 patients had epileptic seizures (ES), 74/129 had nonepileptic seizures (NES), and 2/129 were dual-diagnosed. A reproducible TR was present in 27/129 (20.9%) specific to text messaging ($p < 0.0001$) and present in 28% of patients with ES and 16% of patients with NES ($p =$ NS). The TR was absent during independent tasks and audio cellular telephone use ($p < 0.0001$). Age, gender, epilepsy type, MRI results, and EEG lateralization in patients with focal seizures were unrelated ($p =$ NS).
Conclusions: Our results suggest that the TR on scalp EEG represents a novel technology-specific neurophysiological alteration of brain networks. We propose that cortical processing in the contemporary brain is uniquely activated by the use of PEDs.
Significance: These findings have practical implications that could impact industry and research in nonverbal communication.

1. Introduction

The recent identification of new waveforms includes pathological waveforms [1] and artifacts [2–4] identified during long-term EEG. These novel waveforms have contributed to our understanding of clinical neurophysiology and application to patient care during continuous EEG (cEEG) and video-EEG monitoring (VEM).

Because of advances in modern technology, smartphones and personal electronic devices (PEDs) are now a ubiquitous part of society involving a wide range of social, work-related, and recreational functions. However, while the use of smartphones has drastically increased within the past few years, little is known about their influence on neurophysiological processes [5]. Recently, we have observed more patients using PEDs to communicate by text messaging during VEM. As a result, we have encountered a reproducible, stimulus-coupled, time-locked, 5–6-Hz, generalized, frontocentral-predominant, theta rhythm that occurs during active texting (Fig. 1). We report our experience with the texting rhythm (TR) evoked by the use of smartphones to characterize its neurophysiological features and discuss the potential relevance in patient care.

2. Methods

We prospectively analyzed patient records admitted for diagnostic VEM between May 2014 and September 2015 at Mayo Clinic in Florida to evaluate the effects of text message communication on the scalp EEG. The study was approved by the Mayo Clinic institutional review board for the study of human subjects. A TR was defined as a distinct, paroxysmal, time-synched, rhythmic, generalized, frontocentral, 5–6 Hz, monomorphic, theta rhythm repeatedly induced by text messaging [6]. It was noted to be present only during the time period of active text message communication using a smartphone. A baseline EEG was obtained in each case with activating procedures performed using a previously published protocol [7]. Cognitive tasks included questions detailing mathematical calculation, orientation, and assessment of the general fund of knowledge. Active speech and language functions were assessed by both verbal and audio cellular telephone communication and passively observed during spontaneous smartphone use during VEM.

Abbreviations: cEEG, continuous EEG; ES, epileptic seizures; NES, nonepileptic seizures; PEDs, personal electronic devices; TR, texting rhythm; VEM, video-EEG monitoring.

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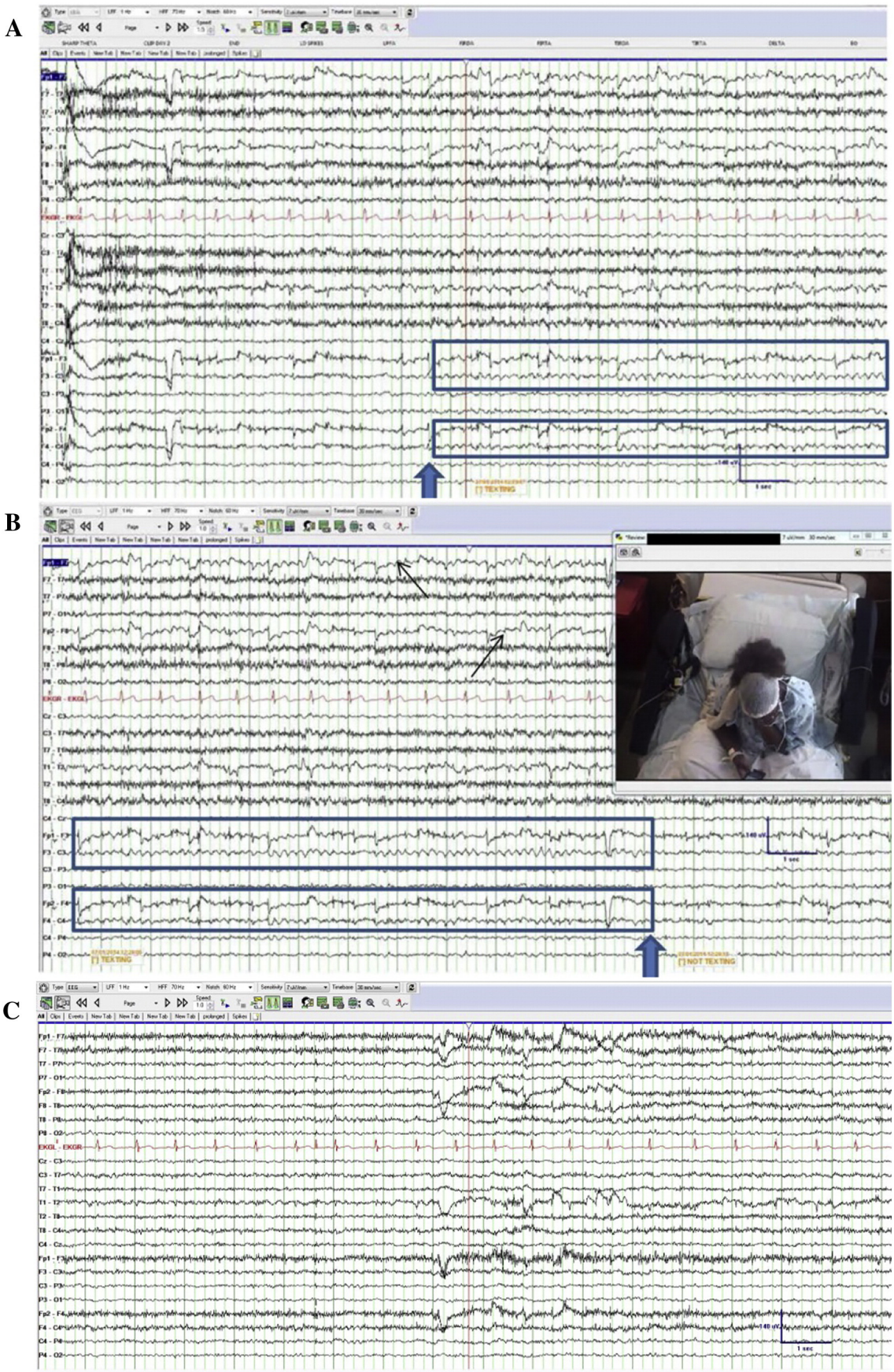

Fig. 1. (A) The onset of a TR during unilateral text messaging; (B) the offset of the TR demonstrating unilateral texting with the right hand (picture insert) during video-EEG monitoring. Note the presence of the TR as a 5–6-Hz frontocentral monomorphic rhythm (blue boxes) at the start and termination of texting (solid blue arrows) on the EEG time-locked to active text messaging. (C) The same 22-year-old female with eyes closed initially then open during verbal communication. Note the same background activity that is seen in (A) prior to the onset of the TR. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)