

## Introduction

Full-field visual evoked potentials (ff-VEP) are fundamental in neurological practice to define the nature of visual disturbances. We explored whether, in case of normal ff-VEP and suspected organic visual pathway involvement, multifocal visual evoked potentials (mf-VEP) and optical coherence tomography (OCT) can be useful in the diagnostic workup. mf-VEP allows in fact the electrophysiological assessment of conduction along the central visual pathways for separate portions of the visual field [1]; this technique has proven to be useful in the investigation of glaucoma [2] and interesting findings are becoming available also in the assessment of patients with other optic neuropathies [3, 4]. OCT instead allows to assess neurodegeneration in vivo and in a non-invasive way; data published in the last years suggest its usefulness in an increasing number of neurological conditions [5-7].

## Methods

Observational case reports. Neurophysiological assessment: ff-VEP were performed using a pattern reversal stimulation (checkerboard, size 60°, 30°, 15°) and one recording channel (Oz-Cz, according to 10/20 international system). mf-VEP were performed using a 56-segments dartboard pattern on LCD monitor and 2 recording occipital channels (1 horizontal: 2 electrodes at 4 cm on each side of theinion, left-right; 1 midline vertical: 1 electrode 2.5 cm above vs 1 at 4.5 cm below the inion, upper-lower) [Figure 1]. OCT was performed using standard RNFL 12° peripapillary circle scan allowing to measure RNFL global and sectoral thickness.

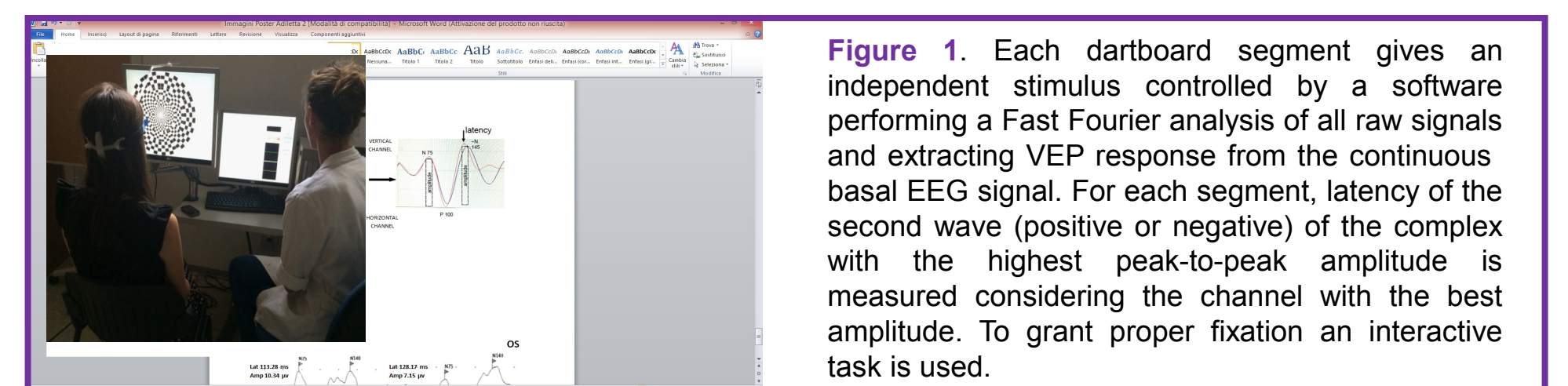


Figure 1. Each dartboard segment gives an independent stimulus controlled by a software performing a Fast Fourier analysis of all raw signals and extracting VEP response from the continuous basal EEG signal. For each segment, latency of the second wave (positive or negative) of the complex with the highest peak-to-peak amplitude is measured considering the channel with the best amplitude. To grant proper fixation an interactive task is used.

## Results

We describe here the cases of 3 patients arrived at our department complaining for visual disturbances. Two young women (29 and 30 year-old respectively) arrived at our attention with a suspect of optic neuritis (ON) characterized by unilateral visual acuity (VA) loss, pain at eye movements and dyschromatopsia. In both cases ff-VEP in the acute phase were not diagnostic or conclusive; OCT and mf-VEP allowed to clearly identify the involvement of the visual pathway [Figures 2 and Figures 3]. The third patient, a 69 year-old woman affected by a left frontal basal meningioma involving the left optic nerve, complained for blurred vision in the nasal visual field of the left eye as confirmed by computerized perimetry (CP). While ff-VEP showed normal latency and non-significant amplitude reduction in the left eye, mf-VEP showed important amplitude reduction in the whole lower hemifield in the left eye. OCT scan confirmed axonal damage showing left RNFL thinning [Figure 4].

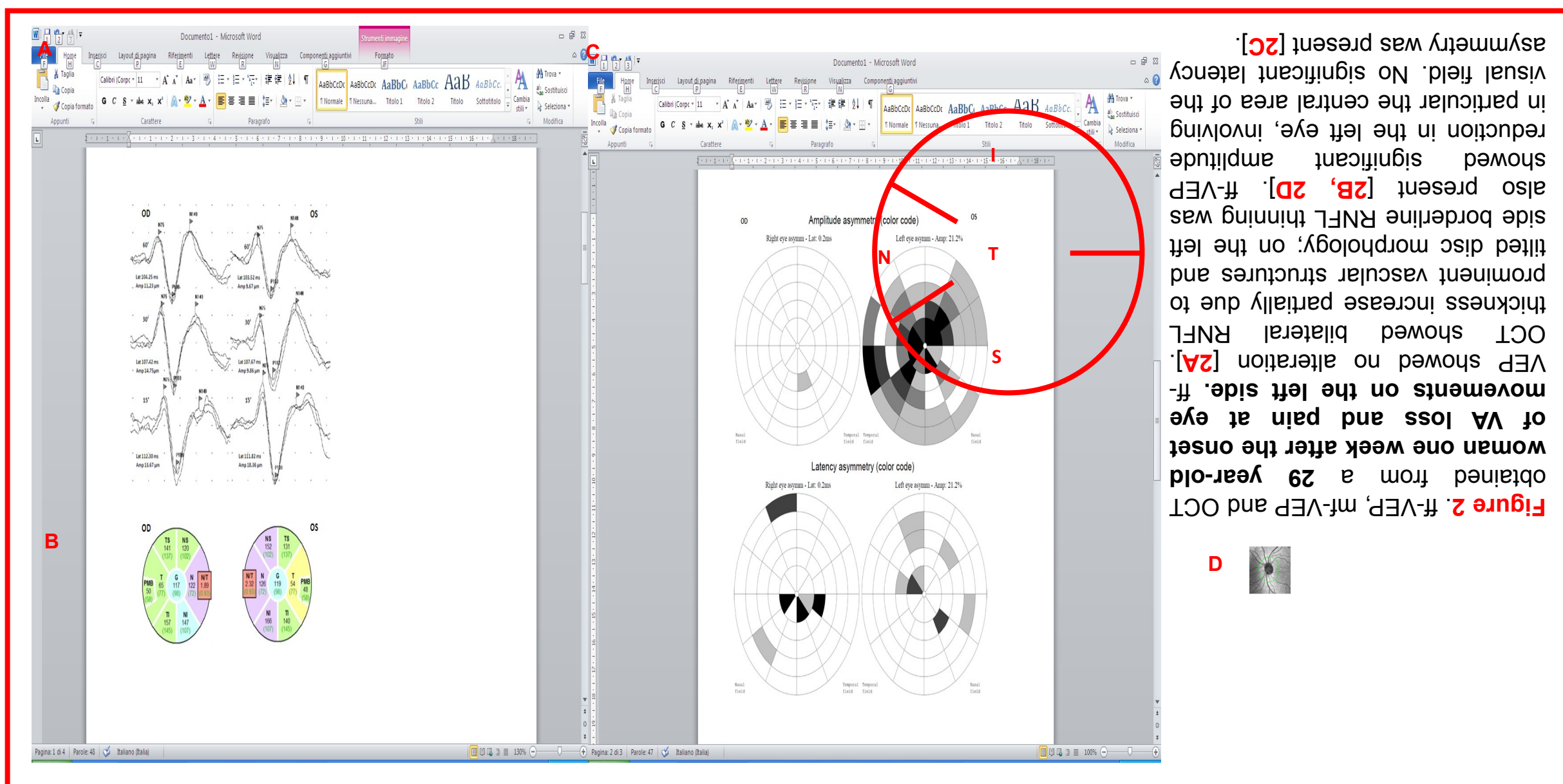


Figure 2. ff-VEP, mf-VEP and OCT obtained from a 29 year-old woman one week after the onset of VA loss and pain at eye movements on the left side. ff-VEP showed no alteration [2A]. OCT showed bilateral RNFL thickness increase partially due to tilted disc morphology; on the left side borderline RNFL thinning was also present [2B, 2D]. ff-VEP showed significant amplitude reduction in particular in the central area of the visual field. No significant latency asymmetry was present [2C].

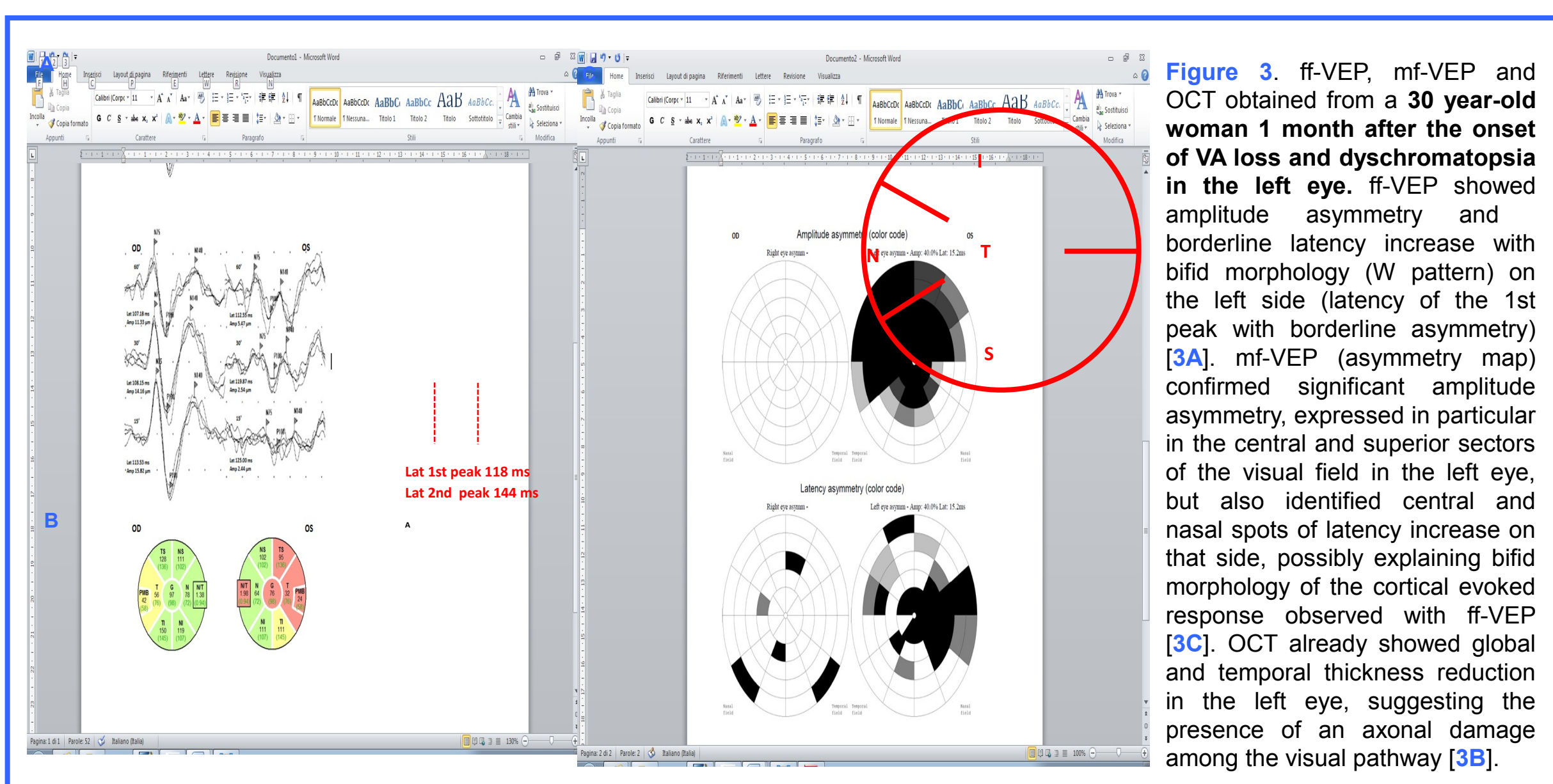


Figure 3. ff-VEP, mf-VEP and OCT obtained from a 30 year-old woman 1 month after the onset of VA loss and dyschromatopsia in the left eye. ff-VEP showed amplitude asymmetry and borderline latency increase with bifid morphology (W pattern) on the left side (latency of the 1st peak with borderline asymmetry) [3A]. mf-VEP (asymmetry map) confirmed significant amplitude asymmetry, expressed in particular in the central and superior sectors of the visual field in the left eye, but also identified central and nasal spots of latency increase on that side, possibly explaining bifid morphology of the cortical evoked response observed with ff-VEP [3C]. OCT already showed global and temporal thickness reduction in the left eye, suggesting the presence of an axonal damage among the visual pathway [3B].

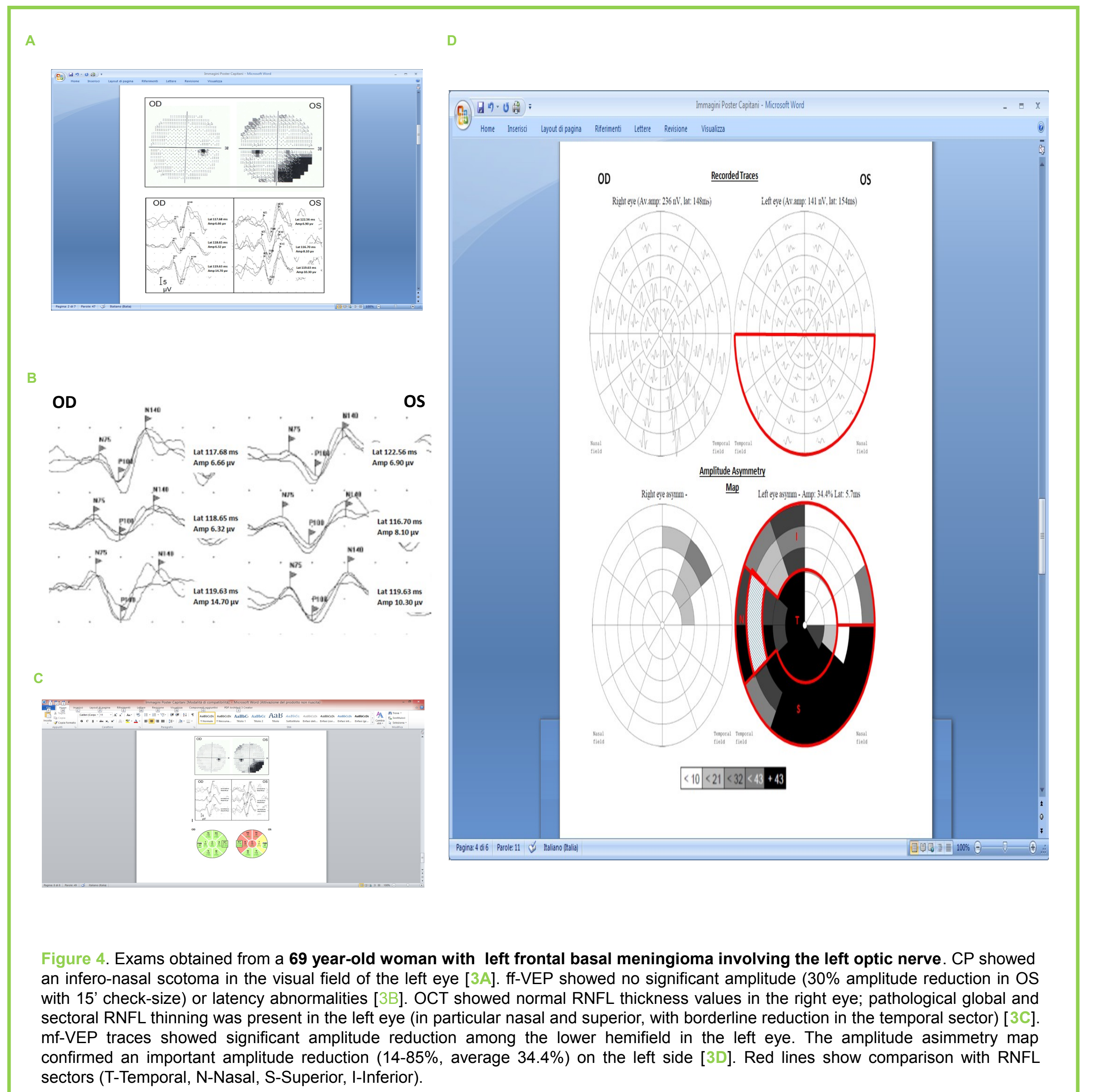


Figure 4. Exams obtained from a 69 year-old woman with left frontal basal meningioma involving the left optic nerve. CP showed an infero-nasal scotoma in the visual field of the left eye [3A]. ff-VEP showed no significant amplitude (30% amplitude reduction in OS with 15° check-size) or latency abnormalities [3B]. OCT showed normal RNFL thickness values in the right eye; pathological global and sectoral RNFL thinning was present in the left eye (in particular nasal and superior, with borderline reduction in the temporal sector) [3C]. mf-VEP traces showed significant amplitude reduction among the lower hemifield in the left eye. The amplitude asymmetry map confirmed an important amplitude reduction (14-85%, average 34.4%) on the left side [3D]. Red lines show comparison with RNFL sectors (T-Temporal, N-Nasal, S-Superior, I-Inferior).

## Conclusions

Sometimes ff-VEP fails in identifying abnormalities in patients with processes involving the visual pathway, particularly in cases with axonal or sectoral optic nerve involvement. In the presence of a patient complaining for visual disturbances with normal ff-VEP examination we suggest the importance of a multimodal evaluation, including OCT and mf-VEP. This integrated approach is likely to increase sensitivity and specificity of the diagnostic workup, potentially giving useful information in the differential diagnosis of neurological and neurophthalmological conditions affecting vision.

## Bibliography and Acknowledgments

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## Key Points

- ff-VEP sometimes fail in identifying visual pathway involvement.
- mf-VEP can identify partial damages of the visual pathway.
- OCT can demonstrate axonal degeneration of the optic nerve.
- Usefulness of a multimodal neurophysiological evaluation to assess visual pathway abnormalities.