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OLFACTORY EFFICIENCY AND FOOD PREFERENCES RELATIONS IN THE ELDERLY WITH DIFFERENT VISION ABILITY

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In this study, a comparative analysis of olfactory efficiency and preferences for selected categories of food products was conducted in the good-sighted elderly (GSE) and in the blind elderly (BE) and relationships between those parameters were determined. The measurements of olfactory sensitivity were conducted by air-blast olfactorimetric method, while food preferences were assessed by a questionnaire using a 5-point hedonic scale. The relationship between vision ability and smell detection thresholds (SDT) appeared statistically significant for both odour substances. In the BE group the detection thresholds within the reference values were noted in 78% subjects in the case of mint oil and in 88% in the case of ground coffee whereas in the good-sighted elderly the normosmia was found substantially less frequently, *i.e*. in 54% and 34% subjects, respectively. Among the examined elderly, diminished odour identification ability was commonly observed whereas no relationship existed between the smell identification thresholds (SIT) and vision ability. With the decline of the total olfactory efficiency (TOE) index in the examined population, the preferences for sweet ($p<0.05$), salty ($p<0.05$) and intensive flavour ($p<0.01$) foods, and fried meat dishes ($p<0.05$) were increasing. Only in the group of good-sighted elderly, the degree of food preference was associated with the intensity of its flavour. The obtained results indicate that the weakened ability of odour perception found in the elderly does not favour formation of the recommended nutritional patterns, whereas the blind elderly seem to be less susceptible to that due to their better olfactory efficiency.

INTRODUCTION

The weakness of chemosensory perception has been considered as a natural physiological phenomenon, which follows ageing of the organism [Murphy, 1993; Ship, 1999; Winkler *et al.*, 1999]. Particularly severe dysfunctions in the elderly pertain to the sense of smell associated with changes both in the sensory and cognitive sphere [Quint *et al.*, 2001; Larsson *et al.*, 2000].

The results of many studies have indicated that the elderly demonstrate lower perception of smell stimuli and different hedonic reactions to food odour in comparison with young adults [De Graaf *et al.*, 1996; Murphy, 1993; Wysocki & Pelchat, 1993]. Moreover, the use of flavour substances increases acceptance of food and results in its higher consumption by elderly persons [Mathey *et al.*, 2001; Schiffman, 2000].

Poor olfactory sensitivity can impair the functions of mechanisms associated with appetite, change food attitudes and eating habits and lead to a less diversified diet followed by an increased risk of malnutrition [Griep *et al.*, 1997]. The hazards specified above can pose severe health problems both for the elderly living in their natural environment and for nursing home residents. There are quite little data in the literature concerning that issue thus it requires extensive studies including various aspects of food attitudes and within various sub-populations of the elderly.

Among the old people there is a relatively high percentage of the blind or suffering from very reduced vision ability. In such persons, a compensation of the lost eyesight by an increased acuteness of other senses is usually observed, among them of the chemosensory ones. In that way, eating habits of blind persons can vary in comparison with sighted persons. Only few reports on that subject, *e.g*. by Smith *et al.* [1993], presented diversified data and the authors did not take into account persons above 60 years of age as a separate age group.

The purpose of this study was to compare olfactory functions and food preferences in regard to certain food products in two groups of elderly persons: one good-sighted and one visually impaired, and to determine relationships between those parameters in the studied groups.

MATERIALS AND METHODS

The examined population. The study was conducted on the population of one hundred elderly persons from 61 to 89 years of age. Among them, one half demonstrated good eyesight (GSE), *i.e*. normal vision ability, and the other one comprised blind (BE) subjects. Both groups exhibited similar sex structure, age, percentage of smokers and persons using artificial dentures. In the studied population presented in Table 1, there were 39 residents of social care homes situated in the Wielkopolska district and 61 persons

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TABLE 1. Characteristics of study participants.

Subjects	Number of persons [percent]			Mean age [years]		
	Total	Women	Men	Total	Women	Men
Elderly (61–89 years)	100	80 (80%)	20 (20%)	74.4±8.0	75.4±7.9	70.1±7.2
Good-sighted	50	39 (78%)	11 (22%)	74.2±7.7	74.9±7.7	71.6±7.8
Blind	50	41 (82%)	9 (18%)	74.6±8.4	75.9±8.2	68.6±6.7

were under municipal social care agency in the city of Poznań. All examined individuals obtained meals given by the social care catering establishments. Persons in both groups demonstrated good health condition and mental development. Immediately prior to and during conduction of sensory tests they reported no pathological state of the nasopharynx, no use of therapeutic agents except vitamins and they were on a normal daily diet. In the case of blind persons, the sample included both blind from birth and ones who have lost eyesight in the early childhood. The evaluation of the mental development was carried out by a test according to the recommendation of Brzozowska [1995] with the use of Mini Mental State Examination (MMSE) form of Molloy *et al.* [1991].

Measurement of olfactory sensitivity. The measurements were carried out by air-blast olfactometric method by Elsberg and Levy, modified by Pruszewicz [1965]. Two standardized aroma substances were used: mint oil (stimulates I-olfactory nerve and V-trigeminal nerve endings) and finely ground coffee (stimulates I-olfactory nerve ending). The smell detection threshold (SDT) and the smell identification threshold (SIT) [*ibid*] were determined. Olfactometric measurements were carried out through both nasal cavities in the same conditions and at the same time of the day (between 11:00 a.m. and 12:30 p.m.), at least three hours after taking meal. Averaged results for both nasal cavities were interpreted with the use of reference values developed by Pruszewicz [Pruszewicz, 1965; Pruszewicz *et al.*, 1969], which are given below:

SDT for mint oil: 1 to 10 cm^3
SDT for ground coffee: 1 to 14 cm^3
} normosmia (detection thresholds within reference values)

SDT for mint oil: 11 to 40 cm^3
SDT for ground coffee: 15 to 40 cm^3
} hyposmia (increased detection thresholds)

SDT for mint oil and
SDT for ground coffee: >40 cm^3
} anosmia (no smell perception)

SIT for mint oil: 3 to 23 cm^3
SIT for ground coffee: 4 to 23 cm^3
} adequate identification

SIT for mint oil and
SIT for ground coffee: >23 cm^3
} increased identification thresholds

The obtained data were subjected to chi-square statistical analysis to estimate the relationship between vision ability and smell perception. To calculate the total olfactory efficiency (TOE) index, following Duffy's *et al.* [1995] approach, the results of measurements were transferred into point scores as follows: normosmia – 10 points; hyposmia – 5 points; anosmia – 0 points; whereas the adequate identification – 10 points; increased identification threshold – 5 points; no identification – 0 points. The scores were summarised for each of the examined persons to obtain the TOE index.

Examination of food preferences. Food preferences were examined by the direct inquiry, by the use of a 5-point hedonic scale: (1) I dislike very much; (2) I dislike; (3) I neither like nor dislike; (4) I like; (5) I like very much. The preference questionnaire comprised 40 products and dishes being offered to the residents of social care homes. All the products and dishes were divided into seven categories: (i) of predominant sweet taste (n=6); (ii) of predominant salty taste (n=6); (iii) of intensive flavour (n=6); (iv) of neutral flavour (n=6); (v) spices (n=6); (vi) boiled meat dishes (n=5), and (vii) fried meat dishes (n=5). Within the examined sub-populations the percentage of hedonic ratings lower than and equal to or higher than the median rating (< Me and ≥ Me) for foods selected in regard to flavour were calculated. The statistical evaluation of results was conducted by Mood's test. Furthermore, the hedonic ratings of products within the given category were averaged for each of the examined persons to obtain the mean

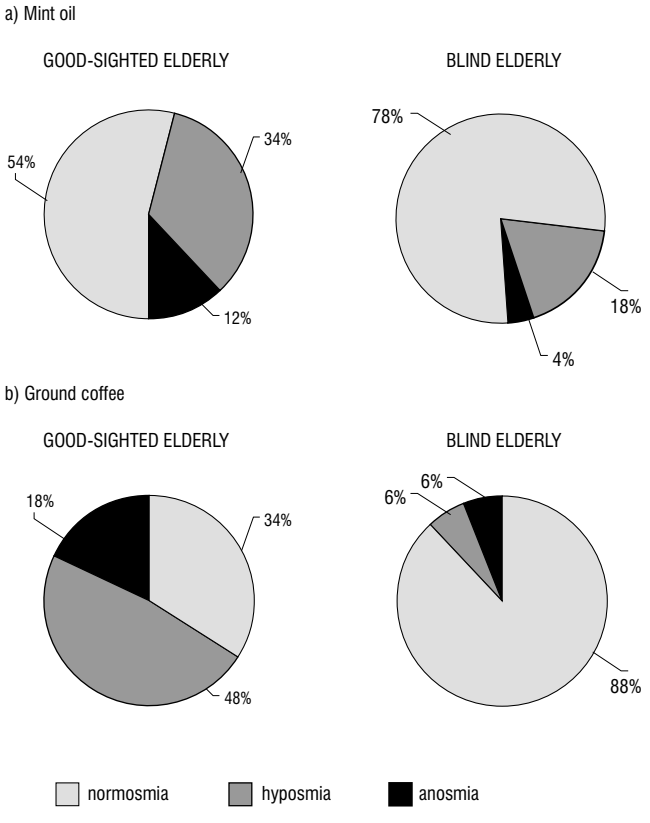

FIGURE 1. Classification of the examined elderly persons according to the smell detection thresholds (SDT) for mint oil and ground coffee.
a/ $\chi^2=6.64$; $p<0.05$
b/ $\chi^2=31.28$; $p<0.001$

individual preference indices, which were correlated with the TOE index by Spearman correlation coefficient.

RESULTS

Significant differences in the olfactory efficiency noted in the examined elderly appeared to be dependent upon the eyesight ability. In the group of the blind elderly, the smell detection thresholds within the normal range were noted in 78% subjects in the mint oil test and in 88% ones in the ground coffee test (Figure 1). Anosmia to the examined odours in the blind sub-population was at the level of 4% and 6% persons, respectively. In the group of the elderly demonstrating normal vision ability the normosmia was noted in the considerably lower number of subjects, *i.e.* 54% in the case of mint oil and 34% in the case of ground coffee. In that group, a higher occurrence of anosmia in regard to both smell stimuli was found, in 12% and 18% subjects, respectively. The commonly observed phenomenon among the elderly was a lower ability of odour identification. Taking into account the values considered as the reference level, an increased identification threshold for mint oil was noted in 84% of good-sighted persons and in 76% of blind persons, and an increased identification threshold for ground coffee – in 92% and in 90% of the examined subjects, respectively (Figure 2).

The relationship between vision ability and SDT appeared to be statistically significant for both odour substances (Figure 1), however, such relationship was not observed between vision ability and SIT (Figure 2). It can indicate that the process of age-related impairment of smell perception causes different changes in abilities of odour detection and odour identification.

To compare preferences in the groups of elderly, concerning foods selected in regard to flavour (intensive or neutral), the hedonic ratings were shown (Figure 3) as percentage of scores, which were lower than and equal to or higher than the median rating, being 4.0 for all categories of foods. The statistical estimation of distribution of preference ratings indicated that the differentiation was significant only in the group of the good-sighted elderly who exhibited higher preference for foods of intensive flavour. It suggests a great importance of properties associated with flavour characteristics of food to its acceptance by the individuals demonstrating normal vision ability.

Table 2 presents results concerning the relationship between olfactory efficiency expressed by the total TOE index and mean preference indices for food categories, which were selected in regard to distinct taste, flavour and kind of culinary technique, in the case of meat dishes. That evaluation was carried out by Spearman correlation coefficients.

The relationship between olfactory efficiency and food preferences was found significant if evaluated for the total examined population. It was noted that with the decline of

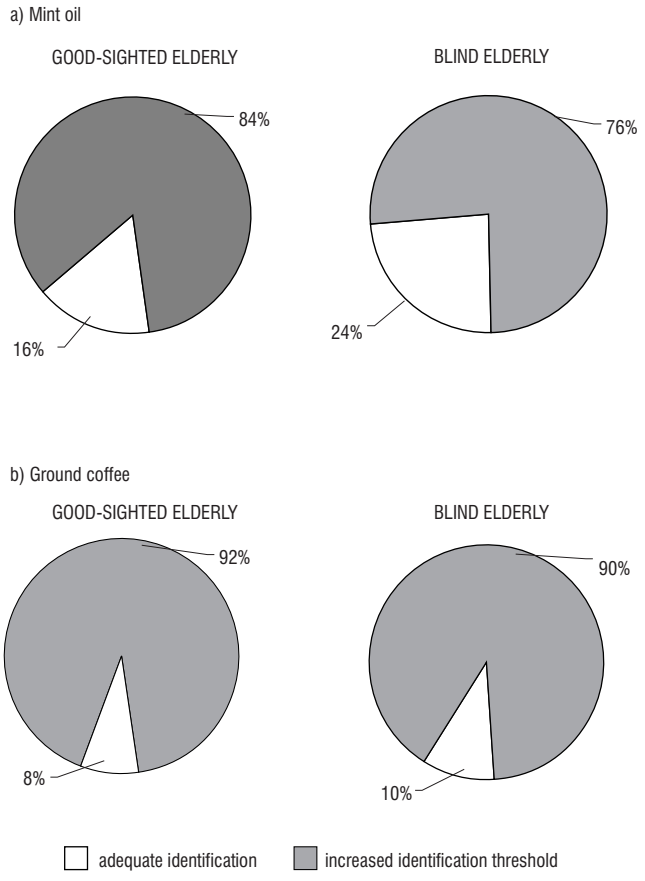

FIGURE 2. Classification of the examined elderly persons according to the smell identification thresholds (SIT) for mint oil and ground coffee.
a/ χ^2=1.00; NS
b/ χ^2=0.12; NS

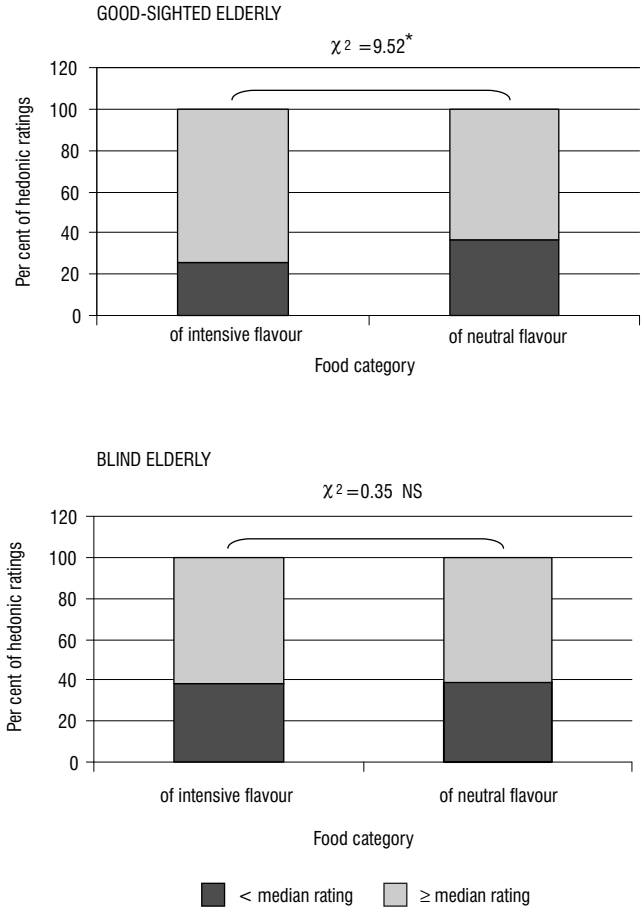

FIGURE 3. Distribution of the hedonic ratings for selected food categories in the examined groups of elderly persons.
* The difference in distribution of the hedonic ratings is significant at $p < 0.01$.

TABLE 2. The relationship between olfactory efficiency and food preferences in the examined groups of elderly.

Parameters		Olfactory efficiency in particular groups		
		Good-sighted elderly	Blind elderly	Total population
Preferences for foods	sweet	r=-0.16 n.s.	r=-0.22 n.s.	r=-0.21 p<0.05
	salt	r=-0.19 n.s.	r=-0.04 n.s.	r=-0.26 p<0.01
	of intensive flavour	r=-0.28 n.s.	r=-0.12 n.s.	r=-0.28 p<0.01
	of neutral flavour	r=-0.13 n.s.	r=0.16 n.s.	r=0.01 n.s.
	boiled meat dishes	r=-0.09 n.s.	r=0.11 n.s.	r=0.04 n.s.
	fried meat dishes	r=-0.12 n.s.	r=-0.05 n.s.	r=-0.21 p<0.05
Preference for spices		r=-0.18 n.s.	r=0.16 n.s.	r=-0.09 n.s.

the TOE index the degree of preference for sweet, salty and intensive flavour foods, and for fried meat dishes was increasing ($p<0.05$; $p<0.01$; $p<0.01$; $p<0.05$, respectively). The relationships were statistically non-significant when evaluated separately for the good-sighted and blind persons.

DISCUSSION

Numerous studies have shown that the efficiency of chemoreceptive senses is decreasing after sixty years of age [Murphy, 1993; Stevens & Cain, 1993; Ship, 1999; Winkler *et al.*, 1999]. That dysfunction pertains to a greater extent to the sense of smell [Stevens & Cain, 1993; Hoffman *et al.*, 1998] and it is the ability of odour identification, which is usually most impaired [Stevens & Cain, 1993].

In this study less than one fourth of the good-sighted elderly subjects identified the odour of mint oil or ground coffee within the reference range of threshold values. The percentage of good-sighted subjects demonstrating anosmia (ranging from 12% to 18% depending on the kind of odour substance) was nearly two times lower than that reported by Doty *et al.* [1984]. Findings of these authors could result from the fact that in the selection of subjects for sensory tests they did not use, unlike in this study, any criteria concerning physical and mental health.

A new light on the problem of involutional changes pertaining to sensory perception in the subjects above sixty years of age is shed by the evaluation of sense of smell efficiency in the good-sighted and blind elderly. Vision ability appeared to be a significant factor differentiating the sense of smell efficiency in the elderly in the case of the detection thresholds for mint oil and ground coffee but not in their identification thresholds. In the literature relatively few studies could be found on the evaluation of chemosensory sensitivity in the visually impaired. The results of those studies concern young and middle aged persons and are inconsistent. For example, Bertolini [1942] observed a greater sensitivity to smell stimuli in blind subjects whereas Cherubino and Salis [1957], Boccuzzi [1962], and Smith *et al.* [1993] have not found that visual impairment was of any importance to odour perception ability. On the other hand, Murphy & Cain [1986] reported that blind persons adequately recognised more kinds of odour than good-sighted ones but simultaneously they demonstrated higher threshold of odour perception. The presented discrepancies concerning olfactory functions in the blind can result from methodological differences as well as from the fact that in certain subjects examined, the loss of sight resulted from systemic diseases affecting sense efficiency. The results of this study conducted on a population of elderly subjects who showed good health suggest that the loss of eyesight is compensated by increased acuteness of the sense of smell. According to Wysocki and Pelchat [1993], the elderly varying in the smell detection thresholds often obtain similarly low scores in the identification tests. That result is ascribed to the deterioration of sensory perception and cognitive functions such as active encoding and retrieval as well as the use of verbal labels [Larsson *et al.*, 2000; Wysocki & Pelchat, 1993].

In this study criteria, describing the food preferences as a general attitude to foods selected taking into account sensory properties were used. The results demonstrate that the differences just within the smell detection thresholds can, in the elderly subjects, be followed by nutritional implications. In the group of good-sighted subjects a greater preference for foods of intensive flavour was therefore noted. The estimation of the relationship between the olfactory efficiency and food preferences being studied in the whole population of elderly subjects, regardless of vision ability, revealed that a lower olfactory efficiency is connected with a higher preference for sweet and salty foods, for foods of intensive flavour and for fried meat dishes. It corresponds to the findings of Mattes *et al.* [1990] who observed that olfactory dysfunction was associated with a higher intake of salt and saccharose and increased preference for meat dishes and sweets. According to Murphy [1993], foods of distinct taste mainly salty, are more preferred by older subjects since they compensate the subjective decrease of stimulation by odour substances in the consumed food. The lack of significant relationship between olfactory efficiency and preference for spices found in this study was not expected. It could be explained by the fact that the examined elderly did not participate in preparing meals since they depended on institutional feeding. Duffy *et al.* [1995] demonstrated that a higher olfactory perception in elderly women who fed themselves was often associated with more frequently used herb and root spices, also as salt substitutes.

A higher preference for fried meat dishes as well as salty and sweet food products observed in the elderly of diminished olfactory efficiency confirms the suggestions of Mattes *et al.* [1990], and Duffy *et al.* [1995] concerning the unfavourable trends in eating habits of such persons from the wholesomeness point of view. Blind elderly persons seem to be less susceptible to developing eating habits considered undesirable for their health.

To prevent the elderly from the unfavourable consequences of the worsened olfactory perception special attention has to be paid to the composition of their diets, *i.e.* products of high nutritive value and attractive in respect of sensory properties should be included in their meals. It will

recover adequate hedonic functions towards food, and consequently better appetite, on the one hand, and prevent from excessive intake of fats, saccharose and salt, on the other.

CONCLUSIONS

1. The elderly persons demonstrated a diminished ability of odour identification whereas the blindness in this age group was associated with lower smell detection thresholds and had no effect on the smell identification thresholds.

2. In the elderly good-sighted persons, the food products of intensive flavour were significantly more preferred to those of neutral flavour. That regularity was not observed in the blind elderly.

3. The diminished smell perception ability in the elderly has an unfavourable effect on the development of healthy eating habits since it promotes a higher preference for sweet and salty food products and for fried meat dishes.

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OCENA ZALEŻNOŚCI POMIĘDZY SPRAWNOŚCIĄ ZMYSŁU POWONIENIA A PREFERENCJAMI POKARMOWYMI OSÓB STARSZYCH O RÓŻNEJ ZDOLNOŚCI WIDZENIA

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Celem badań było dokonanie analizy porównawczej sprawności zmysłu powonienia oraz preferencji względem wybranych pokarmów w grupach osób starszych z dobrą zdolnością widzenia (GSE) i osób starszych niewidzących (BE), a także określenie współzależności pomiędzy tymi wyróżnikami. Pomiarów wrażliwości węchowej dokonywano metodą olfaktometrii podmuchowej, zaś preferencje pokarmowe określano metodą wywiadu stosując 5-cio stopniową skalę hedoniczną. Związek pomiędzy zdolnością widzenia a progiem odczucia zapachu (SDT) okazał się istotny statystycznie dla obu nośników zapachu. W grupie BE próg odczucia zapachu w granicach normy zanotowano u 78% badanych dla olejku miętowego i u 88% badanych dla kawy naturalnej, natomiast w grupie GSE normosmię stwierdzano znamiennie rzadziej, tj. odpowiednio u 54% i u 34% osób (rys. 1). Powszechnym zjawiskiem wśród badanych osób starszych było pogorszenie zdolność identyfikacji testowanych zapachów, przy czym nie stwierdzono istnienia zależności pomiędzy progiem identyfikacji zapachu (SIT) a zdolnością widzenia (rys. 2). Wraz ze spadkiem wartości ogólnego wskaźnika sprawności zmysłu powonienia (TOE) w badanej populacji osób starszych zwiększał się stopień preferencji pokarmów słodkich ($p<0,05$), słonych ($p<0,01$), o intensywnym aromacie ($p<0,01$) oraz potraw mięsnych smażonych ($p<0,05$), (tab. 2). Stopień preferencji pokarmu był związany z intensywnością jego aromatu jedynie w grupie GSE (rys. 3). Na podstawie uzyskanych wyników stwierdzono, że notowane w populacji osób starszych osłabienie zdolności percepcji zapachu nie sprzyja kształtowaniu się zgodnego z zaleceniami modelu żywienia się, przy czym ze względu na lepszą sprawność zmysłu powonienia osoby starsze niewidzące wydają się być na to mniej podatne.