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Photic EEG-Driving Responses in Thalamotomized and Medicated Cases of Parkinson's Disease

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Summary. EEG-driving responses to visual stimulation were studied using EEG Interval Spectrum Analysis (EISA) before and after stereotaxic thalamotomy and Nacom® (L-Carbidopa and Levodopa) treatment of 67 Parkinson patients. Five types of photic-driving responses were distinguished in the EISA results: (1) all-band response, (2) Beta-dominant, (3) Alpha-Beta-dominant, (4) Alpha-Theta-dominant, (5) non-response.

Twenty patients received a daily dose of 750—1000 mg of Nacom orally, and 47 patients 1000—1500 mg for a period of 3 to 4 weeks. In most cases the medication produced no change in photic-driving and EEG patterns. The photic-driving response showed no significant correlation with clinical signs and background EEG.

Unilateral thalamotomy was performed in ten Parkinson patients. In two of these patients the EEG-driving response diminished in the first postoperative week for low frequency stimuli but increased after the second week.

Key words: Parkinson's disease – EEG interval spectrum analysis – Photic-driving response – Thalamotomy – L-Dopa-medication.

Zusammenfassung. Die EEG-Lichtreaktion auf periodische Lichtblitze von 4—26/s, analysiert mit der EEG-Intervall-Spektrum-Analyse (EISA), wurde vor und nach Behandlung von 67 Parkinson-Patienten untersucht.

Die verschiedenen Muster der Lichtreaktionen wurden in 5 Gruppen eingeteilt: (1) Reaktion auf der gesamten Bandbreite, (2) Beta-dominante Reaktion, (3) Alpha-Beta-dominante Reaktion, (4) Alpha-Theta-dominante Reaktion, (5) keine Reaktion.

Die 67 Parkinson-Patienten erhielten L-carbidopa und Levodopa (Nacom, Sharp & Dohme) in therapeutischer Dosierung. Zwanzig Patienten bekamen eine tägliche Dosis von 750—1500 mg/die, für 3—4 Wochen. Bei der Mehr-

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zahl der Fälle bewirkte die Medikation keine Veränderung der Lichtreaktion und des EEG. Eine signifikante Korrelation von klinischen Zeichen und Hintergrunds-EEG zur Lichtreaktion fand sich nicht.

Bei 10 Patienten wurde eine unilaterale Thalamotomie vorgenommen. Bei zwei dieser Patienten verminderte sich die Lichtreaktion für niederfrequente Reize in der ersten postoperativen Woche, nahm jedoch nach der zweiten Woche wieder zu.

Schlüsselwörter: Parkinson-Krankheit – EEG-Intervall-Spektrum-Analyse – Lichtreaktion – Thalamotomie – L-Dopa-Medikation.

Introduction

Photic stimulation is widely used as a provocation method for EEG recordings. Many workers investigated the effects of photic stimulation (the photic-driving response) on normal [4, 7, 10, 15] and pathological EEGs [4—6, 8, 12—15]. In 1969 Tönnies described the EEG interval spectrum analysis, which was proposed as an efficient technique for the analysis of photic-driving responses [1—3, 14]. We used the method in a report on driving in normal subjects and brain tumor patients [4].

After its discovery in 1960, L-Dopa was widely used to treat Parkinsonism. Following its administration the concentration of dopamine increases in the brain and other tissues. MAO inhibitors enhance the accumulation of decarboxylation products and cause a potentiation of the action of L-Dopa. Catechol-O-Methyl Transferase (COMT) also markedly potentials the action of L-Dopa.

Recently the correlation between substances producing adrenergic conditions and photic-driving responses was investigated [8, 9, 13, 14]. It was suggested that the photic-driving response is decreased by MAO inhibitors, Noradrenaline, and Amphetamin, because they raise the excitability threshold of the central nervous system, enhancing in particular the inhibitory function of the reticular system.

The main purpose of the present study was to determine the relationship between L-Carbidopa, Levodopa, and the photic-driving response as assessed by the EISA method in Parkinson's disease. At the same time we studied the effect of thalamotomy on the photic-driving response in Parkinson patients.

Method and Materials

The 67 patients examined in this study were admitted to the Neurosurgical Hospital of the Steglitz Clinic at the Free University of Berlin. All of the patients exhibited clinical signs of Parkinson's disease: tremor, rigidity, hypokinesia, etc. Their ages ranged from 40 to 77 years, averaging 56.6 years. The duration of the disease varied from 18 months to 35 years. Before and after treatment with Nacom (L-Carbidopa and Levodopa), 134 EISA examinations were performed on the 67 patients. The drug was given by mouth in normal therapeutic doses: 750—1000 mg/day in 20 patients and 1000—1500 mg/day in 47 patients. The usual duration of treatment was 3 to 4 weeks. Ten patients of the series in whom unilateral thalamotomy was performed were also tested with EISA before and after the operation.

Table 1. Incidence of photic-driving response patterns in Parkinson's disease

All-band Type	Beta-band Type	Alpha and Beta-band Type	Alpha and Theta-band Type	Non-response Type	Number
7	4	17	14	25	67
11%	6%	25%	21%	37%	

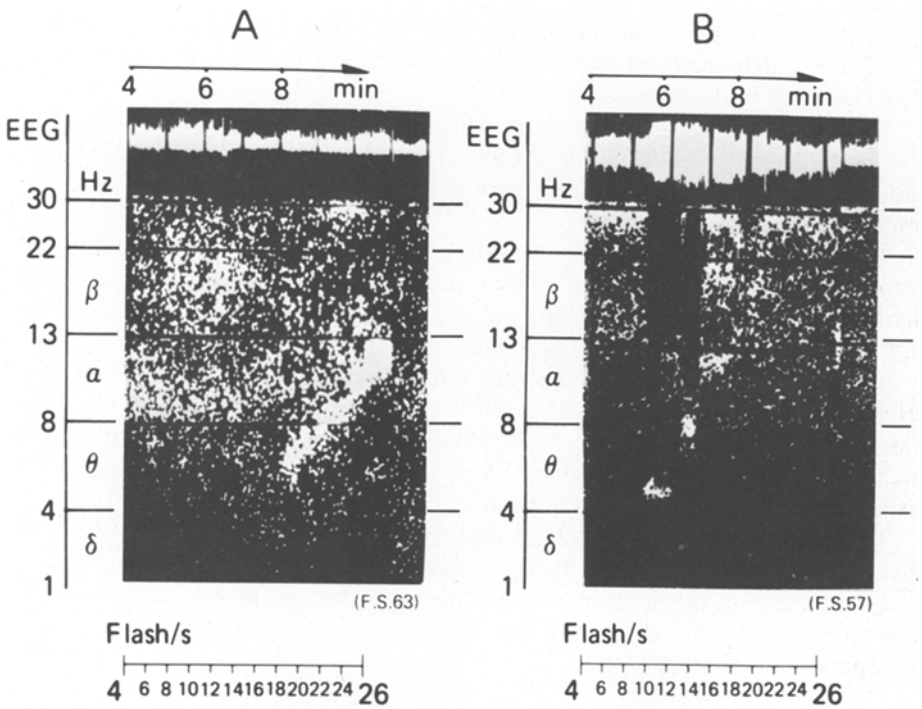

Fig. 1A and B. Two common types of photic-driving responses. **A**: All-band type, **B**: Alpha and Theta type

The patients kept their eyes closed during the examination. The EEG was recorded bipolarly on an EEG apparatus using a time constant of 0.3 s and an upper frequency cut-off at 70 Hz. Disc electrodes were placed at Oz-Fz and 02-F4 according to the international ten-twenty system. The EEG was stored on a magnetic tape for later analysis and also fed directly to an EISA apparatus (Tönnies, 1969). By this method the interval of each EEG wave within the frequency band of 1 to 30 Hz was automatically measured at the level of one-third of the average amplitude. A sweep speed on one minute per division was used. The photic stimulation was delivered by a 15-W Xenon stroboscope (Knott, type STRN), giving a blue light with a flash of 10/μs duration and of 0.725 Joule energy. The flash lamp was placed about 25 cm away from the patient's eyes. The frequencies used were 4 to 26/s in steps of 2/s. Each frequency was used for 15 s.

Results

According to the responses at fundamental frequencies of photic stimulation, we distinguished five patterns of EEG-driving response in the EISA analysis:

(1) all-band type (11%), (2) Beta-dominant type (6%), (3) Alpha-Beta-dominant type (25%), (4) Alpha-Theta-dominant type (21%), (5) non-response type (37%). They are summarized in Table 1.

Of all the patients, 68% showed responses before and after treatment to photic stimulation in one or more frequency bands. Figure 1 shows an example of the all-band type (A) and the Alpha-Theta type (B). The photic-driving response to all frequencies of photic stimulation appears as a diagonal band of white dots.

Figure 2 demonstrates other response patterns: Beta-type (C), Alpha-Beta type (D), and non-response type (E).

It was found that Parkinson patients who had taken L-Carbidopa and Levodopa showed no alteration in their driving response patterns between pre- and posttreatment (Fig. 3). Only two patients showed significantly stronger responses after medication.

Table 2 demonstrates the relationship between the resting EEG activities and driving-response patterns. The EEG resulting from fundamental background rhythmic activity was divided into two types: (1) normal Alpha-dominant type and (2) abnormal diffuse slow activities, or Beta-dominant type.

There was no correlation between background EEG activity and photic-driving response before and after medication. For example, we found that there was a better response in Theta and Beta bands than in the Alpha band in spite of background activity with dominant Alpha. Generally the patients showed no distinct EEG change after medication.

Ten patients who had unilateral thalamotomy were also recorded pre- and postoperatively with EISA. In two patients EISA examinations demonstrated a lower response on the seventh postoperative day than on preoperative days for slow frequency flashes (Fig. 4M), but the response increased again on the 14th postoperative day (Fig. 4N).

Discussion

It has been stated in many reports that the EEG-driving response to photic stimulation varies individually. Therefore I classified the driving responses into five types similar to those reported in our previous paper [4].

Table 2. Resting EEG activities and photic-driving response patterns in 67 Parkinson patients

Resting EEG Activity	All-band Type	Beta-band Type	Alpha and Beta-band Type	Alpha and Theta-band Type	Non-response Type	Number
Alpha-dominant group	5	2	8	8	8	31
Beta-dominant or diffuse slow activity group	2	2	9	6	17	36

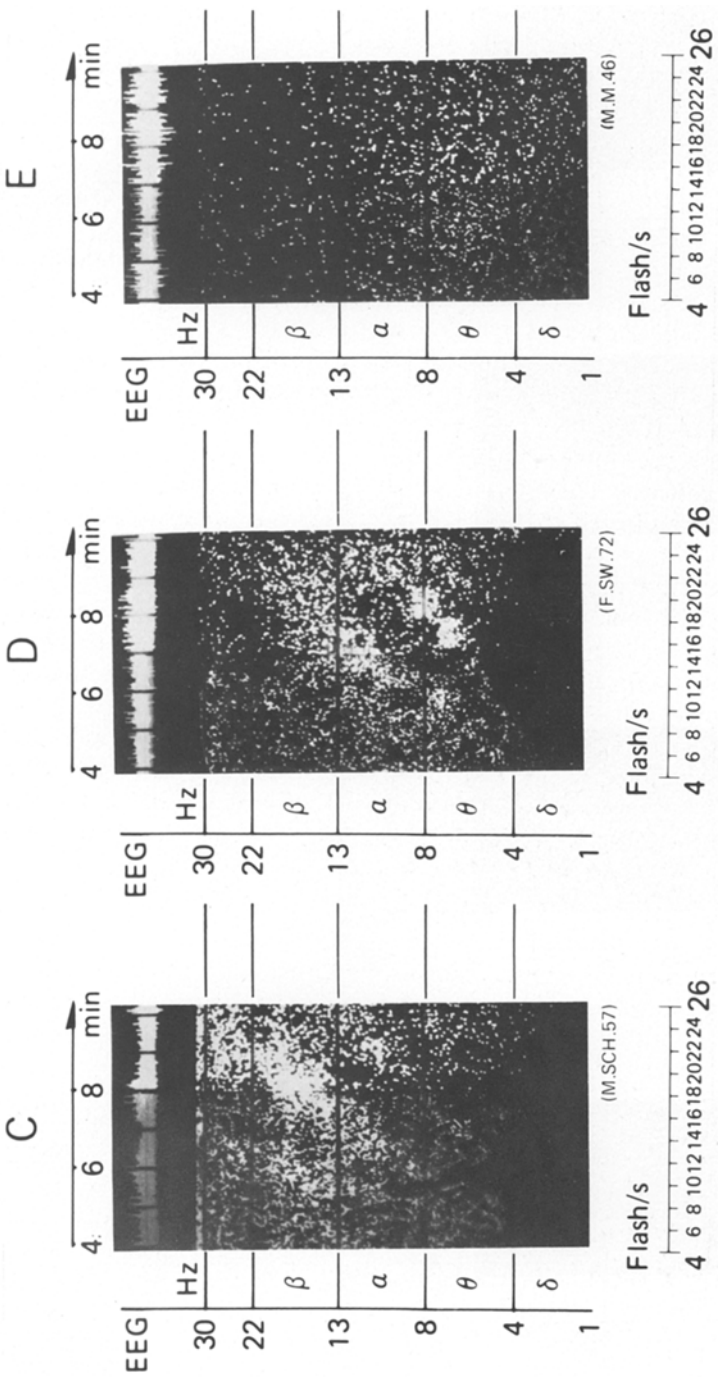

Fig. 2C–E. Other patterns of photic-driving responses. C: Beta type, D: Alpha and Beta type, E: non-response type

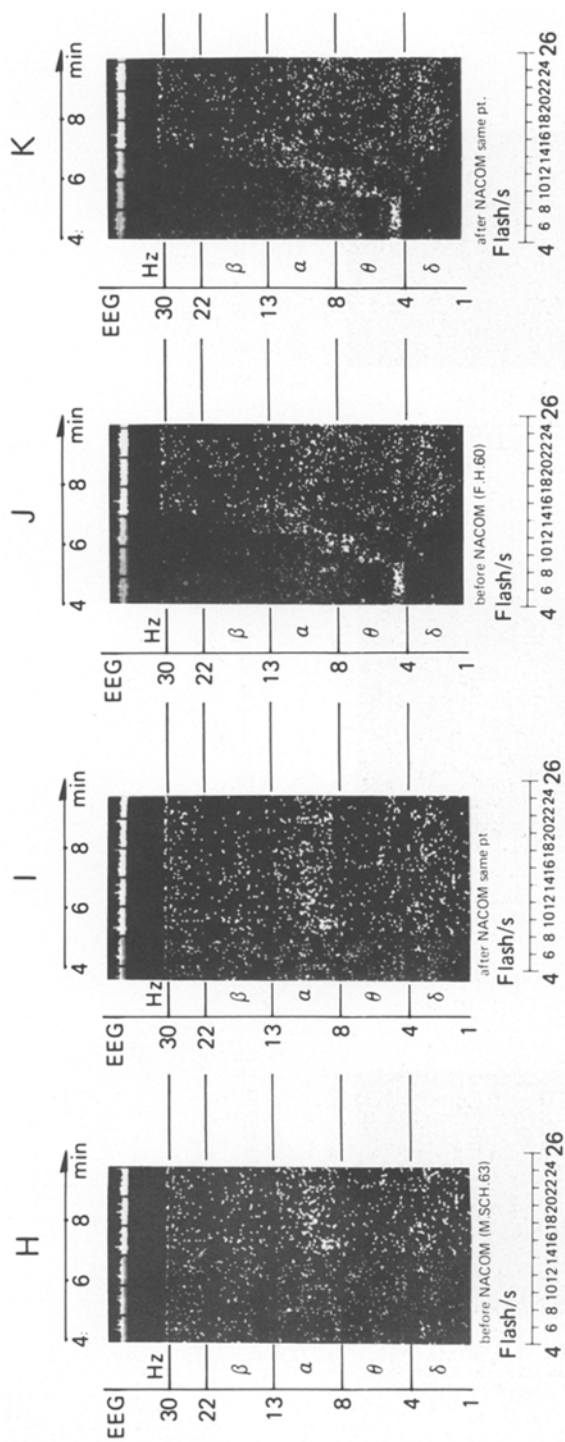

Fig. 3H–K. Two examples showing no change in driving response. Patient 1: **H**: pretreatment, **I**: posttreatment. Patient 2: **J**: pretreatment, **K**: post-treatment

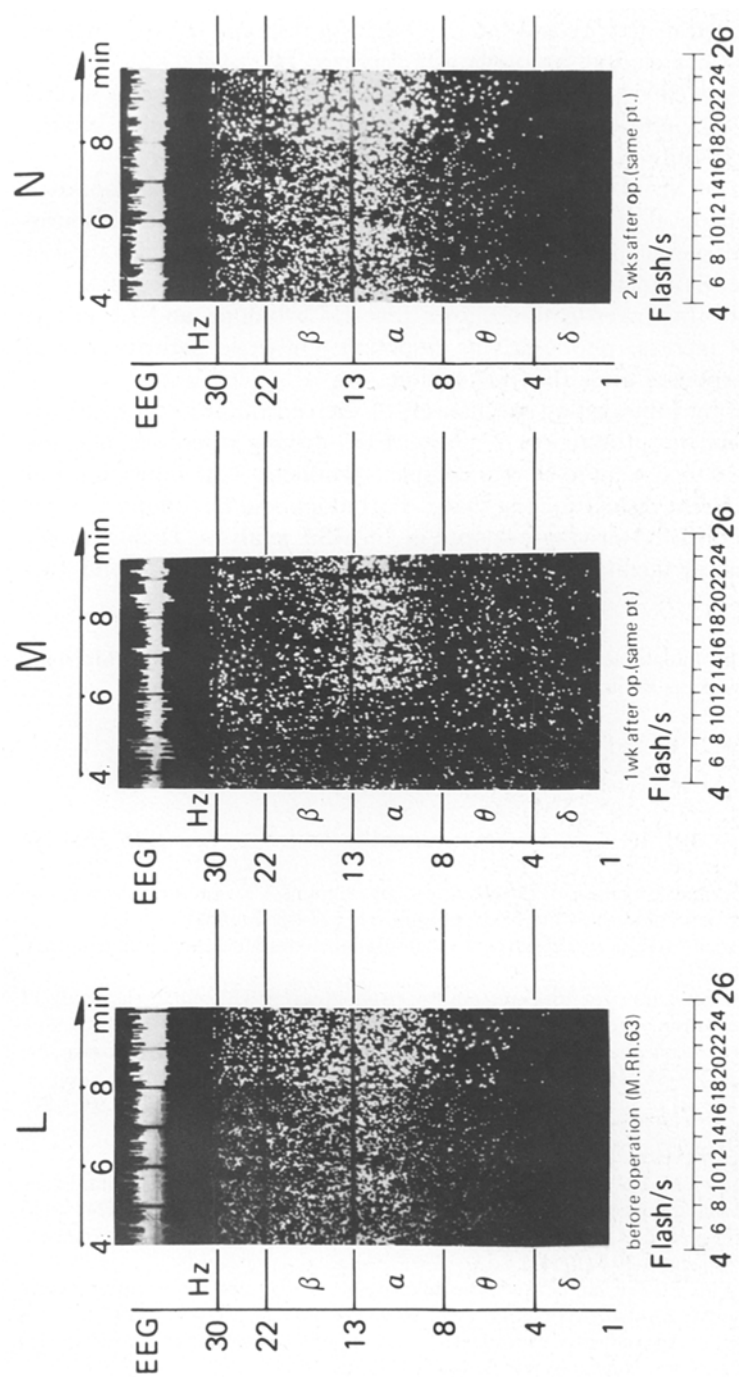

Fig. 4L–N. A case of transiently reduced response to low frequency stimuli after stereotactic operation. **L**: before, **M**: 7 days, **N**: 14 days following a stereotactic coagulation in the thalamus

Some reports emphasized that the driving response to photic stimulation decreases in head injuries, brain-tumors, intracerebral hemorrhages, etc. [4, 8, 10, 12]. We confirm decreased photic-driving responses in brain disease as observed by other workers. Others suggested that there is a close relationship between the dominant Alpha resting activity and the EEG-driving response [8, 9]. However, we found no such correlation, as previously reported [4].

Postthalamotomy EEG findings with varying results were reported by several authors [5, 6]. We found significant differences in the postoperative photic-driving response in only two of ten thalamotomy patients.

The inhibition of MAO activity in the central nervous system is associated with increase in the level of brain monoamines which are believed to be neurotransmitters for adrenergic neurons. It was suggested that there is acceleration of the central adrenergic function which blocks EEG photic-driving responses [9, 12—14]. However, this investigation shows that L-Carbidopa and Levodopa (Nacom) does not increase photic-driving responses. Only two patients showed strong positive responses after this medication.

A complicated and integrating mechanism of the central nervous system is probably at play in the production of photic EEG-driving responses, and the central effects of L-Dopa seem to be very complex, producing both inhibition and facilitation. The present results suggest that L-Carbidopa and Levodopa have no facilitating effects on EEG-driving response in an EISA analysis. Thalamotomy produced short lasting facilitation of photic EEG-driving responses in only two of ten cases.

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References

1. Baldock, G. R., Walter, W. G.: A new electronic analyzer. Electron. Engng. **18**, 339—344 (1946)
2. Burch, N. R.: Automatic analysis of the electroencephalogram: A review and classification of systems. Electroencephalogr. Clin. Neurophysiol. **11**, 827—834 (1959)
3. Dietsch, G.: Fourier-Analyse von Elektroencephalogrammen des Menschen. Pflügers Arch. **230**, 106—112 (1932)
4. Fukushima, T.: Applikation of EEG-interval-spectrum-Analysis (EISA) to the study of photic driving responses. Arch. Psychiat. Nervenkr. **220**, 99—105 (1975)
5. Green, R. L.: Electroencephalographic Changes in Parkinson's Disease. J. Neurosurg. **24**, (Suppl., Part II), 377—381 (1966)
6. Hughes, J. R.: The EEG in Parkinsonism. J. Neurosurg. **24**, (Suppl., Part II), 369—376 (1966)
7. Kelly, D. H.: Sine waves and flicker fusion. Doc. Ophthalmol. **18**, 65 (1964)
8. Kooi, K. A., Thomas, M. H.: Electronic Analysis of cerebral responses to photic stimulation in patients with brain damage. Electroencephalogr. Clin. Neurophysiol. **10**, 417—424 (1958)
9. Kopin, L. J.: Storage and Metabolism of Catecholamines: the role of monoamine oxidase. Pharmacol. Rev. **16**, 179—191 (1964)
10. Montagu, J. D.: The relationship between the intensity of repetitive photic stimulation and the cerebral response. Electroencephalogr. Clin. Neurophysiol. **23**, 152—161 (1967)
11. Mundy-Castle, A. C.: An analysis of central responses to photic stimulation in normal adults. Electroencephalogr. Clin. Neurophysiol. **5**, 1—22 (1953)

12. Shetty, T.: Photic responses in hyperkinesis of childhood. Science **174**, 1356—1357 (1971)
13. Stenn, P. G., Klaiber, E. L., Vogel, W., Broverman, D. M.: Testosterone effects upon photic stimulation of the EEG and upon mental performances of humans. Percept. Mot. Skills. **34**, 371—378
14. Tönnies, J. F.: Automatische EEG-Intervall-Spektrumanalyse (EISA) zur Langzeitdarstellung der Schlafperiodik und Narkose. Arch. Psychiatr. Nervenkr. **212**, 423—445 (1969)
15. Vogel, W., Broverman, D. M., Klavier, E. K., Kobayashi, Y.: EEG driving responses as a function of monoamine oxidase. Electroencephalogr. Clin. Neurophysiol. **36**, 205—207 (1974)
16. Walter, V. J., Walter, W. T.: The central effects of rhythmic sensory stimulation. Electroencephalogr. Clin. Neurophysiol. **1**, 57—86 (1949)

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