# DIFFERENTIATION TO THE STIMULATION OF NERVES ENDING 1ST AND 5TH BY REGISTRATION OF CORE OLFACTORY RESPONSES

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**Abstract: In audiological and otoneurological diagnostics, the values of quantitative investigations of olfactory response in a differential evaluation of pathological changes localized in the central nervous system are of an auxiliary nature. The universally applied Elsberg blast method as modified by Pruszewicz describing the perception and identification thresholds of aromas (substances stimulating only nerve I as well as those stimulating nerves I and V) is a subjective evaluation. The modified own constructed device served automatically odour stimulus to nasal cavity allowed registration evoked cortical potentials in 30 patients with normal olfaction sensitivity and identification. It is possible to differentiate the nerve V receptors responses on odour stimulation (latency range 180-360 ms) as well as nerve I receptors responses (latency range 380-600 ms). The method described in this paper for measuring and registering responses to olfactory stimulants is useful in objectifying olfactory measurements for audiological and otoneurological diagnostics.**

## Introduction

Olfactory tests in humans according to the Elsberg-Levy method as modified by Pruszewicz have been conducted in the Department of Phoniatric and Audiology Poznań University of Medical Sciences from 1962. According to the method, the olfactory organ is provided with odour with the air from a tank by means of the air-flow method. The blast of a given odour is obtained my means of injecting the odour into the tank through a syringe. Perception and identification thresholds of given odour were determined and measured in $cm^3$. Norms were described by means of tests of healthy subjects. This simple method of measuring olfaction has been used for clinical purposes for over 30 years. The speed at which the odour air reached the nose was not uniform. Despite this, testing of the olfactory system found considerable use, primarily in an evaluation and complementation of clinical diagnoses of otorhinolaryngological disorders, e.g., following facial skeletal injuries, inflammation of the sinuses, operations of rhinopharyngeal tumors and also neurological changes, i.e., following craniocerebral trauma, following temporal lobotomies or in diagnoses of endocrinological diseases, i.e. hypothyroidism, hypoadrenalism or simple obesity.

## Materials and Methods

The modified apparatus of own construction for the objective measurement of potentials elicited by an olfactory stimulant has been shown in Fig. 1. The application of the olfactory stimulant is synchronized with the inspiration phase of the subject. The olfactory stimulant dosing device, automatically, by means of a partial vacuum, reacting to the start of each inhalation, switches on the apparatus for registering averaged elicited responses.

Figure 1: Madsen Electronics Era 2250 Apparatus on the left and own constructed device on the right.

Registration of elicited responses was conducted on the Madsen Electronics Era 2250 Apparatus, equipped with Beckman electrodes adhered to the forehead and either side of the nape (or the neck). The summing and averaging method was employed to a quantitatively identical stimulant. The number of trials conducted was 5, 10 or 15, and the time for registering responses was set within the bounds of 0 to 1000 ms. The research employed an olfactory stimulant of 5 to 10 $cm^3$, which was within the norms set by Pruszewicz for the modified Elsberg method.

Research was conducted on 30 subjects aged 20 to 52 years-old without any subjective disorders with their sense of smell (olfactory response), with open access to the nasal cavity for laryngological examination, among whom thresholds of sensation and identification were determined by Pruszewicz's pneumatic dosing method as modified by Elsberg and remained within the accepted norm. Natural coffee as well as anise seed oil stimulated the nerve endings of the olfactory nerve, and


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mint and lemon oil stimulated the nerve endings of the olfactory and trigeminal nerve.

**Results**

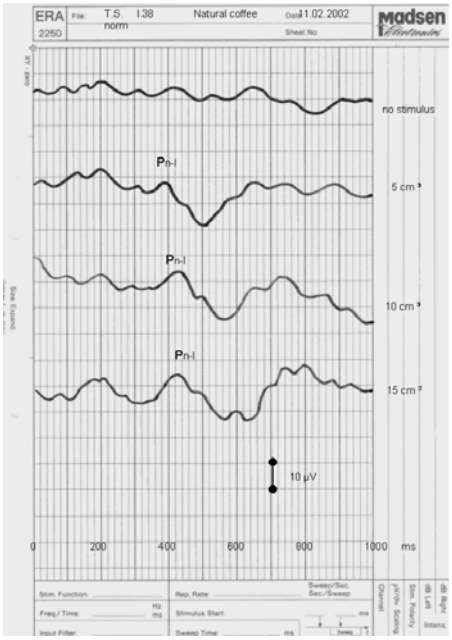
Among all subjects with a normal olfactory response (sense of smell) researched, latency potentials within a range of 180 to 600 ms were registered. Reaction to anise seed oil or natural coffee, hence substance eliciting a response in only nerve I, there was only 1 response potential registered within a latency potential of 380 to 600 ms. Whereas in response to mint oil and lemon oil, i.e. substances eliciting a response from 1st and 5th cranial nerve, a registration of two potentials was obtained: the first with a time of 180 to 340 ms and a second with a time of 380 to 600 ms. These potentials were respectively labeled as Pn-V and Pn-I.

Average values, standard deviations, medians and ranges (maximal and minimal values) of latency times for these potentials in a group of subjects without olfactory disturbances have been presented in Table I.

Table 1: Average values of times for classifying potentials elicited in a group of 30 persons with a proper olfactory response (sense of smell).

| | | | Mean value | Median value | range | SD |
|---|---|---|---|---|---|---|
| substances stimulating 1st cranial nerve | Anise seed oil | **P**n-I | 477 | 480 | 380- 600 | 60.08 |
| | Natural coffee | **P**n-I | 494 | 490 | 380- 600 | 67.03 |
| substances stimulating 1st and 5th cranial nerves | Mint oil | **P**n-I | 500 | 485 | 380-620 | 58.56 |
| | | **P**n-V | 266 | 270 | 180-370 | 51.86 |
| | Lemon oil | **P**n-I | 492 | 460 | 430-640 | 74.45 |
| | | **P**n-V | 220 | 210 | 160-370 | 65.43 |

The initial results for stimulation by 5, 10 and 15 $cm^3$ quantities of olfactory stimulants showed no differences as to the latency times of responses both in Pn-I as in Pn-V. It was, however, observed that independent of the volume of stimulant inhaled, there was a quick drop in the amplitude of responses measured. We suspect that this is an expression of olfactory fatigue. Further to this, we limited the number of olfactory responses to the averaged response number of 10. Table I shows that in the case of substances stimulating 1st and 5th cranial nerve, the latency of the second response elicited was within the bounds of the latency time of the potential registered during stimulation of only 1st cranial nerve. The latency time of responses in the stimulation of the 5th nerve ending was shorter, within the range of 160-370 ms. Fig. 2a,b presents examples of registering responses elicited in a 48-year-old male subject with a normal olfactory response (sense of smell) over two stimulants.

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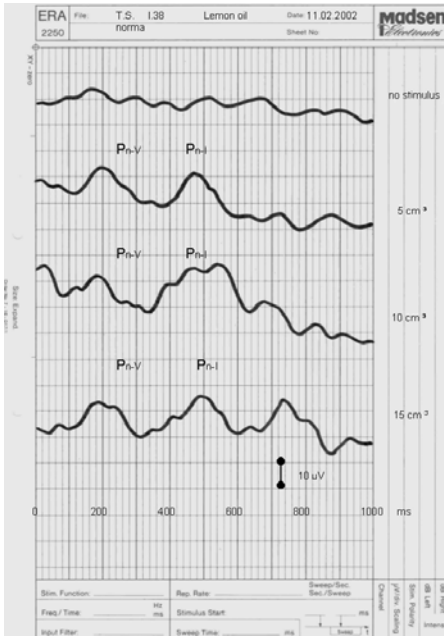


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Figure 2: An example of registering potentials elicited in a 48-year-old male subject with proper olfactory response (smell) when subjected to stimulation: a) Natural coffee, b) Lemon oil.

On the other hand, Fig. 3a,b show that there was no registration of elicited responses of olfactory potentials among those suffering from total ansomia. Fig. 4a presents a lack of Pn-1 responses to a stimulation of the olfactory nerve (anise oil), whereas Fig. 4b does register response Pn-V to a stimulation of 1st nerve and 5th nerve (mint oil). The results of analyses obtained allow us to state that the registration of core potentials in stimulating the olfactory nerve and trigeminal nerve


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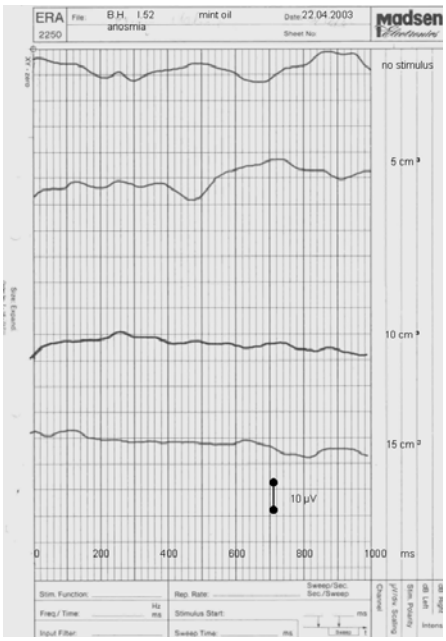
allow for their use in clinical practice as one of the fundamental methods of objective olfactometry.

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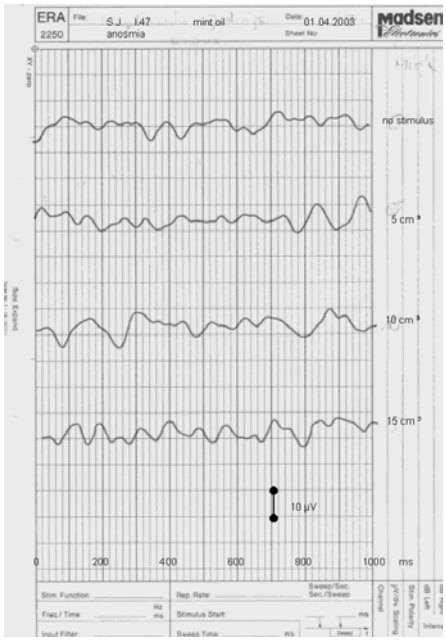


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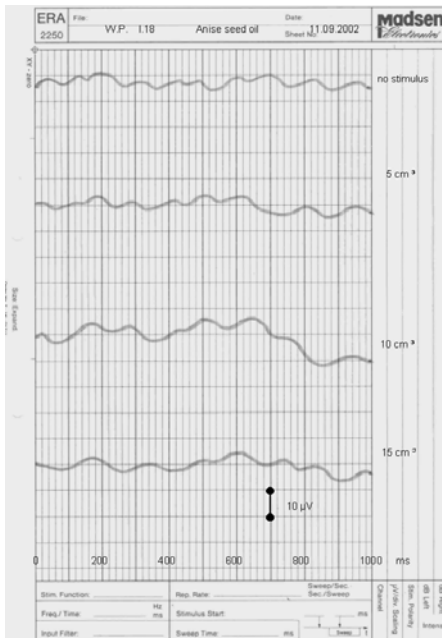
Figure 3: Examples of registering potential elicited in the case of: a) a 52-year-old woman lacking a subjective sense of smell, b) a 47-year-old-man lacking a subjective sense of smell.

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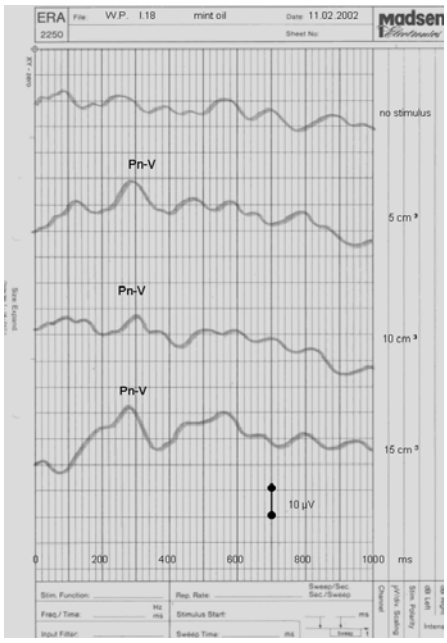


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Figure 4: An example of registering potentials elicited in the lack of a response to stimulation of nerve I (a) with the registered response from nerve V (b).

The initial results of our research confirm the existence of one potential in stimulating the olfactory area with a scent stimulating nerve ending 1st nerve (natural coffee, anise oil) with a latency time of 370 to 600 ms as well as two potentials for stimulants of 1st and 5th nerve (lemon oil, mint oil), with latency times of 180 to 370 ms as well as 380 to 640 ms. The potential of shorter latency time is the reason for the stimulation of 5th nerve, having a longer latency time of response to the stimulation of olfactory receptors.


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## Conclusions

1. The method developed for stimulating receptors in the area of the nasal-olfactory cavity allows for the registration of olfactory core potentials.

2. An analysis of latency times elicited by olfactory core potentials allows for the differentiation to the stimulation of nerve endings 5th nerve (shorter latency time) and 1st nerve (longer latency time)

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