ORIGINAL ARTICLE

The development and test retest reliability of Malaysia Smell Test (MAST)

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Abstract:

Background: Olfaction has an essential role in daily life. A decline in the olfactory function could possibly be an early signal of neurodegenerative disorders such as Alzheimer's disease. Currently, there are few smell test that have been developed but not all test are appropriate in different regions due to the cultural differences. **Objective:** To develop and validate the Malaysia Smell Test (MAST) for elderly population in Malaysia. **Study design:** Cross sectional study. **Method:** A market survey on healthy elderly people (n = 125) was performed to identify familiar odours remembered among elderly people in Malaysia. Ten odours were selected and the MAST kit was developed using raw material. MAST was tested on 38 subjects and repeated after two weeks. All data was analysed using SPSS version 21. **Result:** There was a statistically significant differences in MAST score from test and retest (p=0.003). Test-retest study revealed that MAST is a reliable test (Spearman's rank correlation coefficient between test-retest identification scores: r=0.93), ICC value of 0.92 and Kappa value of 0.31. **Conclusion:** Although MAST has significant differences between test and retest, the time stability appears to be consistent and reliable over time. There was no changes in odour identification during time interval.

Keywords: Elderly people, olfaction, smell identification test

1. INTRODUCTION

Malaysia is expected to become an ageing nation by 2030 where the elderly population in Malaysia setting has reached 28.3 million in 2010 and is predicted to rise to 38.6 million in the next 30 years [1]. A reduction in the sense of smell is very common among elderly with the prevalence of >50% for elderly aged between 65 to 80 years and 62-80% of individuals aged 80 years and above [2].

Olfactory function could possibly be an accurate predictor of the integrity of the aging brain. A decline in the olfactory function could possibly be an early signal of neurodegenerative disorders, especially Parkinson's disease, Alzheimer's disease, and mild cognitive impairment that eventually will develop dementia [2].

Decline in odour identification was related with a lower cognitive function in all of the domains but more rapid deterioration in semantic and episodic memory, perceptual speed, and executive function but not in working memory or visuospatial ability [3]. Besides, decline in olfactory function in normal people are associated with some brain measures of grey and white matter integrity. Decrease of olfaction is related to the loss of integrity of cerebral white matter fibres [4] The present measures to diagnose Alzheimer's disease which are invasive, expensive, time-consuming and limited accessibility which only available at specialty clinic. Hence, there is an increasing demand for other non-invasive and cost-effective measures in identifying early stages of AD.

Olfactory function screening will be an affordable, non-invasive and easy method of identifying older adults at risk for developing cognitive impairments and also easy to carry out at primary care settings [5]. Currently, there are few smell test that have been developed such as Taiwan Smell Identification Test (TWIST) and Iran Smell Identification Test (Iran-SIT). But, not all smell identification test are appropriate in different regions due to the cultural differences. Besides, the odor used in the tests may not culturally appropriate to Malaysian culture.

Therefore, a Malaysia version of smell test that are simple, cost-effective and applicable to the Malaysian culture is needed.

2. MATERIALS AND METHODS

Stage 1: Identification of familiar odours

A survey was conducted on 125 subjects from community living to determine types of odours that are common/familiar among elderly people. They need to list down the familiar odours that they often encountered in their

daily life in a questionnaire form that contained question of familiar odours divided into three which are food or drinks, plants and chemical substances.

The inclusion criteria for this stage includes older people aged 60 years and above, score ≥25 in (SLUMS-BM) that signify normal cognitive function, score 0 – 5 in Geriatric Depression Scale which no depression, education level: at least finished primary school while the exclusion criteria includes older people aged 60 years and below, having problem related to nose and olfactory such as polyps, chronic rhinosinusitis, or allergic rhinitis [18], impaired vision or hearing because it was associated with poorer performance on cognitive function tests independent of the other sensory impairments and factors associated with cognition [19], frail and dependent elderly.

Stage 2: Development of Malaysia Smell Test (Mast)

Literature search was conducted to identify method of development in smell test and eight studies that develop test on smell were identified.

(MAST) was developed using raw materials based on the 16 odours that were identified [6] and packaged in opaque plastic container as shown in figure 1. The lid of the container was opened for 3 seconds for the participants to smell with 30 seconds interval each sniff to prevent confusion. The distance of test items was placed about 2 cm in front of the participant's nostril [7] as shown in figure 2. Both of this study was selected because of the reasonable time duration and time interval of the test, the distance of test item with the participants, test materials that was easily found and the test item that able to prepare in short amount of time.

Figure 1: Plastic with the number of items that were marked on the container lid and the blindfold.

Figure 2. Procedure of MAST.

Stage 3: Pilot study

Before the main experiment, a pilot study was carried out by 18 elderly peoples (15 males and 3 female). The aim of pilot study is to identify any issues in the MAST procedure.

Before the test conducted, participants were asked few questions on their demographic profile. Then, the elderly people were needed to sit and their eyes were covered to prevent any chance of visual identification. MAST was conducted based on the protocol that has been set. Next, they were asked three question which are smell identification, intensity and item identification.

Then, semi – structured interview was conducted using open ended questions included in the form which asking any issue encountered while taking the test.

Stage 4: Test-Retest of MAST

Thirty-eight subjects (12 male and 26 female) aged 60 years and above were selected to participate in the main study to validate the Malaysia Smell Test (MAST). This study was started by meeting all the elderly at Rumah Sri Kenangan, Cheras. Participants were chosen based on the inclusion and exclusion and criteria. Then, the elderly people were assessed using Malaysia Smell Test (MAST) after few modifications have been done. To check the internal consistency and time stability of the MAST, the test were conducted again to the same person two weeks after the main study. The procedure for the retest study was same as the main study.

3. RESULTS

Stage 1: Identification of familiar odours

There are 193 odours identified by 125 elderly peoples. The highest odours mentioned is durian which is 94 (75.2%) peoples, followed by belacan, 91 (72.8) peoples. The example of odours that are less familiar are margarine, mayonnaise, and peach which were only mentioned by one person.

From the market survey, 21 highest smell as shown on table 1 were selected but several items which have higher number or people identified were omitted due to some reasons. The items includes *sambal tumis, ros, diesel, gas*, and perfume.

After five items were omitted, 16 highest odours from any types that with high familiarity and intensity were selected as presented in table 2.

Table 1: 21 type of odours with high identification rate.

No	Items	Number of people identified	(%)
1	Durian	94	75.2
2	Belacan	91	72.8
3	Kopi	83	66.4
4	Petrol	72	57.6
5	Ikan masin	69	55.2
6	Cempedak	66	52.8
7	Clorox	49	39.2
8	Daun pandan	48	38.4
9	Petai	48	38.4
10	Kari	46	36.8
11	Nangka	45	36.0
12	Kuini	41	32.8
13	Sabun mandi	40	32.0
14	Asap	39	31.2
15	Daun kari	37	29.6
16	Nescafe	35	28.0
17	Daun kesum	33	26.4
18	Serai	33	26.4
19	Daun limau purut	30	24.0
20	Ridsect	28	22.4
21	Limau mandarin	22	17.6

Table 2: 16 most familiar items with high identification rate.

No	Items	Number of people identify	(%)
1	Durian	94	75.20
2	Belacan	91	72.80
3	Kopi	83	66.40
4	Petrol	72	57.60
5	Ikan masin	69	55.20
6	Cempedak	66	52.80
7	Clorox	49	39.20
8	Daun pandan	48	38.40
9	Petai	48	38.40
10	Kari	46	36.80
11	Nangka	45	36.00
12	Sabun mandi	40	32.00
13	Daun kesum	33	26.40
14	Serai	33	26.40
15	Daun limau purut	30	24.00
16	Limau mandarin	22	17.60

Stage 2: Development of Malaysia Smell Test (MAST)

The Malaysia Smell Test (MAST) kit was developed using raw materials one day prior to the test. The list of odours includes durian, *belacan, kopi, petrol, ikan kering, cempedak, clorox, petai, daun pandan, kari, nangka, sabun mandi, daun kesum, serai, daun limau purut, and limau mandarin.*

Stage 3: Pilot study

Table 3 present the result of pilot study on 18 subject. 2 (11.1%) and 1 (5.6%) unable to detect odours of clorox and *daun pandan* that are presented to them while another 6 items which is *serai, daun kesum, petrol, cempedak* and *petai* was wrongly identified by the participants ranging from 14 to 18 subjects.

Table 3: The test result of 16 most familiar odours.

No	Smell	Item identification	
		Betul n(%)	Salah n(%)
1	Durian	13 (72.2)	5 (27.8)
2	Belacan	8 (44.4)	10 (55.6)
3	Kopi	10 (55.6)	8 (44.4)
4	Petrol	1 (5.6)	17 (94.4)
5	Ikan kering	7 (38.9)	11 (61.1)
6	Cempedak	3 (16.7)	15 (83.3)
7	Clorox		17 (100)
8	Petai	4 (22.2)	14 (77.8)
9	Daun pandan	2 (12.5)	14 (87.5)
10	Kari	8 (44.4)	10 (55.6)
11	Nangka	1 (5.6)	17 (94.4)
12	Sabun mandi		18 (100)
13	Daun kesum	5 (27.8)	13 (72.2)
14	Serai	5 (27.8)	13 (72.2)
15	Daun limau purut	1 (5.6)	17 (94.4)
16	Limau		18 (100)

Several issues had arisen during the administration of MAST. Most of them claimed that the items are too much, 12(66.7%), followed by 9(50%) participants that said the odours of items were reduced. Besides, other issue that elderly people mentioned was the test location that is not suitable 7(38.9%) and they can see the items inside the container 5(27.8%). Modifications that have been done includes 10 distinctive types of smells with high identification rates were chosen for the test, the transparent container were sprayed with black paint to prevent the subjects from seeing the materials inside, for the preparation process, the raw materials would be changed for at least 3 hours to keep the freshness of the materials, and location of the test were changed from outdoor to a room that is well ventilated [6].

Ten final items was selected from step 3 (item identification) are durian, *belacan, kopi, kari, ikan kering, limau, cempedak, sabun mandi, daun limau purut and daun pandan.* Six items that were omitted are *serai, daun kesum, petrol, clorox, nangka and petai*. 2 items that was selected due to higher intensity which is *daun pandan* and *cempedak.*

Stage 4: Test-retest of MAST

For step 3, the number of participants that were able to identify the items correctly or wrongly are almost the same for test and retest as shown in table 4 except for *durian* which is 24 (63.2%) and 14 (36.8%) participants that correctly identified and 31 (81.6%) and 7 (18.4%) that wrongly identified for both tests.

Table 4: Test and retest result of MAST.

Odours	**Item identification**			
	True n(%)		**False n(%)**	
	Test	**Retest**	**Test**	**Retest**
Durian	24 (63.2)	31 (81.6)	14 (36.8)	7 (18.4)
Belacan	22 (59.5)	28 (73.7)	15 (40.5)	10 (26.3)
Kopi	24 (64.9)	25 (65.8)	13 (35.1)	13 (34.2)
Kari	15 (40.5)	15 (39.5)	22 (59.5)	23 (60.5)
Ikan kering	22 (57.9)	24 (63.2)	16 (42.1)	14 (36.8)
Limau	18 (47.4)	18 (47.4)	20 (52.6)	20 (52.6)
Cempedak	16 (42.1)	20 (52.6)	22 (57.9)	18 (47.4)
Sabun mandi	17 (47.2)	17 (44.7)	19 (52.8)	21 (55.3)
Daun limau purut	16 (43.2)	18 (47.4)	18 (56.8)	20 (52.6)
Daun pandan	16 (42.1)	21 (56.8)	22 (57.9)	16 (43.2)

The correlation between the responses at the two time points that was tested using Spearman's rank correlation coefficient is (r=0.93) which shows there is very strong relationship between test-retest identification scores. The reliability of MAST shows that there is an almost perfect agreement (0.92). The Kappa value for each item is 0.31 which shows that there is a fair agreement between two time points on the response for the item (Table 5).

Table 5: Test and retest reliability of MAST.

Items	**Spearman**	**ICC**	**Kappa**
Test & Retest	0.93	0.92	0.31

There was a statistically significant differences in MAST score from test (M = 5.04, SD = 3.34) to retest (M = 5.71, SD = 3.31), t (37) = -3.17, p = 0.003 (two tailed). The magnitude of differences in the means (mean difference = -0.68, 95% CI: -1.11 to -0.24). The eta squared statistic (.21) indicated a small effect size (Table 6).

Table 6: Paired sample t-test result of MAST.

	Mean (SD)	**df**	**t**	**Sig.**	**Eta**
Test	5.04 (3.34)	37	-3.17	0.003	0.21
Retest	5.71 (3.31)				

4. DISCUSSION

The study shows that there is significant differences in score of MAST in time 1 (test) and time 2 (retest). A study found that there was a significant differences in odor identification and odor thresholds testing indicating there was an improvement in subjects' performance during retest session [8]. Other factors that might influenced the result and performance of participants during test and retest were the sensitivity of odours that have changed, the learning effect during interval, reduced number of test items, and the environmental factors such as season, differences of the examiners or any social distractions [9].

Test and retest of MAST were conducted in the participants' room thus they were distracted by the noises from other and the room was not well-ventilated. In previous study, the olfactory testing was done in a room that are well-ventilated with room temperature [6] and administration of Sniffin' Sticks were conducted in a quiet and well-ventilated rooms [10].

The intensity and concentration of the odours also alters the identification of odours especially when the raw materials were used. According to a study done, the odours will be less recognizable when the concentration is decreased. When the intensity of an odour reduces, the olfactory system entry may lead to a lack of information, which may negatively impact identification [11].

Moreover, participant who take medications prior to the test could also affect the olfaction system. Those with medication were more likely to complain that their sense of smell had decline compared to nonmedicated subjects [12].

Besides, there were more female participants' involved compared to male due in this study. Female rated the odour stronger, less cool, less irritating and more familiar compared to male [14].

This study shows that MAST has very strong relationship between test-retest of smell identification scores. Similar result was obtained in the test retest reliability of Iran-SIT where the Spearman's rank correlation coefficient indicates a very strong relationship and it is assumed that the test is reliable and stable over time [15]. The intra class correlation of MAST shows that there is an almost perfect agreement for both test and retest. A reliability study of Italian Olfactory Identification Test (IOIT) also shows an almost perfect agreement for both neurologist test and nurse retest and also for self-administration test and neurologist retest [16]. Kappa value indicates that there is a fair agreement. Any agreement less than perfect (1.0) not only the measure of agreement but also of disagreement between the raters and any kappa below 0.60 suggests inadequate agreement between the raters [17].

There are several factors that can influence smell such as age, gender, race or ethnicity, socioeconomic factor including family earnings and educational achievement, and also past history of asthma or cancer, smoking or being exposed to harmful substance, and light to moderate alcohol intake [13].

5. CONCLUSION

MAST is the first smell test that were developed and culturally appropriate for Malay population. Test and retest of MAST shows a significant differences but the time stability of MAST shows a very strong relationship between test and retest identification score, an almost perfect agreement and consistency of agreement and also a fair agreement between two time points on the response for the item.

The time stability appears to be consistent and reliable over time. There was no changes in odour identification during time interval. Therefore, MAST is a useful tools in screening for cognitive problem and predicting dementia but few improvements are needed in future study to improve the validity and reliability of MAST.

For future research, the manufacturing process of MAST by using test solution or microencapsulated fragrance to ensure a long-lasting odours, consistent test location for both tests, develop MAST based on the races, conduct on elderly people that live in both village and town area and in a bigger sample size to obtain more accurate result.

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