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Research Article

Odour and Salt Taste Identification in Older Adults: Evidence from The Yakumo Study in August, 2015 - 2017

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Abstract

This study examined the relationship between olfactory function and taste function as same as last report. A personal function test was calculated from the Yakumo study database, and the odour stick identification test and salt taste identification test were administered to healthy elderly people. The participants were community dwellers who voluntarily participated in the Yakumo Study and had managed everyday life by themselves. We united data for three years (2015-2017) and checked a taste test result and the olfactometry result. We compared the answer of female participants with that of male participants and found that recognition of odour identification test was better in female participants than male participants. Regarding the salt taste, it was revealed that there was no statistically significant difference between males and females. It was also found that there was no statistically significant difference between age with regard to taste. As for olfaction, it became clear that there is statistically significant difference between males and females. Female had statistically significant olfactory test results better than males. Statistically significant olfactory test results were particularly good in the sixties and seventies. It was also clear that there was statistically significant difference between age with respect to olfaction. The olfaction was diminished with age. Result of 12 kinds of odour recognition, male and female have the same result of top three incenses and bottom four incenses. The most comprehensible smell was the following order. That incense is Curry, Sweat socks, and Fried garlic. The most incomprehensible smell was the following order. That incense is Cypress, Mandarin orange, Menthol, and Wood. We regard the test-result of the saltiness as normalcy if participant can recognize saltness in less than 0.1%. And we regard the test-result of odour as normalcy if participant can recognize the smell of Curry, Sweat socks, and Fried garlic.

Keywords

Healthy Elderly People; Olfactory Function; Taste Function; Ya-

kumo Study

Introduction

Japan is an ageing society. The proportion of elderly population in Japan will become the highest among the total population in the next ten years. There is a concern that with increasing age, individuals would soon be unable to identify through the sense of smell. Furthermore, nasal congestion and olfactory disorders occurring after inflammation that are caused by allergic rhinitis, modern-day hay fever, and common colds also inhibit the sense of smell [1,2,3] Present in a narrow region of the mucosa that covers the inside of the nose (olfactory epithelium) are the olfactory receptor neurons. The dendritic ends (olfactory cilia) of these neurons detect odour molecules that enter the nose via currents of air, which produces an electrical signal. This signal travels up through the bone that forms the ceiling of the nasal cavity (the cribriform plate) via nerve fibres that converge on the olfactory bulb, an enlarged area of nerve cells of the brain that also form olfactory nerves. Signals passing through the olfactory bulb travel to the brain along these olfactory nerves, where the signals are interpreted, and the smell is recognized [4]. The medial aspect of the temporal lobe that remembers smells is also stimulated at this point, and the brain can identify the odour based on a memory of previously experienced smells. In other words, smell identification requires an already-accumulated set of experienced smells [5,6]. Both olfaction and gustation start to decline in humans around the age of 50-59 years, with 40% of the elderly experiencing a noticeable decline [7]. A person's first awareness of decline in olfaction as our primary dependence for identification of flavour occurs when one is unable to distinguish foods by taste alone. Olfaction also performs an important and essential role in our ability to detect dangers, including the smell of leaking gas, the burning odour of fire, and the putrid smell of rotten food. Olfaction is also responsible for enrichment and psychological stimulation in our everyday lives, such as with the scents and smells of foods and flowers [8]. In an already aged society, healthy olfaction is a necessary part of creating a safe and fertile living environment and for improving an individual's quality of life. Considering these circumstances, this study aims to understand the age-related decline in olfactory and taste function in participants aged 40-49 years; 50-59 years; 60-69 years; 70-79 years and 80-89 years. We identified the odours and taste particularly difficult to distinguish for individuals of these age and sex groups. This might help draw attention to issues faced by individuals in their daily lives and facilitate improvement in their quality of life.

Material and Methods

Participants

The participants were community dwellers who voluntarily participated in the Yakumo Study and had managed their everyday life themselves. The Yakumo Study has been conducted since 1981 as a joint project between the town of Yakumo in Hokkaido and the Nagoya University Graduate School of Medicine. Professionals in the fields of epidemiology, internal medicine, orthopaedics, neuropsychology, ophthalmology, otolaryngology, and urology have joined to the Yakumo Study. The analysed data here were based upon the database from 2015 from the neuropsychology and otolaryngology teams. The participants had been engaged in a variety of jobs, not only white collar but also in agriculture, fishery, and forestry. Therefore, this town can be regarded as representative of today's Japanese society. From the database, 1210 participants (660women and 550 men) were selected form data in August, 2015-2017 (Table 1).

Year	2015	2016	2018	Total
Male	142	214	194	550
Female	169	262	229	660
Total	311	476	423	1210

Table 1: Participant number of inhabitant's examination in Yakumo-study 2016-2018 (n=1210).

Assessment of Salt Taste Identification

The gustatory test was performed using test paper SALSAVE (ADVANTEC Co. Ltd.), which include 7 different densities of NaCl on a test paper, as follows: 0.0 mg/cm2, 0.6 mg/cm2, 0.8 mg/cm2, 1.0 mg/cm2, 1.2 mg/cm2, 1.4 mg/cm2, and 1.6 mg/cm2. The participant placed a test paper on the tongue and closed the mouth to feel the taste. We inspect it from the light taste. When the participant understood that there is taste is detection. When participant might be said that it is saltiness is the recognition. Firstly, the participant rides 0.0% of test papers on the tongue and checks taste. The participant learns the taste of the test paper. Participant checks taste on a tongue from a test paper having a low density of NaCl sequentially afterward. There is the report that detection of salt taste is more important than recognition to salt taste [9].

Assessment of Odour Identification

The Odour Stick Identification Test (OSIT-J) was used to assess odour perception. This test possesses high reliability and validity [10]. The OSIT-J includes 12 different odorants to be identified. As odour perception is not necessarily culture-free, the Japanese version was employed [11,12]. The basic procedure resembles that of the San Diego Odour Identification Test [13]. The aromas used in the OSIT-J includes curry, perfume, Japanese cypress, India ink, menthol, rose, wood, nattou/sweat socks, roasted garlic, condensed milk, gas for cooking, and Japanese mandarin aromas. Each fragrance was enclosed in microcapsules made of melamine resin. These microcapsules were mixed with an odourless solid cream and then shaped to look like a lipstick. During the inspection test, the examiner applied each odorant to a piece of paraffin paper. After application, the examiner handed the paper to the participant, who would then sniff the paper and identify the odour. Participants selected each answer from a set of cards, each of which listed the name of an odorant, including the cor-

rect answer. Each correct answer was scored as one point, with the total performance score ranging from 0 to 12 points.

Statistical Processing

All data were confirmed to be normal distribution by F test. Data that was normally distributed was compared with Student-t without correlation of parametric test. The data that was not normally distributed was compared with the uncorrelated Mann-Whitney test of the nonparametric test.

Ethical Review Board

This study was conducted with the approval of the Ethical Review Board (Nagoya women's university 'hito wo mochiita kennkyuu ni kansuru iinnkai'). The approval number is 27-11.

Results

Participants Age distribution

We united data for 3 years and had a table according to sex and the age of the participant. The male was 550 participants in all, 40s were 45 participants, 50s were 87 participants, 60s were 261 participants, 70s were 125 participants, 80s were 32 participants (Table 2). The female was 660 participants in all, 40s were 81 participants, 50s were 146 participants, 60s were 268 participants, 70s were 136 participants, 80s were 29 participants (Table 3).

Male	40's	50's	60's	70's	80's	Total
2015	11	23	73	27	8	142
2016	20	35	102	43	14	214
2017	14	29	86	55	10	194
Total	45	87	261	125	32	550

Table 2: Age composition of participants in Yakumo-study.

(Total number of males in 3 years: 2016-2017) (n=550).

Female	40's	50's	60's	70's	80's	Total
2015	20	43	69	32	5	169
2016	37	54	103	53	15	262
2017	24	49	96	51	9	229
Total	81	146	268	136	29	660

Table 3: Age composition of participants in Yakumo-study.

(Total number of females in 3 years: 2016-2017) (n=660).

Assessment of Salt Taste Identification

We performed cognitive inspection of the saltiness. The participant who recognized 0.6% of saltiness in male 40s was 22.2%, in male 50s was 32.2%, in male 60s was 40.2%, in male 70s was 32.0%, and in male 80s was 40.6%. The recognition of 0.6% of saltiness was a very low value in all generations. However, about 60% of participants were able to recognize saltiness when they confirmed a result in saltiness within 1% (0.6%, 0.8%, 1.0%). In addition, there were 51 participants who could not recognize less than 1.6% of saltiness. The most of participants who could not recognize less than 1.6% of saltiness were in 60s and in 70s (Table 4).

The participant who recognized 0.6% of saltiness in female 40s was 39.5%, in male 50s was 41.1%, in male 60s was 41.8%, in male 70s was 40.4%, and in male 80s was 37.9%. The recognition of 0.6% of saltiness was a very low value in all generations. However, about 70.0% of participants were able to recognize saltiness when they confirmed a result in saltiness within 1% (0.6%, 0.8%, 1.0%). In addition, there were 60 participants who could not recognize less than 1.6% of saltiness. The most of participants who could not recognize less than 1.6% of saltiness were in 60s and in 70s. Female results of salt concentration cognitive test was better than male results (Table 5).

Assessment of Odour Identification

12 kinds of olfactometry results in the man were as follows table 6.

Male participant who was able to recognize smells more than eight kinds among 12 kinds of smells was 84.4% in 40s, 70.1% in 50s, 47.9% in 60s, 22.4% in 70s, and 18.8% in 80s. But, male participant who was able to recognize smells more than six kinds among 12 kinds of smells was 91.1% in 40s, 86.2% in 50s, 65.1% in 60s, 51.2% in 70s, and 46.8% in 80s. The median at 12 kinds of smells in 40s male was 9 kinds, in 50s male was 9 kinds, in 60s male was 7 kinds, in 70s male was 5 kinds, and in 80s male was 4 kinds. The average at 12 kinds of smells in 40s male was 8 kinds, in 50s male was 8 kinds, in 60s male was 6 kinds, in 70s male was 5 kinds, and in 80s male was 5 kinds. It was revealed that the olfactory recognition fell with age. The olfactory recognition suddenly decreased in 60 years old or more in particular. 12 kinds of olfactometry results in the foeman were as follows table 7.

Male participant who was able to recognize smells more than eight kinds among 12 kinds of smells was 82.7% in 40s, 82.9% in 50s, 69.0% in 60s, 43.4% in 70s, and 207% in 80s. But, male participant who was able to recognize smells more than six kinds among 12 kinds of smells was 88.9% in 40s, 89.7% in 50s, 83.6% in 60s, 66.9% in 70s, and 27.6% in 80s. The median at 12 kinds of smells in 40s male was 10 kinds, in 50s male was 10 kinds, in 60s male was 9 kinds, in 70s male was 7 kinds, and in 80s male was 4 kinds. The average at 12 kinds of smells in 40s male was 9 kinds, in 50s male was 9 kinds, in 60s male was 8 kinds, in 70s male was 6 kinds, and in 80s male was 4 kinds. It was revealed that the olfactory recognition fell with age. The olfactory recognition suddenly decreased in 80 years old in particular.

Odour Identification Ratio of 12 Different Smells

We checked 12 kinds of odour recognition individually. We show the result of the male in table 8, and the result of the female in table 9.

Salt concentration	40's (n=45)	50's (n=87)	60's (n=261)	70's (n=125)	80's (n=32)
0.60%	10	28	105	40	13
0.80%	12	21	44	29	7
1.00%	12	17	33	19	1
1.20%	3	10	14	10	4
1.40%	3	5	17	3	3
1.60%	2	0	15	3	1
More than 1.6%	2	5	30	19	2
Taste less	1	1	2	0	0
Not examination	0	0	1	2	1
Percentage of recognition in less than 1%	75.60%	75.90%	69.70%	70.40%	65.60%
Percentage of recognition with 0.6%	22.20%	32.20%	40.20%	32.00%	40.60%

Table 4: Result of Salt taste-test (Male = 550): Number of participants perceived at each concentration of salt by age.

Salt concentration	40's (n=81)	50's (n=146)	60's (n=268)	70's (n=136)	80's (n=29)
0.60%	32	60	112	55	11
0.80%	17	31	55	34	7
1.00%	9	14	37	14	3
1.20%	4	11	16	9	0
1.40%	5	15	17	4	2
1.60%	2	3	10	4	0
More than 1.6%	11	11	19	13	6
Taste less	0	0	1	0	0
Not examination	1	1	1	3	0
Percentage of recognition in less than 1%	71.60%	71.90%	76.10%	75.70%	72.40%
Percentage of recognition with 0.6%	39.50%	41.10%	41.80%	40.40%	37.90%

Table 5: Result of Salt taste-test (Female = 660): Number of participants perceived at each concentration of salt by age.

Female result was higher recognition for each smell than male result. Result of 12 kinds of odour recognition, male and female have the same result of top three incenses and bottom four incenses. The most comprehensible smell was the following order. That incense is Curry, Sweat socks, and Fried garlic. The most incomprehensible smell was the following order. That incense is Cypress, Mandarin orange, Menthol, and Wood. Five kinds of other smells were different in some turns that they were able to recognize. The male recognized it in order of Perfume, Condensed milk, India inc, Home gas, and Rose. The female recognized it in order of Rose, India inc, Perfume, Home gas, and Condensed milk. As for the olfactory recognition of the male, it became clear in comparison with a female as approximately 10% low in many cases.

Statistical Results

Statistical treatment was carried out for male salt taste test results by age by using F test. When there was no statistically significant difference in this result, statistical processing was performed again using the Student-t test with no correlation. And when there was a statistically significant difference in this result, statistical processing was performed again using Mann-Whitney test without correlation (Table 10). Likewise, statistical treatment was performed on the female salt taste test results (Table 11). Statistical treatment was also conducted on the salt taste test results of males and females of the same age (Table 12). Regarding the salt taste, it was revealed that there was no statistically significant difference between males and females. It was also found that there was no statistically significant difference between age with regard to taste.

Statistical treatment was carried out for male olfactory test results by age by using F test. When there was no statistically significant difference in this result, statistical processing was performed again using the Student-t test with no correlation. And when there was a statistically significant difference in this result, statistical processing was performed again using Mann-Whitney test without correlation (Table 13). Likewise, statistical treatment was performed on the female olfactory test results (Table

Olfactometry recognition number	40's (n=45)	50's (n=87)	60's (n=261)	70's (n=125)	80's (n=32)
0	0	1	12	7	2
1	1	5	14	8	5
2	0	0	7	10	0
3	1	1	18	8	0
4	0	2	17	12	7
5	2	3	23	16 (A)	3 (M&A)
6	2	6	19 (A)	12 (M)	3
7	1	8	26 (M)	15	6
8	9 (A)	10 (A)	46	10	2
9	13 (M)	15 (M)	33	11	4
10	4	14	19	10	0
11	8	11	20	5	0
12	4	11	7	1	0
Percentage of recognition more than six kinds	91.10%	86.20%	65.10%	51.20%	46.80%
Percentage of recognition more than eight kinds	84.40%	70.10%	47.90%	22.40%	18.80%

Table 6: Result of Olfactometry recognition-test (Male = 550): Number of participants perceived at 12 kinds of smell by age.

(A) = Average value for that age; (M) = Median value for that age.

Olfactometry recognition number	40's (n=81)	50's (n=146)	60's (n=268)	70's (n=136)	80's (n=29)
0	3	2	3	6	5
1	2	3	10	3	0
2	2	3	7	4	5
3	0	1	4	11	2
4	0	3	8	10	4 (A & M)
5	2	3	12	11	5
6	1	5	16	11 (M)	2
7	4	5	23	21 (M)	0
8	4	24	39 (A)	19	2
9	16 (A)	20 (A)	41 (M)	11	3
10	22 (M)	31 (M)	42	10	1
11	16	27	37	5	0
12	9	19	26	6	0
Percentage of recognition more than six kinds	88.90%	89.70%	83.60%	66.90%	27.60%
Percentage of recognition more than eight kinds	82.70%	82.90%	82.90%	43.40%	20.70%

Table 7: Result of Olfactometry recognition-test (Female = 660): Number of participants perceived at 12 kinds of smell by age.

(A) = Average value for that age; (M) = Median value for that age.

Correct answer rate %	Smell Name	Rank
74.9	Curry	1
67	Sweat socks	2
61.4	Fried garlic	3
58.7	Perfume	5
57.2	Condensed milk	4
55.9	India inc	6
55.6	Home gas	7
55.2	Rose	8
51.2	Wood	9
49.5	Menthol	10
47.4	Mandarin orange	11
42.1	Cypress	12

Table 8: Evaluated in descending order of correct answer rate in odor recognition test (Male=550).

Correct answer rate %	Smell Name	Rank
83	Curry	1
74.1	Sweat socks	2
71.8	Fried garlic	3
70.8	Perfume	5
67.7	Condensed milk	4
67.3	India inc	6
65.1	Home gas	7
64.8	Rose	8
63	Wood	9
61.8	Menthol	10
59.2	Mandarin orange	11
55.3	Cypress	12

Table 9: Evaluated in descending order of correct answer rate in odor recognition test (Female=660).

14). Statistical treatment was also conducted on the olfactory test results of males and females of the same age (Table 15). As for olfaction, it became clear that there is statistically significant difference between males and females. Female had statistically significant olfactory test results better than males. Statistically significant olfactory test results were particularly good in the sixties and seventies. It was also clear that there was statistically significant difference between age with respect to olfaction. The olfaction was diminished with age.

Discussion

As expected, the correct identification rate measured using the odour identification test decreased with an increase in age, showing that olfaction declines with an increase in age. This result was similar to that obtained by Ayabe et al. [14] and shows

	40's × 50's	**40's × 60's**	**40's × 70's**	**40's × 80's**	**50's × 60's**
F test	0.202	0.109	0.367	0.221	0.003**
Student-t test without correlation	0.225	0.248	0.144	0.249	
Mann-Whitney test without correlation					0.783
	50's × 70's	**50's × 80's**	**60's × 70's**	**60's × 80's**	**70's × 80's**
F test	0.252	0.069	0.021*	0.524	0.139
Student-t test without correlation	0.751	0.961		0.958	
Mann-Whitney test without correlation			0.261		

Table10: Comparison of salt taste test results by age group of Male.

(Statistical analysis of F test, Student-t test without correlation and Mann-Whiten y test without correlation).

	40's × 50's	**40's × 60's**	**40's × 70's**	**40's × 80's**	**50's × 60's**
F test	0.278	0.343	0.267	0.211	0.372
Student-t test without correlation	0.546	0.689	0.715	0.535	0.741
Mann-Whitney test without correlation					
	50's × 70's	**50's × 80's**	**60's × 70's**	**60's × 80's**	**70's × 80's**
F test	0.084	0.121	0.109	0.145	0.325
Student-t test without correlation	0.248	0.309	0.33	0.368	0.663
Mann-Whitney test without correlation					

Table11: Comparison of salt taste test results by age group of Female.

(Statistical analysis of F test, Student-t test without correlation and Mann-Whiten y test without correlation).

the validity of the test method used in this study. Our level of sensory recognition of odours is created by the circumstances of our everyday lives [15]. This data provided this time were about the same with our last data which was accepted [16,17]. It was that there were very few participants who could recog-

	Male 40's × Female 40's	**Male 50's × Fe male 50's**	**Male 60's × Fe male 60's**
F test	0.471	0.039*	0.091
Student-t test without correlation	0.081		0.474
Mann-Whitne y test without correlation		0.515	
	Male 70's × Female 70's	**Male 80's × Fe male 80's**	
F test	0.451	0.081	
Student-t test without correlation	0.694	0.324	
Mann-Whitne y test without correlation			

Table 12: Comparison of salt taste test results by age and sex group.

(Statistical analysis of F test, Student-t test without correlation and Mann-Whitne y test without correlation).

	Male 40's × Female 40's	**Male 50's × Fe male 50's**	**Male 60's × Fe male 60's**
F test	0.083	0.045*	0.176
Student-t test without correlation	0.568		0.0001**
Mann-Whitne y test without correlation		0.079	
	Male 70's × Female 70's	**Male 80's × Fe male 80's**	
F test	0.275	0.307	
Student-t test without correlation	0.004**	0.281	
Mann-Whitne y test without correlation			

Table 15: Comparison of olfactory test results by age and sex group.

(Statistical analysis of F test, Student-t test without correlation and Mann-Whitne y test without correlation).

	40's × 50's	**40's × 60's**	**40's × 70's**	**40's × 80's**	**50's × 60's**
F test	0.024*	0.002**	0.006**	0.174	0.266
Student-t test without correlation				0.0001**	0.0001**
Mann-Whitne y test without correlation	0.008**	0.0001**	0.0001**		
	50's × 70's	**50's × 80's**	**60's × 70's**	**60's × 80's**	**70's × 80's**
F test	0.322	0.299	0.47	0.179	0.201
Student-t test without correlation	0.0001**	0.0001**	0.0001**	0.010*	0.403
Mann-Whitne y test without correlation					

Table 13: Comparison of olfactory test results by age group of Male.

(Statistical analysis of F test, Student-t test without correlation and Mann-Whitney test without correlation).

	40's × 50's	**40's × 60's**	**40's × 70's**	**40's × 80's**	**50's × 60's**
F test	0.13	0.272	0.306	0.363	0.013*
Student-t test without correlation	0.954	0.014*	0.0001**	0.0001**	
Mann-Whitne y test without correlation					0.004**
	50's × 70's	**50's × 80's**	**60's × 70's**	**60's × 80's**	**70's × 80's**
F test	0.033*	0.144	0.493	0.497	0.487
Student-t test without correlation		0.0001**	0.0001**	0.0001**	0.0001**
Mann-Whitne y test without correlation	0.0001**				

Table 14: Comparison of olfactory test results by age group of Female.

(Statistical analysis of F test, Student-t test without correlation and Mann-Whitney test without correlation).

nize saltiness in 0.6% that was the most interesting in this study. Some researcher judges we have a decline in taste if we do not feel saltiness in 0.6%. However, it became clear necessary that we changed the standard from this result by the generation. If a participant can recognize saltiness in with 1.0%, 0.8%, and 0.6%, we should think that it is normal. In this study, among 12 kinds of smells, most people were not able to recognize four kinds of smells. Therefore, we think that it is enough if we will give a test having smelly eight kinds, need not 12 kinds of smell inspection in future. To prevent food poisoning; such as Sweat socks is necessary to identify. It is necessary to identify the home gas to prevent a gas explosion. We think that you should inspect it for these smells by all means. However, the smell of the rose and the smell of the perfume are similar very much. So, it is enough if we check only rose or perfume, we think. The opportunities when the modern society smells a cypress or the wood decrease. We think that it is good to do the olfactory test with four kinds of curry, steamed socks, fried garlic, and home gas. Or olfactory test may be three kinds of curry, Sweat socks and fried garlic. It is necessary to reduce the number of smells to be inspected in order to discover participants with olfactory decay by doing olfactive examination in a short time at the inhabitant medical examination. In late years it may be necessary to change contents of the olfactometry in future because Japanese lifestyle and living environment greatly change. We collect more data and we want to decide the cut-off level of taste examination and cut-off level of odour examination in future.

Conclusion

We performed an examination of taste and olfactometry in Yakumo-cho inhabitants' medical examination. Odour results of female had better recognition than male. Taste results was not different between male and female. As for the male, odour recognition decreases from 60 years old in particular. As for the smell of three high ranks, man and woman was the same when we checked 12 kinds of smells individually. The most comprehensible smell was the following order. That incense is Curry, Sweat socks, and Fried garlic. The most incomprehensible smell was the following order. That incense is Cypress, Mandarin orange, Menthol, and Wood. We think that it is necessary to examine the top three kinds of smell without incomprehensible eight kinds of smell in the olfactometry in future. Because it is necessary to inspect many participants in short time in the inhabitant's examination. It will be necessary to gather more data to decide the cut-off level in each generation of the olfactometry and taste examination in future. Because it is necessary to inspect many participants in a short time that in the inhabitant medical examination. We collect more data and we want to decide the cut-off level of taste examination and cut-off level of odour examination for each generation.

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