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Watching television: a previously unrecognized powerful trigger of lambda waves

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Conflict of interest

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Abstract

Objective: To assess whether lambda waves are elicited by watching television and their association with demographical and EEG features.

Methods: We retrospectively compared lambda waves occurrence in prolonged EEG-monitorings (PEEG) of outpatients who were allowed to watch television, and in standard EEGs (SEEG) recorded in television-free rooms. All EEGs were interpreted by the same two electroencephalographers.

Results: 36/2072 (1.7 %) SEEG reports mentioned lambda waves vs. 46/143 (32.2%) PEEG reports ($p < 0.001$). Multivariable comparison of PEEGs and SEEGs disclosed that recordings performed in rooms with a television (OR 20.6, 95% CI: 4.8 -88.0) and normal EEGs (OR 3.03, 95% CI: 1.5 – 6.25) were independently associated with lambda waves. In the PEEG group, all recordings with lambda waves also had POSTS.

Conclusions: Watching television likely represents a powerful and previously unrecognized stimulus for lambda waves. Furthermore, this study confirms the benign nature of this EEG variant and its strong association with POSTS.

Lambda waves on EEG are sharp transients occurring over the occipital regions of waking subjects during visual exploration of the environment (Noachtar S et al., 1999); they typically show a surface positive polarity, with a triangular shape in the theta band and amplitudes below 50 μV (figure 1), very similar to positive occipital sharp transients of sleep (POSTS). Lambda waves were first described more than six decades ago (Gastaut Y, 1951); their prevalence has been reported to vary between 2 and 88%, with the highest occurrence in children between three and twelve years old (Chatrian GE, 1976). Scanning eyes movements is felt to play an important role in the generation of these transients; in particular, they are usually recorded in brightly lit EEG laboratories and cannot be elicited in darkness (Niedermeyer E, 2005). This point emphasizes the link between lambda waves and visual activity.

As opposed to the seldom recognition of these wavelets in our EEG recording laboratory, we have been struck by the frequent occurrence of lambda waves in our outpatient EEG monitoring unit, especially when patients were watching television. Since to the best of our knowledge no previous study has addressed this question so far, and the available literature on lambda waves seems extremely scarce (the last comprehensive study dates back to 12 years ago, except a series on three patients in 2005 (Weber P, 2005)), we undertook this study in order to assess the occurrence of lambda waves and its association with demographical and EEG features.

Methods

<u>Design and population</u>

We retrospectively analyzed two EEG recording groups. The first one resulted from outpatients undergoing a prolonged EEG monitoring (PEEG) between December 2006 and July 2010; referral was motivated by unclear diagnosis of epilepsy or non-epileptic seizures. All patients were recorded over one afternoon and the following night, and had the possibility to freely watch television. The second group was represented by patients having a standard EEG (SEEG) in our EEG laboratory in the year 2009; these were out- and in-patients, and underwent 20-30 minutes wake recordings, or 1-2 hours EEGs after sleep deprivation (including wakefulness). These subjects were mostly referred because of epilepsy, unclear loss of consciousness related to other disorders (such as stroke, cerebral trauma, cerebral tumors), or metabolic-toxic encephalopathy. Patients younger than 2 years old (including premature newborns) and subjects undergoing EEG monitoring in the

ICU (mostly during coma) were excluded, in order to obtain a homogenous distribution in both groups. We identified EEG reports mentioning lambda waves through review of our computerized database.

EEG Recording and analysis

PEEG were recorded in our sleep laboratory, where patients had a quiet room with a television. Light was turned off for the night. SEEG were recorded in our EEG laboratory in a quiet room without television, in our emergency department, in the intensive care unit (we only considered wake patients), or in our inpatient units (mostly neurology, neurosurgery, pediatrics, and internal medicine).

EEGs were recorded using 21 or 23 electrodes arranged according to the international 10-20 system (anterior temporal leads were added if necessary). Recordings were acquired on digital fixed or portable machines (Nicolet, Neuroswiss, Switzerland; Micromed, Italy) by registered EEG technologists. During acquisition, high frequency filter was set at 70 Hz, low frequency filter at 0.5 Hz, and the notch filter at 50 Hz.

All tracings were interpreted on longitudinal bipolar and average reference montages, which were freely interchangeable, by EEG fellows supervised by two experienced electroencephalographers (M.M-I and A.O.R). All EEG reports included indication, duration, detailed description and a conclusion. Lambda waves were mentioned if sharp positive occipital transient in the theta band, with the typical triangular shape, occurred in a waking patient (Noachtar S et al., 1999). Asymmetrical lambda occurrence (Weber P, 2005) was not considered in our reports.

Data and statistical analyses

In the PEEG and the SEEG groups, we identified demographics, presence of lambda waves, POSTS occurrence, whether the study was performed on outpatients or inpatients, and if the EEG was described as normal or not. Comparisons were performed using χ^2, two-sided Fisher, or t-tests, as needed. In order to adjust for potential confounders, the relationship between lambda waves occurrence and all potential variables of interests was assessed with a stepwise logistic regression analysis, and its goodness of fit proofed with a χ^2 test. For this purpose, a randomly selected subgroup of SEEG recordings was compared with PEEGs.

Results

In the year 2009, 2181 SEEG were performed (792 outpatients, 36.3%); 71 were excluded (children younger than 2 years old or ICU monitoring), leaving 2072 recordings in this group. Between December 2006 and July 2010 we recorded 145 PEEG; here, two recordings were excluded because of the age of the patients, thus we further analyzed 143 recordings in this group.

While 36/2072 (1.7 %) SEEG reports mentioned lambda waves, these were found in 46/143 (32.2%) PEEG reports; this difference was statistically significant ($p < 0.001$ χ^2 test). **Table 1** illustrates variables in the PEEG group stratified for the occurrence of lambda waves: while gender and age were equally distributed, all subjects with lambda waves also had POSTS, and they more often had normal recordings. Differences were statistically significant for these two variables.

From the 2072 SEEG recordings, we randomly selected 102 studies (about 5% of the 2072 SEEG) to be compared to the PEEGs. Occurrence of lambda waves (36/2072 vs. 2/102, p=0.540, Fisher) was similar, confirming a reasonable sampling. **Table 2** shows demographical and EEG characteristics in the two groups; all resulted significant in the univariate analysis. Stepwise logistic regression, using lambda waves occurrence as dependent variable and all the other parameters as independent variables, disclosed that only recording in a room with television (OR 20.6, 95% CI: 4.8 -88.0, p<0.001) and EEG interpreted as normal (OR 3.03, 95% CI: 1.5 – 6.25, p=0.002) were independently related to lambda waves occurrence; the model had an acceptable goodness of fit (p=0.21, χ^2).

Discussion

The main finding of this study is that prevalence of lambda waves was clearly higher in prolonged EEG monitorings as compared to EEG recorded in our EEG laboratory, and this was independently related to a recording setting in a room with television and the occurrence of normal EEGs. Furthermore, all recordings with lambda waves also had POSTS.

The main differences between the SEEG and PEEG groups were represented by the duration of EEGs, the proportion of outpatients and normal studies, the fact that only patients of the PEEG group could watch television, and (to a lesser extent) different demographics (**Table 2**). Since lambda waves are by definition transients occurring during wakefulness (Noachtar S et al., 1999), duration of recordings and sleep occurrence should not influence their prevalence, as long as wakefulness is present. Moreover, our multivariate analysis showed that while demographical differences and the proportion of outpatients were not independently related to the occurrence of lambda waves, recordings performed in rooms with televisions and normal EEGs were strongly associated with these typical transients. As lambda waves are induced by visual activity (Niedermeyer E, 2005) and likely represent a sort of visual evoked potential induced and visible in susceptible subjects, it does not appear surprising that powerful and complex visual stimuli, such as those elicited by television, can trigger them. In analogy with POSTS (Rey V et al, 2009), the independent association between lambda waves and normal EEG studies confirms that lambda waves are part of a normal brain activity (Niedermeyer E, 2005, Weber 2005) and could be abolished by pathologic processes. On the other side, we could not confirm a higher occurrence of lambda waves in children (Chatrian GE, 1976).

The second finding of this study is the strong association between lambda waves and POSTS in the PEEG group. In our previous prospective study, we found that POSTS occur in less than 10% of EEG recordings (Rey V et al., 2009) and are features of the physiologic sleep. In view of the similarity of shape and distribution of POSTS and lambda waves, an association between them has been postulated several decades ago (Vignaendra V et al., 1974). In the present analysis, all recordings with lambda waves had also POSTS, whereas this was true in only 40.2% of recordings without lambda waves, confirming the association between these two to relatively EEG common variants. The higher incidence of POSTS found among PEEG as compared to our previous assessment (Rey V et al. 2009) is probably explained by the fact that all patients in this group slept, and this was not the case in the former cohort (which analyzed unselected EEG recordings over a definite period of time).

Our study has some limitations. Firstly, its retrospective nature implies that under-ascertainment of lambda waves is possible. However, since all EEG recordings in both groups were supervised by the same two electroencephalographers, a bias between PEEG and SEEG appears highly unlikely. Secondly, a definite concordance between lambda waves and the time during which patients watched television was not strictly assessed; nevertheless, as stated in the introduction, we have been repetitively surprised by this association during EEG reading. The timely concordance of watching TV and the occurrence of lambda waves should be precisely recorded in a future study. The multivariable approach, on the other side, corroborates in our view our results by taking into account potential confounders. To definitely prove our hypothesis, neurologically normal subjects should be investigated to confirm the effect of television on inducing lambda waves. Finally, recordings duration was by definition much longer in the PEEG group than in the SEEG group; however, we tend to believe that this aspect did not affect their occurrence in a decisive way. Indeed, all patients in the SEEG group were recorded in a bright room with opened eyed allowing visual scanning, and all patients with lambda waves showed them at the beginning o the recording under those circumstances.

In conclusion, since lambda waves are enhanced by visual scanning, watching television probably represents a powerful and previously unrecognized stimulus; the common availability of television screens, apart from EEG recording facilities, suggests that lambda waves prevalence is possibly higher than previously reported. Furthermore, this study confirms the benign nature of this EEG variant.

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Tables & Figures:

Table 1: Comparisons among 143 outpatients with or without lambda waves recorded on prolonged EEG monitoring (PEEG)

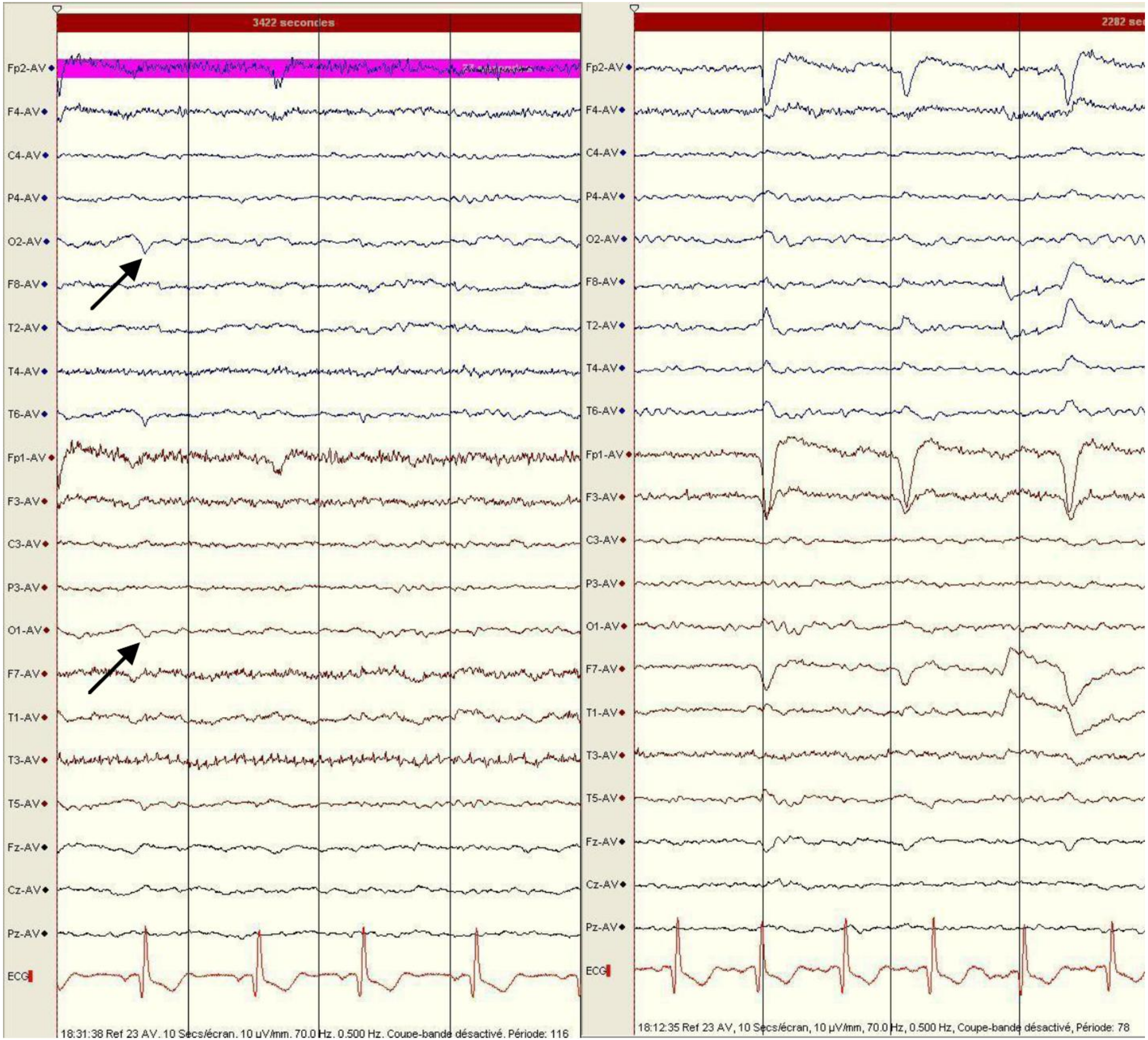
Table 2: Univariate comparisons between 102 randomly selected standard EEGs from 2072, and 143 prolonged EEG monitorings.

Figure 1: EEG of an 18 year-old man with referential average montage, 30mm/sec and 10µv/mm. On the right he is watching television and lambda waves (arrows) are seen in the occipital regions. On left, the same patient with television turned off. No lambda waves are seen between eye blinking.

	Total	Lambda	No lambda	p (test)
All Prolonged EEG monitorings	143	46 (32%)	97 (68%)	
Male gender	66 (46.2%)	21 (45.7%)	45 (46.4%)	0.208 (χ^2)
Age (years) (±SD)	34.7 (18.9)	35 (16)	34.6 (20)	0.92 (t)
POSTS occurrence	82 (55%)	46 (100%)	39 (40.2%)	<0.001(χ^2)
Normal EEG	51 (35.7%)	25 (54.3%)	26 (26.8%)	<0.001(χ^2)

POSTS= positive occipital sharp transients of sleep

	Standard EEG	**Prolonged EEG monitoring**	**p (test)**
Total	102	143	
Age (years) (±SD)	42.9 (24.4)	34.7 (18.9)	0.004 (t)
Male gender	59/102 (57.8%)	66/143 (66%)	0.001 (χ^2)
Outpatient EEG	48/102 (47.1%)	143/143 (100%)	<0.001 (χ^2)
Normal EEG	20/102 (19.6%)	51/143 (35.7%)	<0.001 (χ^2)
Lambda waves occurrence	2/102 (1.95%)	46/143 (32%)	<0.001 (χ^2)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O1-AV
F7-AV
T1-AV
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