Short communication

EEG photic driving: Right-hemisphere reactivity deficit in childhood autism. A pilot study

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In 14 autistic boys, aged 6–14 years, free of drug treatment, with relatively intact verbal functions and without severe or moderate mental retardation (I.Q. 91.4±22.8), intermittent photic stimulation at 11 fixed frequencies of 3–24 Hz revealed latent deficiency of the right hemisphere in the photic driving reactivity, predominantly at the fast alpha and beta frequencies of stimulation. The left-side prevalence was observed: 1) in the total number of driving peaks evaluated for the first four harmonics in the EEG spectra of 14 cortical areas and 2) in the driving amplitude in the spectra of the 2 occipital areas. As compared to 21 normally developing boys matched on age who did not show interhemispheric asymmetry in the driving reactivity, the autistic patients had significantly lower driving characteristics only in the right hemisphere. There were no significant differences between the autistic and control groups in the spontaneous EEG spectra of the occipital areas in the resting state.

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Intermittent photic stimulation (IPS) induces photic driving response in the electroencephalogram (EEG). This rhythmic activity is time-locked to the stimulus at a frequency identical or harmonically related to that of the stimulus. The resonance-like mechanisms of the driving response may enhance latent normal or abnormal bioelectrical oscillations (Takahashi, 1987). Besides paroxysmal reaction to IPS in photosensitive epilepsy, non-paroxysmal driving responses were found to correlate with various types of cerebral pathology, not always manifested in the resting EEG (Scheuer, 1983), such as partial epilepsy and brain lesions (Beydoun et al., 1998). These responses can also be informative in the neurophysiological study of neuropsychiatric functional and endogenous disorders such as headache (Gronseth and Greenberg, 1995) and schizophrenia (Jin et al., 2000), which, as a rule, are not evident in the EEG diagnostics. In these pathologies, topographic photic driving response in different brain areas has shown a promising potential for revealing subtle functional disturbances in regional reactivity (Jin et al., 2000). It was demonstrated that IPS can emphasize the functional interhemispheric asymmetry (Hirotta et al., 2001) and can also indicate regional functional alterations through asymmetric driving effects (Scheuer, 1983; Beydoun et al., 1998).

Our previous research has shown that detailed topographic quantitative analysis of the EEG photic driving at various stimulation frequencies, may be a quite sensitive indicator of functional brain maturation in children. This approach enabled us to reveal certain additional features of the brain electrical activity development via latent theta oscillations in the posterior brain areas not present in the resting EEG at preadolescent and adolescent stages (Lazarev et al., 2001, 2004). In normal subjects, the topographic index of the photic driving generalization in the non-visual cortical areas proved to be positively correlated with age. Moreover, this index reflected a likely delay in brain maturation in patients with partial epilepsy. Similarly, this index appeared to be useful as a tool to evaluate the effects of antiepileptic drug therapy (Lazarev et al., 2006). These promising results prompted us to test the capacity of the proposed IPS methodology to reflect neurophysiological features of functional neuropsychiatric disorders that do not manifest explicit alterations in the spontaneous EEG.

Childhood autism can be considered one of such disorders. The literature on the EEG correlates in autism is quite discrepant and usually describes general and nonspecific changes, such as some prevalence of slow bioelectrical activity and alpha rhythm suppression and disorganization (Cantor et al., 1986; Small, 1987; Bashina et al., 1994; Chan et al., 2007). Some authors observed EEG signs of relatively lower activation in the left anterior areas in comparison with the right ones (Dawson et al., 1983; Harrison et al., 1998). In many cases, such asymmetry could probably reflect language developmental problems inherent to most autistic patients and traditionally considered as a central feature of autism. On the other hand, recent neuropsychological data emphasize a crucial role of right-hemisphere dysfunction in the development of some basic features of the autistic spectrum (Ozonoff and Miller, 1996; Siegal et al., 1996; Sabbagh, 1999). These features include impairments in social interaction, communication and imagination which constitute the classical autistic triad (Wing, 1997). The right-hemisphere abnormalities in the high-functioning forms of autism have been observed in neuroimaging studies (McKelvey et al., 1995; Waiter et al., 2005).
However, to date in the electrophysiological literature, only in some special tasks of event-related potential paradigm such as discrimination of speech prosody (Kujala et al., 2005) or processing gaze direction in face perception (Senju et al., 2005), certain right-hemisphere alterations in autistic patients were detected. For the spontaneous rhythmic EEG activity, abnormal left-side prevalence in the EEG spectral power during sustained visual attention was recently described for the temporal areas in young autistic children (Stroganova et al., 2007).

Since the left-hemisphere specialization for language is a decisive determinant of the EEG interhemispheric asymmetry (Butler and Glass, 1974; Lazarev, 1998), language disorders may probably shade some finer right-hemisphere manifestations. For this reason, in the present research, the IPS test was applied in autistic patients without significant language problems or mental retardation. This approach was expected to facilitate detecting likely right-hemisphere dysfunction not apparent in the resting EEG and thus testing the sensitivity of the proposed methodology to reveal subtle functional alterations.

1. Materials and methods

Fourteen boys aged 6–14 years (mean ± standard deviation: 9.7 ± 2.3) were diagnosed as autistic patients according to the DSM-IV criteria (Filipek et al., 1999). All of them had a classical autistic triad of impairments in social interaction, communication and imagination (Wing, 1997), with relatively intact verbal functions and without severe or moderate mental retardation. According to the WISC-III intelligence test (Wechsler, 1991), their IQ levels were average (90–109)—7 patients, below average—4 patients or above average—3 patients. Their verbal, performance and total IQ levels, were on average, 91.2 ± 27.5, 94.3 ± 20.4 and 91.4 ± 22.8, respectively. The patients did not have epileptic symptoms and abnormalities in the neurological examination other than those directly related to autism. Computerized helicoidal tomography of the brain was normal for all cases. The patients were free of drug treatment. The control group consisted of 21 boys, aged 6–16 years (10.1 ± 3.3), without a history of neurological, psychiatric or drug related illnesses and with normal academic achievement. The patients and controls were right-handed according to their hand preference and the reports of their parents. The study was approved by the local Ethics Committee.

EEG signals were recorded by a Nihon Kohden machine EEG-4418 at 14 scalp points (International 10/20 System, see Fig. 1) with unilateral references to the corresponding earlobes, during 2–3 min of initial resting state before stimulation (background) and during white flicker IPS of 11 fixed frequencies of 3, 4.5, 6, 8, 10, 12, 15, 18, 21 and 24 Hz, 25-s duration each, with 30-s periods between stimulation runs. Each EEG fragment registered was of 25-s duration. The artifact control during recording was visual with simultaneous registration of EOG. The subjects were wakeful with eyes closed throughout the experiment. Photic stimulator was Nihon Kohden 4418 K-LS-701B—a xenon lamp whose flash had duration of less than 20 μs. The lamp was positioned at a distance of 25 cm from the eyes, with dim surrounding light. The recording characteristics were: 0.3-s time constant, 70-Hz high frequency filter and 15-μV/mm sensitivity. Ground electrode was applied in Fpz. EEG signals were digitized at the sampling frequency of 256 Hz.

The duration of EEG epochs submitted to spectral analysis (FFT) was 2 s. The results were presented in the absolute form of amplitude spectra, i.e., the square root of the power spectrum, with a frequency resolution of 0.5 Hz. For each lead, the presence of the driving response at the frequency of stimulation was ascertained by in-house software as an amplitude peak which was at least 20% higher than the amplitudes at adjacent frequencies (±1 Hz) (20% criterion). In computer simulation, this level of prevalence gave a false-positive rate of less than 5% when the spectrum of signals was white, i.e., when there was no response to the stimuli (Lazarev et al., 2001). Our previous research in normal subjects has shown that most of the driving responses detected by this criterion proved to be significant (in relation to the previous background) according to the statistical estimation by spectral F-test (Lazarev et al., 2004).

Two aspects of the photic driving effect were evaluated quantitatively:

1. The photic driving presence according to the 20% criterion was estimated for each of the first four harmonics, i.e. fundamental IPS frequency and its three integral multiples (provided they fell at EEG frequencies below 70 Hz)—high frequency filter which determined evaluation of only three harmonics for the IPS 18 and 21 Hz and two harmonics for 24 Hz). The total number of the driving peaks at each harmonic and their sum for the first 4 harmonics were evaluated as average for all IPS frequencies corresponding to each standard frequency band (i.e. for 4 IPS frequencies in the beta, 3—in the alpha and in the theta and 1—in the delta bands) separately for 6 non-visual and 1 occipital visual leads in each hemisphere. In the latter case, only the sum of such averages for 4 harmonics was calculated.

2. Analysis of the driving magnitude was performed for the two occipital leads traditionally considered most representatives for the study of this reaction due to the highest occurrence of the driving response and its higher amplitude in this region (Lazarev et al., 2001, 2004). In order to observe simultaneously the responses to all the IPS frequencies, amplitude spectra measured at the stimulation frequency for each of the 11 EEG fragments corresponding to different stimulation runs, were plotted on a single graph called frequency “profile” of the individual driving reactions (Lazarev et al., 2001). For each standard frequency band, mean profile values and mean background amplitude spectra were evaluated (delta—3.0 and 3.5; theta—4.0–7.0; alpha—7.5–12.5; and beta—13.0–24.0 Hz). At each IPS frequency, an increase in amplitude spectra during stimulation (profile value) in relation to the spontaneous background EEG at the same frequency was also calculated.

The interhemispheric asymmetry in the total number of driving peaks in each group and the difference between autistic and control groups in each hemisphere were evaluated for each frequency band: at each of the four harmonics in the non-visual areas and for the sum of the four harmonics in both non-visual and occipital visual areas. The amplitude differences between the occipital driving profiles (between groups in each hemisphere and between hemispheres in each group) were estimated in 4 frequency bands and also at each of 11 frequencies of stimulation. The same comparisons were made for an amplitude increase during stimulation in relation to the background EEG. For the resting spontaneous EEG spectra in the occipital areas, the differences between hemispheres and groups were evaluated only for mean amplitude in each band.

The statistical significance of the interhemispheric and intergroup differences was calculated by non-parametric Kruskal–Wallis multiple test followed by Wilcoxon (for related samples) and Wilcoxon–Mann–Whitney (for independent samples) post-hoc pair tests. The data at different IPS frequencies or at their harmonics as well as in different frequency bands were not compared statistically among themselves.

The likely association between interhemispheric asymmetry and age was estimated by one linear regression model applied to the asymmetry characteristics averaged for all the frequencies in each band. For the 12 non-visual leads, the asymmetry was evaluated as the difference between the number of driving peaks in the left (L) and right (R) hemispheres related to the total number in both, i.e. (L−R)/(L+R). For the driving profiles in the two occipital leads, the interhemispheric amplitude difference was related to the mean amplitude, i.e. (L−R)/(L+R)/2.

2. Results

Two examples of strong and generalized driving response to the IPS of 6 Hz in normal subject (A) and autistic patient (B) may be seen in the spectrograms of Fig. 1. They show the driving peaks at the
stimulation frequency and some harmonics not only in the occipital 'visual' region (where the driving effects are usually studied) but also in the other 'non-visual' areas. In these areas, the reaction peak amplitudes are lower and decrease towards the frontal region. This trend was observed in all other subjects and patients studied (Lazarev et al., 2004). Individual topography of driving peaks' occurrence was very variable across both groups, however, a reduced number of driving responses in the right hemisphere in Fig. 1B proved to be characteristic (usually to a lesser degree) for autistic patients.

In both groups, the highest occurrence of the driving responses was as a rule in the occipital (visual) areas, where they could be observed at the first harmonic (stimulation frequency) in 62–95% of normal subjects at different frequencies of IPS (Fig. 2B). In autistic patients, this percentage was more or less similar in the left lead (64–93%) while in the right one, it was substantially lower than in the control group at the IPS frequencies of 3 and 4 Hz and particularly at the beta frequencies (Fig. 2C). This resulted in the percentage prevalence of the left occipital area over the right one in the autistic group at all the IPS frequencies.
Such prevalence was also observed at higher harmonics. In the right occipital area, each IPS frequency evoked driving response at, on average, 2.39±0.36 harmonics in normal subjects and at 1.55±0.49 harmonics in autistic patients, while in the left one these indices were similar: 2.34±0.45 and 2.57±0.47, respectively. The mean total number of occipital driving peaks at the first four harmonics in the autistic group was substantially lower in the right hemisphere: 1.88 as against 2.74 in the left one at the theta stimulation frequencies (p<0.01), 1.81 as against 3.07 at the alpha (p<0.001), and 1.11 as against 2.20 at the beta frequencies (p<0.001), respectively. There was no significant asymmetry in the control group. As a result, the prevalence of the normal subjects over autistics in the right occipital lead was observed for the theta (p<0.05), alpha (p<0.05) and beta (p<0.001) IPS frequencies while in the left lead, there was no significant difference in any band. For all these differences, the Kruskal–Wallis multiple test showed p=0.108 for theta, p=0.009 for alpha and p=0.000 for beta IPS frequencies.

In the 12 non-visual areas, where the localization of the leads with driving peaks varied at different IPS in both groups, the general extent of topographic generalization of the driving reaction could be evaluated by means of the total number of peaks in the left and right hemispheres. The summary scalp maps of the response percentage at the first harmonic in the group of autistic patients showed the left-side reactivity prevalence at almost all IPS frequencies, except for 4 and 5 Hz (Fig. 2A). In the control group, such prevalence was apparent only at five of eleven IPS frequencies (Fig. 2B). However, a comparison of the reactivity percentage in the two groups in each lead (by subtraction of the values of the maps for control group from the corresponding values for patients) showed that in most pairs of homologous symmetrical leads, a cell with higher percentage is grey or black.
In the right hemisphere of autistic patients, the total number of ‘non-visual’ leads with driving peaks at the first four harmonics was only 54.98% of those in the left one in the alpha band \((p<0.001)\) and 51.25% in the beta band \((p<0.01)\). These percentages decreased from 78.63% at the first harmonic to 39.58% at the fourth one for the alpha IPS frequencies and from 53.27% at the first harmonic to 30.86% at the third one (the fourth harmonic was not estimated) for the beta IPS frequencies \((p<0.01)\) for asymmetry at all harmonics of both bands. In the control group, no significant asymmetry was observed (Table 1).

Correspondingly, in the right hemisphere, the total number of driving peaks for the first four harmonics in the autistic group was 74.03% of those in the control group for the alpha IPS frequencies \((p>0.1)\) and 55.21% for the beta ones \((p<0.01)\). Such ratio was significant for the third (58.11%) and fourth (47.03%) harmonics of the alpha IPS frequencies, with a strong tendency towards the lower percentage in autistics (67.05%, \(p=0.59\)) at the first beta harmonic. No significant differences between the groups were observed in the left hemisphere (Table 1).

The Kruskal–Wallis multiple test applied to the number of driving peaks in the non-visual areas showed significant \(p\)-values (0.05–0.01) for all three harmonics of the beta IPS frequencies and three higher harmonics of the alpha ones.

In the occipital areas, where the driving magnitude was evaluated, the mean values of the background amplitude spectra in the alpha band in the autistic group were lower than in normal subjects. However, the Kruskal–Wallis test did not show significant differences for any band in the spontaneous EEG. Only post-hoc evaluation revealed a tendency to

**Table 1**

Topographic generalization of photic driving in non-visual cortical areas (6 leads in each hemisphere) evaluated in number of leads with driving peaks (according to 20% criterion) averaged over all IPS frequencies in each band (4 IPS frequencies in the beta, 3 in the alpha and in the theta and 1 in the delta bands)

<table>
<thead>
<tr>
<th>Band</th>
<th>Delta</th>
<th>Theta</th>
<th>Alpha</th>
<th>Beta</th>
</tr>
</thead>
<tbody>
<tr>
<td>IPS frequencies (Hz)</td>
<td>Left</td>
<td>Right</td>
<td>Left</td>
<td>Right</td>
</tr>
<tr>
<td>Autistics</td>
<td>1 harm.</td>
<td>0.93</td>
<td>0.57</td>
<td>1.98</td>
</tr>
<tr>
<td></td>
<td>2 harm.</td>
<td>1.64</td>
<td>1.71</td>
<td>2.26</td>
</tr>
<tr>
<td></td>
<td>3 harm.</td>
<td>0.71</td>
<td>1.14</td>
<td>2.31</td>
</tr>
<tr>
<td></td>
<td>4 harm.</td>
<td>1.14</td>
<td>0.86</td>
<td>1.55</td>
</tr>
<tr>
<td></td>
<td>∑1–4 harm.</td>
<td>4.43</td>
<td>4.29</td>
<td>8.1</td>
</tr>
<tr>
<td>Controls</td>
<td>1 harm.</td>
<td>0.81</td>
<td>0.57</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>2 harm.</td>
<td>1.86</td>
<td>1.52</td>
<td>2.21</td>
</tr>
<tr>
<td></td>
<td>3 harm.</td>
<td>1</td>
<td>1.43</td>
<td>1.79</td>
</tr>
<tr>
<td></td>
<td>4 harm.</td>
<td>0.81</td>
<td>0.29</td>
<td>1.37</td>
</tr>
<tr>
<td></td>
<td>∑1–4 harm.</td>
<td>4.48</td>
<td>3.81</td>
<td>7.37</td>
</tr>
</tbody>
</table>

\(∑1–4\) harm—sum for four harmonics; *—\(p<0.05\) for interhemispheric differences; **—\(p<0.05\) and ***—\(p=0.07\) for differences between the groups.

![Fig. 3](image_url)

**Fig. 3.** Group average EEG photic driving profiles (broken lines) and background spectra (curves) in the occipital areas. (A and B) Comparison between left (solid lines) and right (dashed lines) hemispheres in autistic (A) and control (B) groups. (C and D) Comparison between autistic (solid lines) and control (dashed lines) groups in right (C) and left (D) occipital areas. Arrows show significant differences \((p<0.05)\) between profile values at different IPS frequencies.
the prevalence of the controls in the left hemisphere (p = 0.75) (Fig. 3, C and D). In both groups, the right-side mean amplitude prevalence was observed in all the bands. In the control group, the post-hoc estimation showed significance of this asymmetry in the delta and beta bands and in the autistic patients in the theta band (p = 0.05), with a tendency (p = 0.1) in the alpha band for both groups (Fig. 3, A and B).

Pronounced difference between the two groups was observed in the interhemispheric asymmetry of the occipital photic driving amplitude profiles. In the autistic patients, the values in the right hemisphere, in contrast to the background pattern, proved to be lower than in the left one (Fig. 3A). When averaged for each frequency band, the right-side profile values were 82.83% (p = 0.1) of the left ones in the theta, 85.50% (p = 0.05) in the alpha and 59.76% (p = 0.001) in the beta bands. In the control group, the reactivity was almost equal in both hemispheres in all the bands. Correspondingly, in the right hemisphere, the profile values of the autistic group were 75.79% of those in the control group in the theta (p < 0.02), 74.52 (p = 0.05) in the alpha and 59.85 (p < 0.01) in the beta bands, while there were no significant differences in the left hemisphere. Kruskal–Wallis multiple test showed for the band averaged values: p = 0.086 for the theta, p = 0.184 for the alpha and p = 0.001 for the beta bands.

For 11 separate profile values, this multiple test detected significant differences at 4 Hz (p = 0.031), 18 Hz (p = 0.005), 21 Hz (p = 0.004) and 24 Hz (p = 0.000), and relatively low value at 15 Hz (p = 0.15). Post-hoc pair comparisons specified these differences showing left-side amplitude prevalence in the autistic group at 5 and 6 Hz (p < 0.05), 12 Hz (p < 0.01) and at all the beta frequencies (p < 0.01, except for 15 Hz; p < 0.05) (Fig. 3A). In the control group, the reactivity was almost equal in both hemispheres, except for the peak alpha frequency of 10 Hz that had significant right-side amplitude prevalence (p < 0.01) similar to the background asymmetry (Fig. 3B). When directly compared, the profiles of the two groups did not show any significant differences in the left hemisphere (Fig. 3D), while in the right one, the profile voltage in the patients was significantly lower at almost all IPS frequencies utilized (p = 0.05–0.001), except for 6 and 8 Hz (p < 0.1 and 6 Hz) (Fig. 3C).

The amplitude increase during IPS in relation to the background resting state in the autistic patients also prevailed in the left hemisphere at all the IPS frequencies (p < 0.05–0.001; except for 3 and 10 Hz: p < 0.1). In the control group was found no significant asymmetry in this more direct reactivity characteristic. When compared to the controls, the autistic patients showed significantly lower amplitude increase only in the right hemisphere at eight IPS frequencies (p < 0.05–0.001) with such a tendency at 6 and 10 Hz (p < 0.1) and except for 8 Hz. The results of Kruskal–Wallis test were significant at all beta frequencies (p = 0.05 at 15 Hz and p < 0.01 at 18, 21 and 24 Hz), had a character of tendency at 12 Hz (p = 0.75) and relatively low value at 4 Hz (p = 0.15).

The regression coefficients did not show any significant association between age and interhemispheric asymmetry, except for the number of driving peaks in the non-visual areas for the third harmonic of the beta IPS frequencies in the autistic group (p < 0.02; regression coefficient 0.18) and for the beta profile amplitudes in the occipital areas of normal subjects (p < 0.02; regression coefficient –0.013).

### 3. Discussion

The EEG photic driving quantitative characteristics proved to be sensitive enough to detect in autistic patients functional alterations in the right hemisphere, not reported in the EEG literature. The capacity of this methodology to uncover latent abnormalities is most obvious in the occipital areas, where the background EEG spectra did not show significant differences between autistic and control groups, while the driving profiles demonstrated strongly pronounced interhemispheric asymmetry only in the autistic patients. This asymmetry may be apparently treated as a right-hemisphere deficit in the photic driving reactivity, since in the left hemisphere, the driving profiles in both groups were similar.

The right-hemisphere driving deficit proved to be spatially generalized and was also apparent in the non-visual brain areas through the left-side topographic prevalence in the total number of the driving peaks and in the group percentage of the driving responses. This finding confirms the importance of the topographic approach to the photic driving study argued in our previous publication (Lazarev et al., 2004).

The nature of the driving reactivity deficit needs further investigation. However, some latent deficiency in the right-hemisphere activation can be hypothesized since the observed asymmetry was most pronounced at the IPS frequencies of the alpha and beta bands and at their harmonics. The latter for the greater part fell in the EEG frequencies of the gamma band. Some authors have shown that the photic driving prevalence at higher frequencies and particularly at higher harmonics correlates with a higher functional state of the brain (Mundy-Castle, 1953; Danilova, 1961). The photic driving reactivity can probably reflect some finer aspects of the cortical activation different from those related to traditional EEG signs of arousal such as alpha rhythm desynchronization etc. (Lazarev, 2006).

The results of the present research could also be considered in terms of the brain maturation due to the ability of the photic driving to reveal and emphasize latent neuronal sources of synchronization characteristic for certain stages of the brain development. In our previous research, we observed an enhanced driving reaction in the theta band in normal preadolescents and adolescents who did not show any theta peaks in the EEG spectra of the resting state (Lazarev et al., 2001). We also observed positive correlation of age with the number of driving peaks in the non-visual cortical areas (Lazarev et al., 2006). In this way, the right-hemisphere deficiency in resonance synchronization at fast alpha and beta frequencies observed in our autistic patients only in the driving patterns and not in the spontaneous EEG (at least in the occipital areas) may also reflect a likely delay in the development of this hemisphere, taking into account that the increasing frequency of photic driving is peculiar to normal brain maturation (Eeg-Olofsson, 1980). However, the main results of the present research have not shown an apparent correlation of the interhemispheric asymmetry with age. On the other hand, a reduced spontaneous EEG synchronization in the theta and alpha bands in the right temporal lobe was recently described for the younger autistic boys (mean age 5.2 years) (Strganova et al., 2007). The authors consider this effect in terms of a diminished capacity of the regional cortex to “generate sustained synchronous oscillations” due to likely decrease in inter-neuronal connectivity. Such a decrease is posited to relate to a decrease of the deep white matter in the right hemisphere of autistics observed in neuroimaging studies (Boddaert et al., 2004; Waiter et al., 2005). This suggests that the developmental aspect of the EEG photic driving interhemispheric asymmetry in autistic patients deserves special investigation in larger groups of individuals.

Our findings are in accordance with the afore stated correlation between the autistic triad of symptoms (impairments in social interaction, communication and imagination) (Wing, 1997) and functional alterations in the right hemisphere (Ozonoff and Miller, 1996; Siegal et al., 1996; Sabbagh, 1999). In addition, the results also show that this syndrome in autistic patients with relatively preserved language functions and without significant mental retardation may be accompanied by a lack of apparent electrophysiological signs of left-hemisphere impairment. The EEG patterns of the interhemispheric asymmetry are, to a greater degree, determined normally by the signs of higher activation of the left hemisphere and particularly its verbal fronto-temporal regions, predominantly owing to the verbally mediated processes of voluntary attention (Butler and Glass, 1974; Lazarev, 1998). This can partially explain why many EEG studies of autistic patients with language disorders describe abnormalities predominantly in the anterior and temporal areas of the left hemisphere (Dawson et al., 1983; Harrison et al., 1998). A strong influence of the “verbal factor” can mask subtle right-hemisphere functional manifestations (Lazarev, 1998). In the present work, probably due to a relative exclusion of this factor, the utilization of a sensitive photic driving test enabled us to...
References


