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Cross-Cultural Comparison of Data Using the Odor Stick Identification Test for Japanese (OSIT-J)

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Abstract

A new olfactory test, the odor stick identification test for Japanese (OSIT-J), has been developed in Japan. To determine if the OSIT-J would be effective cross-culturally, we administered the test to 52 US and 50 Japanese subjects reporting normal olfactory function. The average composite OSIT-J test score for US subjects was significantly lower (77%) than that for Japanese subjects (94%, $P < 0.0001$). Both US and Japanese subjects correctly identified eight of the 13 odorants included in the OSIT-J with scores of 80% or higher. However, for five odorants, the US subjects' scores fell below 80% and were consistently lower than Japanese subjects, presumably reflecting cultural differences in odor experience. Most of the US subjects found the OSIT-J to be easy, interesting, pleasant, and short in duration. Although the 13-odorant OSIT-J was found to be suitable for testing US populations, elimination of five test odorants that were unfamiliar to US subjects significantly enhanced the test's effectiveness. Findings from this study emphasize the importance of identifying test odorants that may have a cultural bias, a crucial issue when comparing data obtained from different smell tests used at smell and taste centers around the world.

Key words: cultural difference, distractor, odorant, olfaction, smell and taste center, smell test

Introduction

During the last quarter of a century, a variety of olfactory function tests have been developed throughout the world. In the United States, the University of Pennsylvania Smell Identification Test (UPSIT) (Doty *et al.*, 1984) and the Connecticut Chemosensory Clinical Research Center Test (Cain *et al.*, 1983) are frequently used to assess olfactory dysfunction. In Germany, Sniffin' Sticks (Kobal *et al.*, 1996; Hummel *et al.*, 1997) have become popular and are accredited by the German Society for Otorhinolaryngology. In Japan, T&T olfactometry (Zusho, 1983) is employed as a standard olfactory function test for diagnosing patient's olfactory dysfunction. Although, each test has its advantages when considering ease of administration, cost, and reproducibility of results, a single ''gold standard'' olfactory function test, universally accepted by all research centers, has not been established. A gold standard olfactory test would be ideal for comparing results obtained from different centers across the world. In addition to technical differences in methodology and odorant delivery, a major issue in designing olfactory tests is the selection of the individual test odorants. The odorants selected and tested in one population may demonstrate a high level of effectiveness, yet when tested in populations with different cultural backgrounds and experience may prove to be relatively ineffective. Therefore, selecting and incorporating odorants that are universally effective is a crucial issue for the development of olfactory tests if they are to have global applicability.

There have been no studies reporting data obtained with a Japanese smell identification test when administered to a US population, although several studies have reported

US olfactory function tests administered to Japanese populations (Doty *et al.*, 1985; Kondo *et al.*, 1997, 1998; Fukazawa *et al.*, 2001; Suzuki *et al.*, 2004). Delay in the development of smell identification tests in Japan is one reason, the other is the predominant use of T&T olfactometry, which is fundamentally an olfactory threshold test. In order to solve this problem, a new olfactory smell identification test, the odor stick identification test for Japanese (OSIT-J), has been developed in Japan and has proven to be useful not only for research subjects but also for patients with olfactory dysfunction in Japanese otorhinolaryngological clinics (Saito *et al.*, 1998; Kobayashi *et al.*, 2004). Test items included in the OSIT-J consist of odorants familiar to Japanese people and were selected based on the results of preliminary studies in Japan (Saito *et al.*, 1999). The present study was conducted to determine if the OSIT-J is suitable for use in US populations in which the cultural background and odor experience is different from Japanese populations. In addition, an analysis of individual test odorants was performed to identify odorants having a cultural bias, and if through modification of selected odorants, the global effectiveness of the OSIT-J would be improved.

Materials and methods

Subjects

A total of 102 volunteers who reported having no olfactory complaints participated in this study. Subjects included 52 US residents and 50 Japanese who were born and grew up in the United States and Japan, respectively. The 52 US subjects consisted of 42 Caucasians, 5 African Americans, and 5 Asian Americans. US subjects included 29 males and 23 females and had a mean age of 38 (range, 21–67). Japanese subjects included 22 males and 28 females and had a mean age of 39 (range, 25–74). The protocol for this study was reviewed and approved by the Virginia Commonwealth University Office of Research Subjects Protection. Informed consent was obtained from all subjects prior to study participation.

OSIT-J

The OSIT-J is composed of 13 different odorants familiar to the Japanese population (Figure 1, Saito *et al.*, 1998; Kobayashi *et al.*, 2004). These odorants are described as condensed milk, cooking gas, curry, cypress wood (Japanese cypress, ''hinoki''), Indian ink, Japanese orange, menthol, perfume, putrid smell, roasted garlic, rose, sweaty smelling clothes/fermented soybeans (''natto''), and wood. Test odorants are microencapsulated in a melamine resin and contained within an odorless solid cream that is dispensed in a lipstick container. The cream is applied to one side of a 5 × 10–cm strip of paraffin paper within a circle 2 cm in diameter. The paper strip is folded into two and rubbed together to release the odorant. Subjects receive the paper,

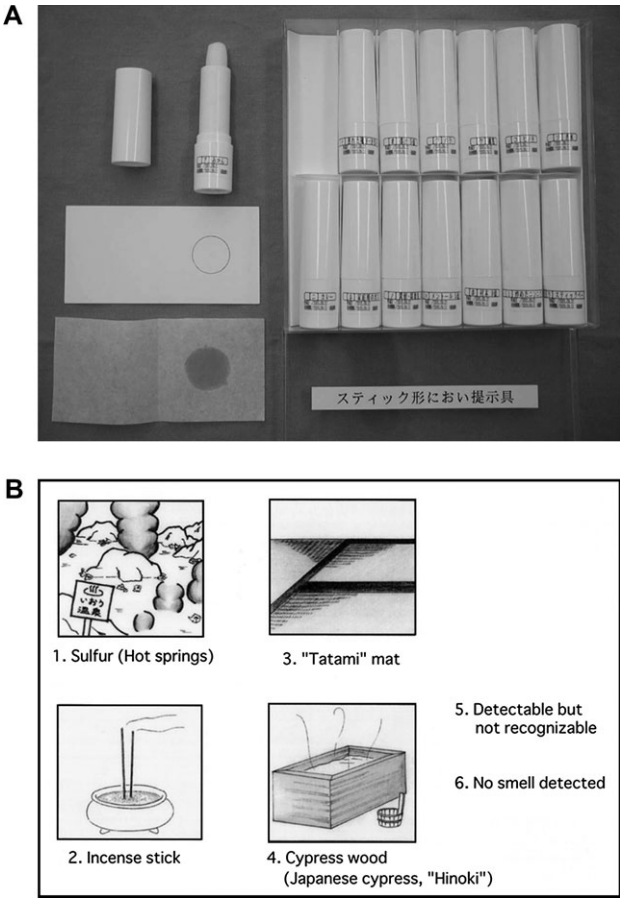

Figure 1 OSIT-J test kit components. **(A)** Lipstick applicators containing the 13 microencapsulated test odorants and one control (blank). A template with 2-cm circle and a paraffin paper strip were used for odorant presentation. **(B)** A sample of selection sheet providing the four odor names and associated pictures and the two alternative selections.

open it in front of their nose, and sniff it. For each odorant, subjects are presented with four odor names and associated pictures and are asked to select the correct answer (Table 1). For only one odor item, both answers of ''sweaty smelling clothes'' and ''fermented soybeans'' are regarded as correct answers. If they cannot select one of the four odor choices, they must respond by selecting one of the two alternative answers: ''detectable but not recognizable'' or ''no smell detected.'' The total number of correct answers for the 13 odorants presented, expressed as a percentage, is used to determine the OSIT-J score.

Experimental protocol

The order in which OSIT-J odorants were presented was randomized. In order to examine the acceptability of this test, upon completion of testing, subjects were asked if they found the OSIT-J easy or difficult, interesting or boring, pleasant or unpleasant, and short or long in duration. The time required to administer the test was also recorded.

Table 1 Test odorants and distractors used in the OSIT-J

Test odorants	Distractors		
Condensed milk	Chocolate	Cinnamon	Peanut
Cooking gas	Cresol disinfectant	Sulfur (hot springs)	Sweaty smelling clothes
Curry	Coffee	Pineapple	Butter
Cypress wood (Japanese cypress, "hinoki")	Sulfur (hot springs)	Incense stick	"Tatami" mat
Indian ink	Sulfur (hot springs)	Varnish	"Tatami" mat
Japanese orange	Banana	Apple	Peanut
Menthol	Incense stick	Mold	"Tatami" mat
Perfume	Incense stick	Honey	Coffee
Putrid smell	Gasoline	Cooking gas	Caramel
Roasted garlic	Wood	Coffee	Japanese horseradish ("wasabi")
Rose	Grassy plants	Apple	Raisins
Sweaty smelling clothes/ fermented soybeans ("natto")	Leather	Soybean paste (Japanese "miso" soup)	
Wood	Spoiled food	Leather	"Tatami" mat

We analyzed the OSIT-J composite scores and odor identification rates of each odor item for US and Japanese subjects. Subjects were asked to report if the smell name for each test item used in this study was familiar or unfamiliar to them.

Odorant items determined to be inappropriate for US subjects may require substitution with new odorant items to ensure that a reduction in the number of test items does not weaken the test's effectiveness. Therefore, US and Japanese subjects were asked to identify those odorants that were familiar or unfamiliar from among the four odorant names and pictures. Prior to the testing, subjects were also asked if they had a favorite smell. A list of favorite smells provides new candidate odorant items that are familiar to both US and Japanese subjects.

All numerical data are expressed as means ± standard errors. The Mann–Whitney *U*-test was used to determine differences in average values between US and Japanese subjects. The chi-square (χ^2) test for independence was used to test for differences in the response to individual odors. Data were regarded as significant when $P < 0.05$.

Results

Subjects' opinions and OSIT-J test time

The majority of US and Japanese subjects reported the OSIT-J to be easy, interesting, pleasant, and short in duration when asked their opinions (Figure 2). The average time to administer the test was 7 min for both US (range 6–11 min) and Japanese (range 6–10 min) subjects. There were no significant differences found when comparing US and Japanese subjects' opinions or the time needed to administer the test.

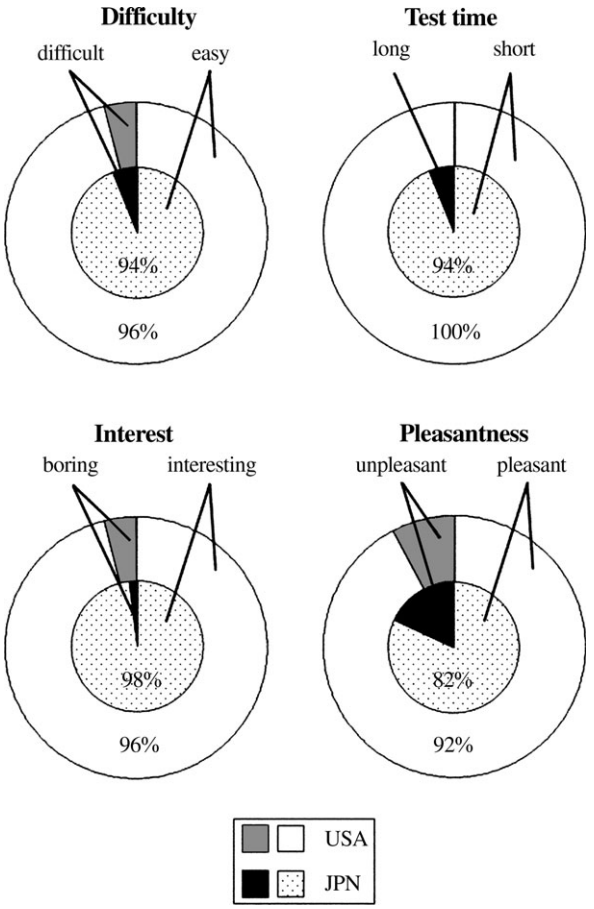

Figure 2 Opinions regarding the OSIT-J. Differences between US and Japanese subjects were not statistically significant.

OSIT-J scores and odorant analysis

OSIT-J test scores for US subjects were significantly lower than those for Japanese subjects (Table 2). Significant differences were also observed for both male and females.

When comparing the odor identification rate for each item, both US and Japanese subjects correctly identified eight of the 13 odorants included in the OSIT-J with identification rates of 80% or higher for menthol, rose, curry, Japanese orange, putrid smell, roasted garlic, perfume, and sweaty smelling clothes/fermented soybeans (Figure 3). For five odorants, however, US subjects' identification rates fell below 80% and were lower than Japanese subjects. For four of the five items, Indian ink, cooking gas, condensed milk, and wood, there were significant differences between US and Japanese subject scores. Although there was no significant difference between US and Japanese subjects' scores for cypress wood, subject interviews following testing revealed that 40% of US subjects selected the correct answer as "wood," even though they did not know the specific smell of "cypress wood."

Based on these results, a separate analysis of scores was performed using the eight items in the OSIT-J that had response rates of >80%. In the eight-item OSIT-J analysis, there were no significant differences found between scores from US and Japanese subjects (Table 3).

Table 2 Comparison of 13-item OSIT-J scores between US and Japanese subjects

	US subjects	Japanese subjects	*P* value
All subjects	77 ± 2 (*n* = 52)	94 ± 1 (*n* = 50)	<0.0001
Males	76 ± 2 (*n* = 28)	92 ± 2 (*n* = 22)	<0.0001
Females	78 ± 2 (*n* = 24)	96 ± 1 (*n* = 28)	<0.0001

Familiarity to odorants

Figure 4 shows data obtained regarding familiarity with the odors and distractor smell names used in this study. The test odors fermented soybeans, Indian ink, cypress wood, and condensed milk, and the distractors "tatami" mat, soybean paste (Japanese "miso" soup), and cresol disinfectant were unfamiliar to more than 20% of US subjects, while all of the test odors and distractors were familiar to over 90% of the Japanese subjects.

To determine if odorants in the distractor list could serve as new test items, distractors familiar to 100% of both US and Japanese subjects were identified (Table 4). Of the 23 different distractors, 10 odorants (43%) were reported to be familiar to 100% of US and Japanese subjects. Subjects were also asked if they have a favorite odor (Table 5). Rose was the most frequent odorant named by both US and Japanese subjects.

Discussion

The present study revealed that the OSIT-J method is effective in identifying both US and Japanese subjects with normal olfactory function. However, its effectiveness as a universal test for different populations may be limited due to the cultural bias that exists in test odorants. One important characteristic of an ideal olfactory test is that it is easy and quick to administer to subjects. T&T olfactometry, the Japanese standard olfactory test, is not easy to administer and it is time consuming (Kobayashi *et al.*, 2004). The T&T olfactometry method is also designed primarily to assess olfactory threshold. Threshold tests are very useful for examining levels of olfactory dysfunction. On the other hand, smell identification tests are helpful for diagnosing central olfactory disorders such as Alzheimer's and Parkinson's diseases. Interestingly, smell identification tests are not widely used in Japan. The OSIT-J has been developed in

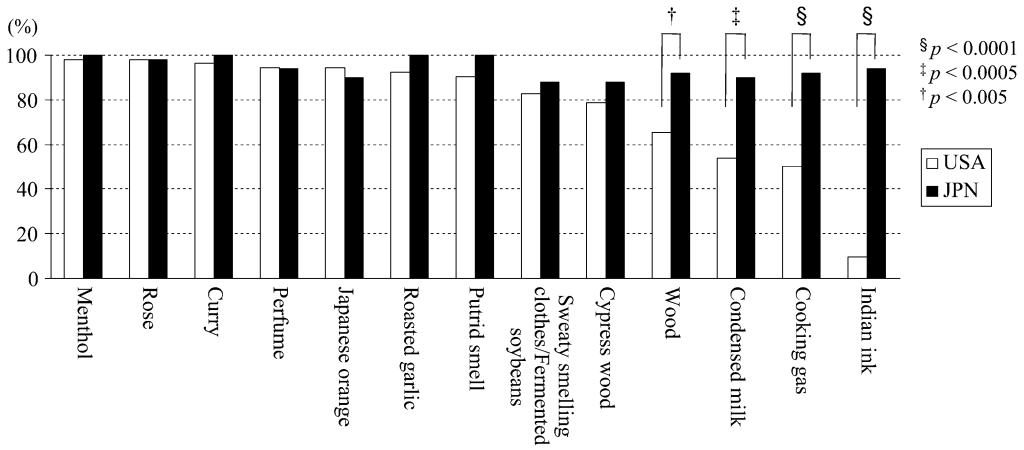

Figure 3 Comparison of odor item identification rates for US and Japanese subjects. For eight of the items, the identification rate for both US and Japanese subjects is >80%. For five of the items, the rate fell below 80%, and significant differences between the two groups were observed. §$P < 0.0001$, ‡$P < 0.0005$, †$P < 0.005$.

an attempt to address some of these problems and has been shown to work well in testing Japanese people (Saito *et al.*, 2001; Hashimoto *et al.*, 2004; Kobayashi *et al.*, 2004). The results of this study reveal that the OSIT-J is considered to be easy, interesting, and pleasant and is judged to be short in duration by US as well as Japanese subjects. The recorded test time for both US and Japanese subjects averaged only 7 min. Findings suggest that the OSIT-J test method is acceptable to US subjects.

The present study employed a self-reporting method for selection of study subjects with normal olfactory function. Several studies have shown that self-reporting correlates poorly with results from chemosensory function tests (Nordin *et al.*, 1995; Murphy *et al.*, 2002; Doty and Haxel, 2005). However, Murphy *et al.* (2002) reported that, while the overall sensitivity of self-reporting of olfactory impairment (ability of self-reporting to identify subjects true with impairment) is poor (20%), the specificity (ability of self-reporting to identify subjects with normal olfactory function) is very high (94%) and that normosmic subjects tend to accurately report no abnormalities. In the present study, we screened out subjects reporting olfactory dysfunction and selected only those reporting normal olfactory function.

One unique feature of the OSIT-J is that it uses microencapsulated odorants which makes the test kit compact and portable. A single test kit has the capacity to test approximately 250 subjects. By using microencapsulated odorants, containing them within an odorless solid cream and enclosing within a plastic case, this combination extends the shelf life of the test kits. Testing has shown that the quality and strength of the odorants used in the OSIT-J are maintained for a minimum of 18 months (Nozawa *et al.*, 2003). As for microencapsulated odorant delivery systems, the UPSIT is another example of this methodology used in the United States (Doty *et al.*, 1984). The UPSIT is a booklet-type test and, because it is self-administered, it is very effective in conducting large mail surveys to determine olfactory function at multiple time points. Several differences between the OSIT-J and UPSIT are worth noting regarding the methods used for subjects' selection of odorants. The OSIT-J is not based on a standard forced-choice technique such as that used in the UPSIT. The choices available in the UPSIT include one correct answer and three distractor selections, while the OSIT-J includes two optional selections, detectable but not recognizable and no smell detected, along with one correct answer and three distractor selections. In addition, in the UPSIT

Table 3 Comparison of eight-item OSIT-J scores between US and Japanese subjects

	US subjects	Japanese subjects	*P* value
All subjects	93 ± 1 (n = 52)	96 ± 1 (n = 50)	NS
Males	93 ± 2 (n = 28)	96 ± 2 (n = 22)	NS
Females	93 ± 2 (n = 24)	97 ± 1(n = 28)	NS

NS, not significant.

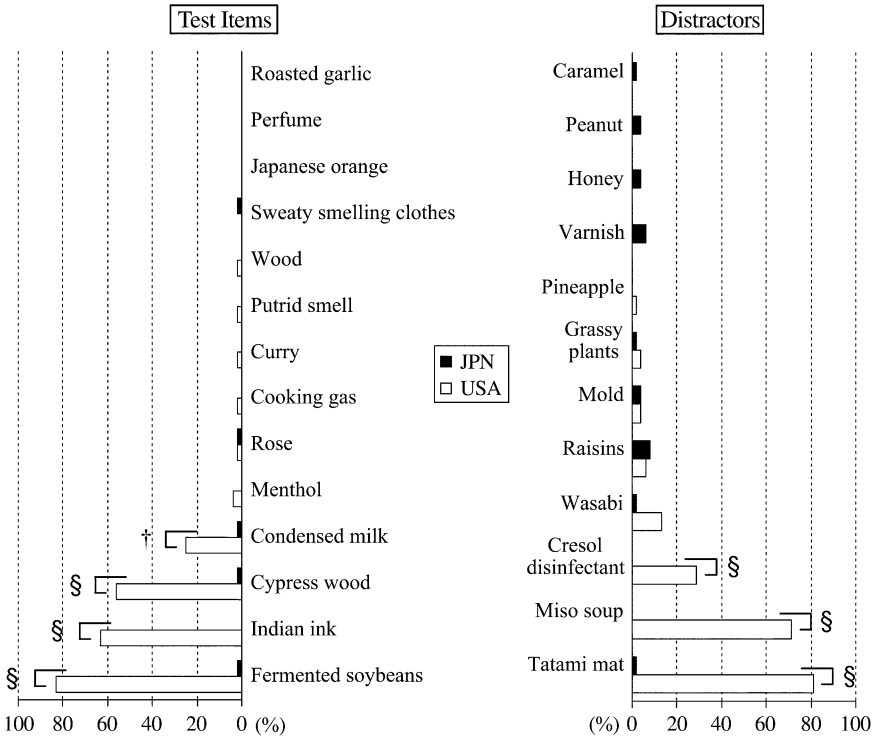

Figure 4 OSIT-J items reported as unfamiliar. Data were obtained from 52 US and 50 Japanese subjects. Significant differences between US and Japanese subjects are expressed as §P < 0.0001, †P < 0.005.

Table 4 Distractors familiar to 100% of US and/or Japanese subjects

US and Japanese subjects	US subjects	Japanese subjects
Apple disinfectant	Caramel	Cresol
Banana	Honey	Pineapple
Butter	Peanut	Soybean paste (Japanese "miso" soup)
Chocolate	Varnish	
Cinnamon		
Coffee		
Gasoline		
Incense stick		
Leather		
Sulfur (hot springs)		

Table 5 Favorite odors of US and Japanese subjects

US subjects	Percentage	Japanese subjects	Percentage
Rose	27	Rose	14
Chocolate	14	Perfume	10
Steak	8	Orange	8
Cinnamon	6	Soysauce	8
Coffee	6	Citrus junos	6
Strawberry	6	Lemon	6
		Rice	6
		Vanilla	6

Each subject was asked to identify one or more favorite odors. Odors shown above are those reported by >5% of subjects.

test, the subject is presented with a list of names representing the stimulus odorant, while the OSIT-J test used in this study utilizes both odorant names and associated pictures.

In the present study, composite scores of the OSIT-J for US subjects were significantly lower than those from Japanese subjects regardless of gender. This result is likely due to differences in cultural experience and backgrounds between US and Japanese people. Assessment of identification rates for individual odorant items revealed that five of the 13 items, Indian ink, cooking gas, condensed milk, wood, and cypress wood, were responsible for the score difference. When composite scores were recalculated from the remaining eight items, there were no differences between composite scores from US and Japanese people. Reasons why the five odor items were problematic are discussed below. Results from our subject interviews showed that of the five odorants, Indian ink, cypress wood, and condensed milk were not familiar to US subjects. However, Indian ink is commonly used for calligraphy taught in most Japanese schools. Cypress wood (Japanese cypress, "hinoki") is one of the most popular building materials for Japanese homes and is typically used for bathtubs at hot springs in Japan (Figure 1B). Condensed milk is still very popular in Japan and is spread on strawberries and other deserts. Condensed milk is rarely used in modern American households. Regarding odors associated with wood and cooking gas items, our interview results indicate that wood and cooking gas are familiar to US and Japanese subjects, however, the specific chemicals for these may be different. For example, cooking gas used in most homes is delivered as natural gas, which is fundamentally odorless but is odorized using sulfur compounds so that gas leaks can be detected. In the United States, the chemical additive introduced into natural gas is ethanethiol (ethyl mercaptan) and smells like rotten eggs, while in Japan, the natural gas chemical additives are tetrahydrothiophene that smells like coal gas, tertiary butyl mercaptan that smells like rotted onions, and dimethyl sulfide that smells like garlic or rotted cabbage. Since the OSIT-J test item for cooking gas odor is made of tetrahydrothiophene, this could explain the difference in identification rates for US and Japanese subjects.

While the eight-item modified OSIT-J is considered to be equally effective in both US and Japanese populations, the limited number of test items could weaken its ability to fully evaluate olfactory function and the addition of new odorant items may be needed. One requirement for selecting new odorant items is that they should be familiar to both US and Japanese populations and that any modified OSIT-J continues to cover a range of different odorants so as to include odorant categories such as sweet, spicy, plant-like, dangerous, and chemical odors (Saito *et al.*, 1999; Saito and Ayabe-Kanamura, 2002). Accordingly, to identify potential odorants for additional test items, we asked subjects if they were familiar with the distractors that were presented and, additionally, if they had a favorite smell. Although most of the favorite smells reported by US and Japanese subjects were different, rose was a common favorite. Interestingly, rose is one of the odorants already included in the OSIT-J test. According to US and Japanese subjects' reports of familiarity with odorants, the potential candidates for new odor items that could be included in a modified OSIT-J are "chocolate," "coffee," and "cinnamon." In addition, composition of distractors is one of the important factors for appropriate testing. Unfamiliar distractors were identified so that they could be removed from choices to enhance validity of testing, especially for US subjects. According to our findings, "tatami mat," "miso soup," and "cresol disinfectant" are distractors that should be removed from the OSIT-J for use with US subjects. Modification of distractors might be also useful so that the test odorant item becomes more contrasted. In addition, we found that fermented soybeans, used as a correct answer together with "sweaty smell clothes," was unfamiliar to US subjects and should also be deleted.

A few previous studies have examined cross-cultural trials of olfactory tests. Ayabe-Kanamura *et al.* (1998) and Distel *et al.* (1999) reported that there were significant differences

in identification, pleasantness, familiarity, edibility, and perceptive intensity rates for some odorants between Japanese and German subjects. In these studies, they administered 18 odorants composed of six Japanese, six European, and six international odorants. Doty *et al.* (1985) demonstrated that test–retest reliability of recognition threshold score of the Japanese T&T olfactometry method was not very high when administered to US subjects, while Kondo *et al.* (1998) administered the UPSIT to Japanese normal subjects and reported that 15 of 40 UPSIT odorants' individual identification rates did not reach 80% and 10 of them were less than 70%. These results reveal problems inherent in cross-cultural administration of olfactory tests. Furthermore, the cross-cultural smell identification test (CC-SIT) has been developed based on surveys from several countries and data from cross-cultural trials of the UPSIT in Japanese (n = 308) and Swedish (n = 96) populations (Doty *et al.*, 1996). Nevertheless, studies reported that the CC-SIT includes some odor items unfamiliar to Japanese people, and scores of the CC-SIT were not very high in normal elderly Japanese subjects (Kondo *et al.*, 1997; Suzuki *et al.*, 2004). Fukazawa *et al.* (2001) reported that scores from the CC-SIT did not strongly correlate with those from the T&T olfactometry method (r_s = 0.56, P < 0.0001, n = 112) and self-assessment of olfactory function by visual analog scale (r_s = 0.26, P = 0.0054, n = 112) in Japanese patients with olfactory dysfunction. The above issues suggest that it may be difficult to establish a single gold standard olfactory test that would be optimal for use throughout the world. Alternatively, the present study indicates that many existing tests known to have inherent regional or cultural bias can be modified to make them more effective for use in different populations (Ho *et al.*, 2002). Analysis of cultural differences and preferences for specific odorants is critical to the application of olfactory test across cultures. In the absence of a universally accepted gold standard evaluation and modification of odorants used in existing olfactory tests could provide an alternative solution for comparing data obtained from smell and taste centers across the globe.

References

Ayabe-Kanamura, S., Schicker, I., Laska, M., Hudson, R., Distel, H., Kobayakawa, T. and **Saito, S.** (1998) *Differences in perception of everyday odors: a Japanese-German cross-cultural study.* Chem. Senses, 23, 31–38.

Cain, W.S., Gent, J., Catalanotto, F.A. and **Goodspeed, R.B.** (1983) *Clinical evaluation of olfaction*. Am. J. Otolaryngol., 4, 252–256.

Distel, H., Ayabe-Kanamura, S., Martinez-Gomez, M., Schicker, I., Kobayakawa, T., Saito, S. and **Hudson, R.** (1999) *Perception of everyday odors-correlation between intensity, familiarity and strength of hedonic judgement*. Chem. Senses, 24, 191–199.

Doty, R.L., Applebaum, S., Zusho, H. and **Settle, R.G.** (1985) *Sex differences in odor identification ability: a cross-cultural analysis*. Neuropsychologia, 23, 667–672.

Doty, R.L. and **Haxel, B.R.** (2005) *Objective assessment of terbinafine-induced taste loss*. Laryngoscope, 115, 2035–2037.

Doty, R.L., Marcus, A. and **Lee, W.W.** (1996) *Development of the 12-item cross-cultural smell identification test (CC-SIT).* Laryngoscope, 106, 353–356.

Doty, R.L., Shaman, P., Kimmelman, C.P. and **Dann, M.S.** (1984) *University of Pennsylvania smell identification test: a rapid quantitative olfactory function test for the clinic*. Laryngoscope, 94, 176–178.

Fukazawa, K., Fujii, M., Takayasu, S. and **Sakagami, M.** (2001) *The relationship between the T&T olfactometer/the intravenous alinamin test and CC-SIT.* Jpn. J. Taste Smell Res., 8, 371–374.

Hashimoto, Y., Fukazawa, K., Fujii, M., Takayasu, S., Muto, T., Saito, S., Takashima, Y. and **Sakagami, M.** (2004) *Usefulness of the odor stick identification test for Japanese patients with olfactory dysfunction*. Chem. Senses, 29, 565–571.

Ho, W-K., Kwong, D.L., Wei, W.I. and **Sham, J.S.** (2002) *Change in olfaction after radiotherapy for nasopharyngeal cancer-a prospective study.* Am. J. Otolaryngol., 23, 209–214.

Hummel, T., Sekinger, B., Wolf, S.R., Pauli, E. and **Kobal, G.** (1997) *'Sniffin' sticks': olfactory performance assessed by the combined testing of odor identification, odor discrimination and olfactory threshold*. Chem. Senses, 22, 39–52.

Kobal, G., Hummel, T., Sekinger, B., Barz, S., Roscher, S. and **Wolf, S.** (1996) *"Sniffin' sticks": screening of olfactory performance*. Rhinology, 34, 222–226.

Kobayashi, M., Nishida, K., Nakamura, S., Oishi, M., Shiozaki, T., Majima, Y., Maeda, T., Furuta, S., Takashima, Y. and **Saito, S.** (2004) *Suitability of the odor stick identification test for Japanese in patients suffering from olfactory disturbance*. Acta Oto-Laryngol., 553(Suppl. 124), 74–79.

Kondo, H., Matsuda, T., Hashiba, M. and **Baba, S.** (1997) *The usefulness and limitation of the smell identification test as an olfactory function test in the Nagoya area, Japan*. Jpn. J. Rhinol., 36, 27–34.

Kondo, H., Matsuda, T., Hashiba, M. and **Baba, S.** (1998) *A study of the relationship between the T&T olfactometer and the University of Pennsylvania smell identification test in a Japanese population*. Am. J. Rhinol., 12, 353–358.

Murphy, C., Schubert, C.R., Cruickshanks, K.J., Klein, B.E., Klein, R. and **Nondahl, D.M.** (2002) *Prevalence of olfactory impairment in older adults*. J. Am. Med. Assoc., 288, 2307–2312.

Nordin, S., Monsch, A.U. and **Murphy, C.** (1995) *Unawareness of smell loss in normal aging and Alzheimer's disease: discrepancy between self-reported and diagnosed smell sensitivity.* J. Gerontol. B Psychol. Sci. Soc. Sci., 50, 187–192.

Nozawa, T., Saito, S., Kobayakawa, T. and **Takashima, Y.** (2003) *Reliability of the odor stick identification test: effects of the inter-stimulus-interval between odor materials and the temporal stability of the odor sticks*. Jpn. J. Taste Smell Res., 10, 267–272.

Saito, S. and **Ayabe-Kanamura, S.** (2002) *Odor descriptors for the evaluation of odor quality, from a classification of Japanese every day odors*. J. Odor Res. Eng., 33, 1–12.

Saito, S., Ayabe-Kanamura, S., Kobayakawa, T., Kuchinomachi, Y. and **Takashima, Y.** (1999) *A smell test based on odor recognition by Japanese people, and its application*. In Bell, G.A. and Watson, A.J. (eds), Tastes & Aromas: The Chemical Senses in Science and Industry. University of New South Wales Press, Sydney, pp. 75–82.

Saito, S., Masuda, Y., Kobayakawa, T., Gotou, N., Mizoguchi, C. and **Takashima, Y.** (2001) *Relation between the Japanese standardized*

olfactory test and the odor stick identification test for Japanese in 108 Japanese participants aged 20 to 81 years. Jpn. J. Taste Smell Res., 8, 143–149.

Saito, S., Tsuchiya, M., Mise, M., Yoshida, Y., Kobayakawa, T., Ayabe-Kanamura, S., Yamaguchi, Y. and **Takashima, Y.** (1998) *A smell test for Japanese people: a study using a new stick-type tool for odor presentation*. Jpn. J. Taste Smell Res., 5, 323–326.

Suzuki, Y., Yamamoto, S., Umegaki, H., Onishi, J., Mogi, N., Fujishiro, H. and **Iguchi, A.** (2004) *Smell identification test as an indicator for cognitive impairment in Alzheimer's disease*. Int. J. Geriatr. Psychiatry, 19, 727–733.

Zusho, H. (1983) *Olfactometry in Japan*. Rhinology, 21, 281–285.

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