Research Article

The Modified Sniffin' Sticks Test in Turkish Population Based on Odor Familiarity Survey

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Summary

Objective: The current study aims to investigate the suitability of Sniffin' Sticks Test (SST) for Turkish normosmic population and make appropriate modifications in Sniffin' Sticks Odor Identification Test for use in Turkey.

Methods: Following the application of standard SST (N=147), an odor familiarity survey was applied (N=360) and used for construction and application of Modified Sniffin' Sticks Test for Turkish Population (MSST-T).

Results: Mean scores for SST were as follows: odor threshold 7.7±2.8, odor discrimination 12.7±1.9, odor identification 12.4±2.0, Total score (TDI; Threshold, Discrimination and Identification) 32.8±4.3. Odors that were not familiar to the population were determined by odor familiarity survey. The MSST-T was developed by replacing unfamiliar odors with more familiar ones in items with low identification scores. MSST-T was applied to 184 participants and identification scores were found to increase from %78.3 to %84.2 (p < .0001).

Conclusion: The odor familiarity as well as threshold, discrimination and identification measures of SST have been field-tested for normosmic population. With suitable modification of distracters in some identification test items, the test is expected to be reliably applicable for clinical use as well as for social, psychological and other research purposes in Turkey.

Key words: Smell, olfactory, odor familiarity, Sniffin' Sticks Test, cross-cultural application, odor identification

Özet

Amaç: Bu çalışmanın amacı Sniffin' Sticks Testini normosmik Türk toplumunda uygulama araştırması ve Sniffin' Sticks Koku Tanımlama Testinde gereken uygulamaları gerçekleştirmek için Sniffin' Sticks Testinin (SST) uygunluğunu araştırmak ve Sniffin' Sticks Koku Tanımlama Testinde gereken uygulamaları gerçekleştirmek. Çalışma iki aşamadan oluşmaktadır olup ilk aşamada standart Sniffin' Sticks Testinin uygunluğunu araştırdık. Bulunan sonuçlara göre Türk toplumunda kullanılan Sniffin' Sticks Testi (MSST-T) oluşturulduktan sonra uygulamalardaki tekrar uygulama yapılmıştır (N=184).

Yöntem: Çalışma iki aşamadan oluşmaktadır olup ilk aşamada standart Sniffin' Sticks Testinin (SST) uygunluğunu araştırdık. Bulunan sonuçlara göre Türk toplumunda kullanılan Sniffin' Sticks Testi (MSST-T) oluşturulduktan sonra uygulamalardaki tekrar uygulama yapılmıştır (N=184).

Bulgular: Standart Sniffin' Sticks (SS) Testi için ortalama değerler bulunmaktadır: Koku eşği: 7.7±2.8, koku ayardı etme 12.7±1.9, koku tanımlama: 12.4±2.0, Total değer (TDI; Threshold, Discrimination and Identification) 32.8±4.3. Popülasyonda tanınmayan koku tanınabilirlik anketi ile belirlenmiştir. Tanınabilirliği düşük olan maddelerde, aşınma olmuyan kokuların yerine, tanınma değeri yüksek olan kokuların yerleştirilmesi ile Uyarlanmış Sniffin' Sticks Testi (MSST-T) oluşturulmuştur. MSST-T yeni 184 katılmaya uygulanmış ve tanınabilirlik değerlerinin %78.3'den %84.2'e yükseldiği saptanmıştır (p < .0001).
Sonuç: Sniffin' sticks testinde yer alan kokuların tannabilirliği ile beraber Sniffin' sticks testinin koku eşği, ayırt etme ve tanımlama alt ölçümleri de Türk normosmik popülasyonda alan çalışması gerçekleştirilmiştir. Tanımlama test maddelerinin bazılarında bulunan çeldiricilerde gerçekleştirilen uygun uyarlamalar ile bu testin Türkiye'de gerek klinik, gerek sosyal, psikolojik ve diğer araştırma ortamlarda kullanıma uygunluğu artmıştır.

Anahtar Kelimeler: Koku, olfaktor, koku tannabilirliği, Sniffin' Sticks Testi, kültürler arası uygulama, koku tanımlama

INTRODUCTION
The sense of smell is important because of its effect on quality of daily life and for its vital contribution to survival in some unique situations. Awareness of danger signs such as fire, or discriminating toxic and rotting substances for eating food safely is all dependent on successful olfactory functioning. Also smell function has a compact relation with taste sensation: to enjoy a meal\(^8,24,25\). Furthermore, the change or loss of smell function has become an increasingly important issue targeting the identification or monitoring of neurodegenerative diseases\(^6\).

The assessment of odor identification plays an important part in the clinical evaluation of olfactory functioning simply because it is easily comprehended by both the patient and the investigator. Various smell tests are currently available around the world such as the University of Pennsylvania Smell Identification Test (UPSIT)\(^5\), Cross-Cultural Smell Identification Test (CCSIT)\(^4\), the test of Connecticut Clinical Chemosensory Research Center (CCCRC)\(^28\), The Scandinavian Odor-Identification Test (SOIT)\(^22\) and Sniffin' Sticks Test (SST)\(^15\). However there is no universal test applicable worldwide, because odor identification tests are problematic when used in different cultures. Research studies in different cultures show poor identification test scores due to variances in odor familiarity. The familiarity of an odor is dependent on personal experience and one of the most important factors contributing to this difference is cultural influence and environmental variables such as geographic location. For this reason, odor identification tests have been tested for convenience and then modified for different cultural regions\(^22,25\).

Sniffin' Sticks Test (SST) (Burghart Medical Technology, Wedel, Germany) was developed in Europe and is a psychophysical test of nasal chemosensory performance. It has three subtests: odor threshold, discrimination and identification. SST is one of the most widely used, reliable and valid test batteries\(^14,16\). SS Identification test was concluded to be applicable for use in Italian samples with no need for modifications\(^9\). On the other hand in countries/cultures such as Taiwan, Korea and Greece some odorants in identification test have been modified and replaced\(^2,17,25,29\). In Asian samples, unfamiliar odors like turpentine, cloves, and anise were either replaced with other odors or renamed\(^2,25,26\). Also in a study on British population and a previous study conducted in Turkey, some changes were proposed for distracters in items with low identification scores\(^20,23\).

There is currently no commercially available smell test specifically adapted for use in the Turkish population. For this reason we aimed to investigate the olfactory function of Turkish normosmik population with SST by specifically addressing results of odor identification, and if needed to plan appropriate cultural modifications in SST according to an accompanying odor familiarity survey.

MATERIAL AND METHODS
Test Material
**Sniffin' Sticks Test**

The pens are 14 cm long, with 1.3 cm diameter and they have a tampon which is filled with 4 ml liquid odorants dissolved in propylene glycol. For odor presentation the cap was removed by the experimenters for approximately 3 seconds and the pen's tip was placed approximately 2 cm in front of both nostrils. Applications were carried out in properly ventilated rooms with the use of odorless gloves and an eye mask. Participants who had a history of diabetes, thyroid dysfunction, high blood pressure, asthma, allergic rhinitis, sinusitis, prior nasal surgery or having cold, using any medication influencing the olfactory function, and participants found to be anosmic were excluded from the study. Additionally subjects who had a history of neurological or psychiatric disorder, head trauma or olfactory dysfunction were not included in the study. The screening of participants for olfactory disorders was carried out under the supervision of the Ear Nose Throat and Head & Neck Surgery Department and patients having signs of acute upper respiratory tract infection, allergic rhinitis or sinusitis were excluded from the study. Participants were asked not to smoke, eat or drink 20 minutes before testing. In all tests the forced choice technique was applied and participants were obliged to reply to each item. Application of the whole test took about 30-35 minutes. SST is comprised of 3 parts: (1) Odor Threshold Test (2) Odor Discrimination Test, and (3) Odor Identification Test

**Odor Threshold Test**

Odor threshold test has 16 triples of odor pens; in triples one pen has N-butanol in diluents while two others contain only the odorless diluents. The concentration ratios of N-butanol dilutions are presented in a geometrical series; number one being the most intense odor (4% N-butanol, dilution ratio 1:2). The given task was to find the pen having an odor. Subjects were blindfolded to prevent them from learning which pen was the target. Simple staircase method was used: The test began with the presentation of triples having the lowest concentration. Two successful responses constituted a reversal to the next lower odorant concentration; a single unsuccessful response constituted a reversal to the next higher concentration. Threshold test was completed when seven reversals were reached. The mean value of the last four reversal points was used as the threshold score. The lowest and highest possible threshold scores are 0 and 16 respectively.

**Odor Discrimination Test**

In odor discrimination, there are 16 triples of odor pens; in each triple two of them have the same odor while the third is different. Pens were presented in random order to the blindfolded subjects, and the task was to find the one with a different odor. The number of correct answers was accepted as the score of this test. The lowest and highest possible scores for this test are 0 and 16 respectively.

**Odor Identification Test**

In odor identification test 16 odorants were presented to the subjects and they identified each odor from a list of four descriptors. The number of correct answers was accepted as the score of this test. The lowest and highest possible scores for this test are 0 and 16 respectively.

Total score (TDI) was calculated as the sum of three subtest scores consisting of odor threshold, odor discrimination and odor identification tests.

**Procedure**

The procedure was comprised of two phases:

Phase I: The application of classical SST in Turkey

Phase II: Item by item analysis of SS Identification Test, application of odor familiarity survey and the application of modified SS Identification items in order
to develop a Modified Sniffin' Sticks Test for Turkey (MSST-T).

**Phase I**

**Application of SST in Turkish Population**

147 healthy participants (55 male, 92 female) completed SST successfully. The participants ranged in age from 10 to 55 years, with a mean age of 20.2±8.0 years. Participants completed a questionnaire with information about name, gender, age, smoking habit, disease history and judgments about their own smell function. Odor threshold, discrimination, and identification parts of the SST were applied to the participants.

**Phase II**

**Item by item analysis of Sniffin' Sticks Identification Test**

Percentage of participants with correct response on each item was investigated. Items which were found to have correct response percentage less than 75 were subjected to further analysis as indicated formerly in the literature\(^{12}\). For the items with correct response percentage less than 75, the percentage of responses corresponding to each choice was compared. The correct response percentage of the items compared to the response percentage corresponding to each distractor was analyzed with repeated measures of ANOVA test followed by Bonferroni post hoc analysis. The percentage of participants responding to the correct choice was expected to be significantly higher than the percentage of participants responding to the distracters.

**Odor Familiarity Survey**

In order to obtain reliable distracters an odor familiarity survey was planned. The survey was targeted to provide a basis to rule out cultural bias factor suggested to be one of the factors contributing to lower identifiability rates of certain odors in the original identification test. In order to determine the familiarity of the odors in the population studied, 360 healthy participants (160 male and 200 female) within an age range of 11 to 65 (mean age of 32.17±12.74) were surveyed. With the aim of ensuring the validity of the survey, and obtaining greater reliability in determining the cultural bias factor, the sample size was extended to include a greater number of people than those who originally took part in the application of SST and MSST-T. Furthermore the sample incorporated participants from a broader age range. Those who took part in the survey were requested to rank the odors in the identification list of SST on a self administered 1-5 numerical visual analog scale according to how familiar the odor was perceived. Numerical value 1 corresponded to not familiar at all while 5 corresponded to a perfectly familiar odor. Numerical values ranging from 1 to 5 were converted to scores out of 100 to obtain the familiarity score for each odor. Numerical values 1 and 5 corresponded to 0 and 100 respectively. Mean familiarity score was determined for each odor and Cronbach Alpha reliability analysis was conducted to determine the internal consistency of the scale.

**Modification of Odor Identification Test for Turkey (MSST-T)**

According to familiarity and identifiability results, some items (distracters) were changed upon a preset threshold. This threshold was set as 75% in identification score. When scores were lower than this threshold, new distracters were obtained from the odor familiarity survey on the basis of familiarity scores. Accordingly Modified Sniffin' Sticks Test for Turkey (MSST-T) was developed and applied to a different group of participants who did not take part in the previous application of the original version of SST.

**Application of MSST-T in Turkish Population**

This group was comprised of 184 (89 female, 95 male) participants between the ages of 10 and 55 (mean age: 26.49±10.34) and only identification part of the test was
applied to this group of participants. Statistical analysis of results between identifiability ratings in the original and modified versions were investigated by SPSS 11.0.1 (Statistical Package for Social Sciences, Inc., USA) with independent sample t-test\(^{(27)}\).

**RESULTS**

**Phase I: SST Results in Turkish Population**

Mean odor threshold was 7.7±2.8; mean odor discrimination score was 12.7±1.9; and mean odor identification score was 12.4±2.0. Mean of TDI score was 32.8±4.3 (Fig. 1).

**Phase II: Odor Familiarity Survey and Modification of SS**

**Odor Familiarity Survey**

Primarily, internal consistency of the scale was determined (Cronbach alpha= 0.94). Familiarity scores ranged from 16.6 to 93.4. The most familiar odors in Turkish culture are coffee (93.4), onion (92.4), garlic (92.0), fish (91.8), cigarette (91.8), spearmint/peppermint (90.6); the least familiar are fir (16.6), liquorice (30.4), rum (33.2), turpentine (34.4), ham (38.2), and rubber (40.3). We accepted the items with scores above 75 as having high familiarity (Fig. 2). For turpentine, 49.4% of participants answered “not at all”, 43.3% for rum and liquorice, 63.1% for fir and 30.8% for ham.

**Modified Odor Identification Test**

Analysis of Identification Test item by item and conducted trials for intended modifications:

At the end of the analysis, four pens (orange, turpentine, apple and pineapple) in the identification test were found to have correct response rate lower than 75% in the original version of SST (Fig. 3).

![Fig 1: Results of Sniffin’ Sticks Test in Turkish Population. The vertical bars denote the mean values in each category (threshold, discrimination, identification and TDI respectively). The vertical lines denote the error bars.](image)
**Fig 2:** Items in Sniffin’ Sticks Identification Test familiarity in Turkish population. The horizontal dashed line indicates the cut-off point (75). Items are presented in order of increasing familiarity; items in the lower sections have higher familiarity scores.

**Fig 3:** Percentage of correct responses in Sniffin’ Sticks Identification Test in Turkish population. The dark horizontal bars depict the scores from the original version of Sniffin’ Sticks Test. The modified items are shown with gray horizontal bars. The vertical line denotes the cut-off point for identification arbitrarily set to 75%. The bottom two bars provide the values for the overall (mean) scores which have increased to 84.2% from 78.3%. (p < .0001)
Pen 1: Orange was identified correctly by 57.1% of the participants. For Pen 1, it was suggested that apricot (familiarity score 71.6) could be used instead of pineapple, since 27.2% of participants misidentified the odor as pineapple and pineapple is not a fruit commonly consumed by the Turkish population (familiarity score 50.3). Also, instead of blackberry (familiarity score 51.3) peach (familiarity score 77.6) has been suggested for MSST-T. As a result of these modifications in Pen 1, orange was correctly identified by 76.6% of the participants; and this was significantly higher than the original version (57.1%) (p<0.01).

Pen 8: Turpentine (a scent which was not known by many people in Turkey as 49.4% of the population surveyed claimed they did not know the scent of turpentine at all with a familiarity score of 34.4%) had a very low correct response percentage of 49.7%. Since 29.9% of participants misidentified the scent as menthol, it was decided that thyme (familiarity score 88.0) can be used in place of the second distracter menthol (familiarity score 86.9). This modification improved the correct response rate from 49.7% to 60.3% in Pen 8. This difference was found to be marginally significant (p=0.05).

Pen 11: Apple which had the lowest identifiability was correctly identified by only 31.3% of the participants. There was no significant difference between the percentage of participants who correctly identified the scent in pen 11 as apple and those who wrongly identified the scent as either melon (32.7%) or peach (32%). Therefore rose (familiarity score 88.0) and cookies (familiarity score 72.4) were chosen to be used instead of melon (familiarity score 86.0) and peach (familiarity score 77.6) as distracters. These modifications increased the identifiability of apple from 31.3% to 66.8% and this increment was statistically significant (p<0.001).

Pen 13: Pineapple (which is not a familiar scent for most of the Turkish population) was correctly identified by 72.8% of the participants. Cherry (familiarity score 59.3) and lemon (familiarity score 81.7) were selected to be used as distracters instead of peach (11.6%) and pear (11.6%), which had familiarity scores of 77.6 and 72.0 respectively and were observed to be misidentified instead of the target odor pineapple. These modifications increased the identifiability of pineapple from 72.8% to 84.8% which was statistically significant (p<0.05).

As rum and fir, with familiarity scores of 33.2 and 16.6 respectively, were found to be less known in Turkey, tea and pine, with familiarity scores of 84.0 and 74.5 were suggested to be assigned in their place as distracters in Pen 4 and Pen 15. However this did not affect the identifiability of target odors in a positive way; in fact, correct response rates for these items were found to decrease. Therefore no modifications were applied for pen 4 and pen 15.

Pen 16: Ham had a familiarity score of 38.2 for Turkish people. As the closest familiar item, salami (familiarity score 59.9) was selected to be used instead of ham. Although this replacement did not have an effect on identifiability scores distracter ham was changed with a more familiar scent of salami according to the results of odor survey. As a result of these trials Modified Odor Identification Test was developed for the Turkish population (Table I).
Table 1: Modified odor identification test in Turkish population. Modified items are shown in bold. Both old and modified items are presented below.

<table>
<thead>
<tr>
<th>ITEM NUMBER</th>
<th>ODOR</th>
<th>DISTRACTER -1</th>
<th>DISTRACTER -2</th>
<th>DISTRACTER -3</th>
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<tr>
<td>1</td>
<td>ORANGE</td>
<td>STRAWBERRY†</td>
<td>PEACH†</td>
<td>APRICOT†</td>
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<td>2</td>
<td>LEATHER</td>
<td>SMOKE</td>
<td>GLUE</td>
<td>GRASS</td>
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<td>CHOCOLATE</td>
<td>VANILLA</td>
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<td>PEPPERMINT</td>
<td>CHIVE</td>
<td>FIR</td>
<td>ONION</td>
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<td>BANANA</td>
<td>COCONUT</td>
<td>WALNUT</td>
<td>CHEERRY</td>
</tr>
<tr>
<td>6</td>
<td>LEMON</td>
<td>PEACH</td>
<td>APPLE</td>
<td>GRAPEFRUIT</td>
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<td>SPEAREMBT</td>
<td>CHEERY</td>
<td>COOKIES</td>
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<td>TURPENTINE</td>
<td>MUSTARD</td>
<td>THYME†</td>
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<td>9</td>
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<td>ONION</td>
<td>SAUERKRAUT</td>
<td>CARROTS</td>
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<td>CIGARETTE</td>
<td>WINE</td>
<td>SMOK</td>
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<td>APPLE</td>
<td>ROSE†</td>
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<td>COOKIES†</td>
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<tr>
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<td>CHERRY†</td>
<td>LEMON†</td>
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<td>HONEY</td>
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<td>16</td>
<td>FISH</td>
<td>BREAD</td>
<td>CHEESE</td>
<td>SALAMI†</td>
</tr>
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DISCUSSION

Our mean scores of 7.7±2.8 for odor threshold and 12.7±1.9 for odor discrimination are within normative data given for SST in normosmic populations(13). However odor identification score of 12.4±2.0 in our study was lower than normative data obtained in other countries, supporting the assertion that culture and odor familiarity is effective on odor identification performance(2,3,18,22,24-26). A recent article evaluating olfactory function in Turkish population with SST was published while our study was still conducted. The results of this study are also in harmony with our findings where olfactory scores were found to be lower than other countries; and odor identification showed variability, suggesting cultural differences affecting the identification of some odors(23).

Every region has its own culture, nutritional habits and different substances utilized or encountered in daily life. Thus odor familiarity and odor identifiability varies from region to region. As identification scores obtained in our study were lower than expected standard norms, we decided to analyze our olfaction identification test results on a pen by pen basis. This analysis revealed four pens (orange, turpentine, apple and pineapple) with a correct response rate lower than 75% and further modifications were planned for those pens with low smell identification scores. In order not to change the original set up of SST; a modification plan was made fundamentally consisting of keeping the original target odors in place and replacing some distracters with more suitable one's for our culture.

Orange in first pen had a high score of familiarity but its identification score was low. The use of blackberry and pineapple as distracters, which have rather low familiarity scores in our culture, were thought to be one of the factors responsible for this outcome. This view was also supported by the fact that the odor was mostly misidentified as pineapple. After changing these distracters with apricot and peach a statistically significant increase in identification score was observed.
Research studies in Taiwan, Korea, Greece, and a previous study in Turkey reported low identification scores for turpentine\(^{(2,7,23,25)}\). Shu et al suggested using the name of tiger balm instead of turpentine and replaced the odor in another version (Veterans General Hospital\(^{(25,26)}\)). In modification of SST in Korea, Cho et al changed the target odor turpentine into resin\(^{(2)}\). In the Greek population, turpentine was found to have low identifiability in the UPSIT, CC-SIT, SST, and concluded to be an unsuitable target odor for use in Greece\(^{(7,17)}\). Similarly in this study both the familiarity score and identifiability of turpentine was low. Since turpentine was observed to be mostly misidentified as menthol, we replaced menthol with thyme. As a result of this modification identifiability of turpentine was improved.

The presence or the nature of certain odorous substances may vary from region to region. For example a certain fruit may have a stronger and fruitier smell in one geographic region and a weaker and more neutral smell in some other location. This is what may have been observed for the misidentification of the apple odor in pen 11. In this study the familiarity score for apple was found to be high; however it's identifiability was low (31.3%). Similarly a previous study using SST in Turkey also found the identifiability of apple to be low (36%)\(^{(23)}\). Exposure to the scent of apple in the Turkish population is quite high; 71.4% of the population surveyed claimed to be able to identify the scent either perfectly (41.7%) or very well (29.7%). Identifiability of an odor depends on past experience; the odor has to be encountered before and an association needs to be established between the memory of the odor and its name\(^{(1,10)}\). Therefore errors made in identifying the scent of apple in pen 11 may be concluded to be resulting from the different nature of the odor of apple in Turkey. We suggested the use of odors which do not belong to fruits (e.g. cookies, rose) as distracters instead of peach and melon. This was found to improve the identifiability of apple item significantly.

Pineapple in pen 13 is not a fruit commonly consumed in Turkey. Therefore the odor of pineapple is unfamiliar to most of the Turkish population and can be confused with other fruit's odors. Distracters consisting of pear and peach were not easily discriminated from pineapple's target odor in the original version of SST. For this reason other fruit odors (cherry and lemon) were replaced as distracters. This modification improved identifiability of the target odor significantly.

We also suggest changing distracters which were found to be unfamiliar or culturally irrelevant. For example we suggested the use of the word salami instead of ham, for the third distracter in pen 16 since 30.8% of the population surveyed claimed that they did not know the scent of ham at all. Furthermore the use of ham has been defined to be problematic for some cultural and religious reasons by Heilmann et al\(^{(12)}\). Fir which appears as a distracter in pens 4 and 15, has the lowest score of familiarity (16.6); however use of the distracter pine tree instead of fir did not improve the identifiability of target odors, therefore the distracter fir remained unchanged.

In the modification of odor identification tests for use in different cultures various studies have either changed incorrectly identified target odors with more familiar odors for that culture\(^{(2,26)}\), changed the label names of target odors\(^{(16)}\) and/or only changed the distracters\(^{(2,17,26,29)}\) or changed both target odor labels and distracters\(^{(25)}\). Distracters have important role in identification tests, and modification of distracter names is a method which has been effectively employed in the adaptation of smell identification tests in other cultures as well\(^{(11,19,25,26)}\). As observed in many studies even unfamiliar target odors may be correctly identified by means of eliminating distracter odors.
which are more familiar (25,26). This observation was also confirmed in our study by a high rate of correct identification for target odor liquorice in spite of its low (30.4%) familiarity score. Participants were able to find the correct response by eliminating other well known distracters such as: “This is not spearmint, not cherry, not cookies, then it should be liquorice”. Therefore we also propose to modify distracter labels while saving main target odors for maintaining the original battery of olfaction tests when making modifications according to cultural requirements. With suitable modification of distracters as mentioned above; the percentage of correct responses for odor identification have also increased from 78.3% to 84.2% (p<0.0001).

Consequently, our results support that this proposed MSST-T can be regarded as an appropriate, reliable and valid test to be used in Turkey and to our knowledge this is the first study recommending appropriate modifications in SST for our geographical region. It would also be interesting to further investigate whether these modifications would be applicable from south Eastern Europe to Middle East due to historical and cultural interactions. Finally this approach can be used for new cultural and adaptive studies in behavioral olfaction field as olfaction analysis is becoming a new emerging field in various conditions such as neurodegenerative diseases (e.g. Parkinson, Alzheimer etc).

Acknowledgement

The authors appreciate the advice and comments of Prof. Dr. Thomas Hummel during the study design and manuscript preparation; and Tugce Bezircioglu, Merve Tetik, Cagdas Guducu, Cansu Ciftci for their assistance in data collection and editing of manuscript. The study was supported by DEU.2008-KB.SAG.019, TUBITAK-108S113 projects.

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Received by: 18 September 2012
Revised by: 29 January 2013
Accepted: 15 February 2013

The Online Journal of Neurological Sciences (Turkish) 1984-2013
This e-journal is run by Ege University Faculty of Medicine, Dept. of Neurological Surgery, Bornova, Izmir-35100TR as part of the Ege Neurological Surgery World Wide Web service.
Comments and feedback: E-mail: editor@jns.dergisi.org
URL: http://www.jns.dergisi.org
Journal of Neurological Sciences (Turkish)
Abbr: J. Neurol. Sci.[Turk]
ISSNe 1302-1664

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