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Original article

Adaptation of the Sniffin' Sticks Test in South-Kivu

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ABSTRACT

Aim: The "Sniffin' Sticks" test is widely used in Europe as a standard test to assess olfaction. Several culturally-adapted versions have been developed. However, no version adapted to Sub-Saharan African populations exists. The aims of the present study were (1) to assess the applicability of the Sniffin' Sticks test in the population of South Kivu (DR Congo), and (2) to develop a culturally adapted version with normative values.

Materials and methods: In a first study, 157 volunteers were tested with the original Sniffin' Sticks test. Based on these results, we selected odors that were poorly recognized in the identification test and replaced them by culturally adapted odors. In a second study, we assessed the modified version of the Sniffin' Sticks test in 150 volunteers and defined normative values.

Results: In the first study, we found that olfactory function (threshold-discrimination-identification: TDI score) significantly decreased with age and was better in females. Five odors were poorly recognized and were replaced by culturally adapted odors. In the second study, we found that this adapted version led to a higher rate of correctly identified odors. We defined normative values for the South-Kivu population (TDI score: 18–35 years: 30.4 ± 6.0 ; 36–55 years: 26.2 ± 5.3 ; > 55 years: 25.6 ± 5.0).

Conclusion: This culturally adapted version of the Sniffin' Sticks test is culturally adapted to the South Kivu population. The normative values will provide the basis for clinical evaluation of pathologic subjects.

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1. Introduction

Olfaction is an essential sense, playing a major role in detecting dangers in the environment, and regulating dietary intake, social behavior, well-being and many cognitive phenomena [1]. Recent studies showed that olfactory disorder is very common, affecting up to 20% of the general population [2]. Individuals may not always be aware of such impairment, but it still severely impacts their quality of life [3]. It is consensual that assessment requires a precise work-up of olfactory function to determine etiology, adapt treatment, establish prognosis and guide counseling.

Most studies of olfactory assessment have been conducted in Caucasian populations, with little research in Africa. Olfactory assessment in African countries runs up against a major problem: cultural difference. Cultural factors have been clearly shown

to strongly impact the results of odorant identification tests [4,5], which therefore needing adapting to the population being studied. The American UPSIT (University of Pennsylvania Smell Identification Test) has been adapted in many countries in Asia and South America and in Australia [6–9]. A cross-cultural test was also developed using odors familiar to subjects from North America, Europe, South America and Asia [8]. To our knowledge, however, there have been no studies of test adaptation to Sub-Saharan African populations, although this would be valuable as the historical context and migratory flow mean that many people of African origin emigrate to Europe.

The present study aimed to assess the applicability of the Sniffin' Sticks test [10], a validated and widely used psychophysical olfaction test, in an African population, and to adapt it to the Congolese population of South Kivu.

2. Materials and methods

Two transverse studies included 307 adult volunteers living in the city of Bukavu in South Kivu, Democratic Republic of Congo

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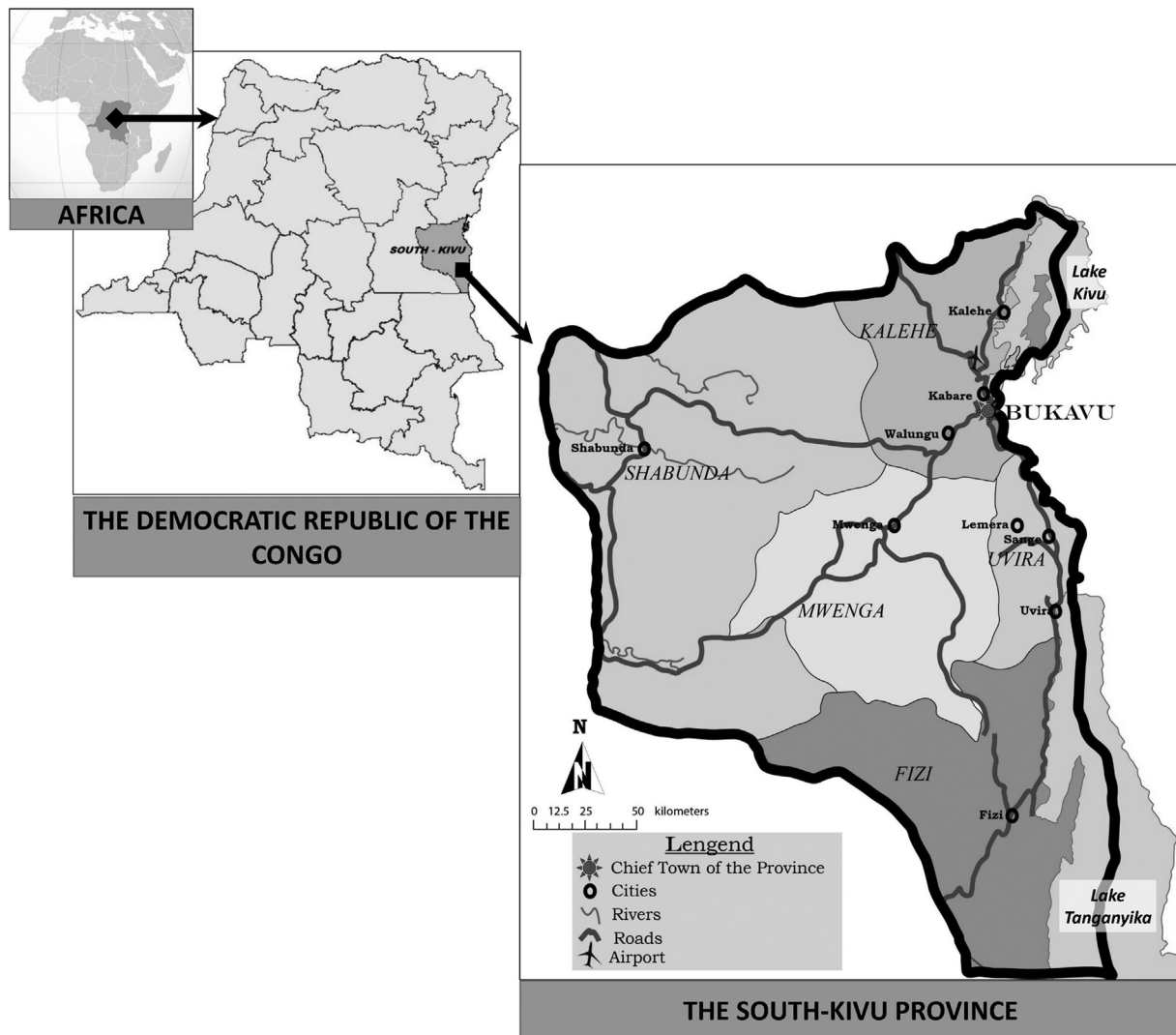


Fig. 1. Location of South Kivu Province.

(Fig. 1), reporting normal olfaction. 157 (76 male, 81 female) were tested with the original version of the Sniffin' Sticks test [10] (Burghart Technology, Wedel, Germany) and 150 (76 male, 74 female) with the culturally adapted version; the study was approved by our institutional review board. Signed informed consent was obtained, in line with the Declaration of Helsinki II.

History taking and full ENT examination were performed. Subjects were asked if they had qualitative (parosmia, phantosmia) and/or quantitative olfactory complaints (anosmia, hyposmia) or rhinologic symptoms; if so, the subject was excluded. Exclusion criteria also comprised history of head trauma or of sinonasal, neurologic or psychiatric pathology.

Nasal cavity examination comprised anterior rhinoscopy and flexible endoscopy. Any serious anatomic abnormality or signs of mucosal inflammation were exclusion criteria. The final cohort thus comprised 307 subjects.

Olfactory function was assessed on the Sniffin' Sticks Test [10], a validated psychophysical instrument assessing olfactory function, with established normative values. Odorants are presented as impregnated pens about 2 cm from the nostril. Stimulation is bilateral. Here we used the "extended" version of the test, assessing 3 criteria, following the methodology described by Hummel et al. [10]:

- detection threshold (T) was assessed using various concentrations of n-butanol. Three sticks were presented, 1 with n-butanol and 2 with an odorless substance. There were 16 levels of dilution, for each of which the subject had to identify which of the 3 sticks presented the odorant. Thresholds were determined on 7 stepwise trials and calculated as the mean score on the last 4 tests, scored out of 16;
- discrimination (D) was assessed by asking the subject to discriminate which of 3 sticks contained an odor different from the other 2, on a forced choice procedure. 16 triplets were presented, with 1 point per correct response, for a score out of 16;
- identification (I) was assessed by asking the subject to identify the presented odor on a forced choice between 4 options, presented simultaneously verbally and as images. 16 odors were presented, with 1 point per correct response, for a score out of 16;
- composite "TDI" scores out of 48 were calculated by summation.

The first study assessed olfaction on the original Sniffin' Sticks test. Odorants with < 40% identification were considered problematic, needing adaptation to the study population.

In the second study, these problematic odorants were changed, so as to adapt the test to the South Kivu population. In a first step (Test 1), only the distractors (alternative responses in the multiple

choice identification test) were changed, keeping the original odors. Then, in a second step (Test 2), not only the distractors but also the problematic odors were changed in favor of culturally adapted odors. All subjects in this second study underwent both tests, at a 48-hour interval. The detection threshold and discrimination tests were not altered.

Statistical analyses used SPSS software (version 17.0). Quantitative data were reported as mean, standard deviation and range, and qualitative data as number and percentage. Means were compared on ANOVA with post-hoc Bonferroni correction. Numbers were compared on Chi² test. The significance threshold was set at $P < 0.05$.

3. Results

3.1. Study 1. Applicability of the Sniffin' Sticks test in a normal population in South Kivu

This study used the original Sniffin' Sticks test (threshold, discrimination and identification).

157 healthy volunteers were included: 76 (48.4%) male, 81 (51.6%) female; mean age 36.3 ± 15.0 years (range, 18–75 years). The sample was divided into 3 age groups: 18–35 years ($n=88$), 36–55 years ($n=45$) and >55 years ($n=24$).

Overall mean TDI score was 27.7 ± 4.4 : 28.5 ± 4.1 in 18–35 year-olds, 28.2 ± 4.1 in 36–55 year-olds and 24.1 ± 4.3 in >55 year-olds.

Analysis of age effects on T, D, I and TDI scores found significant differences for T ($P=0.023$), D ($P=0.001$) and TDI ($P<0.001$), but not for I ($P=0.116$). Post-hoc analyses showed:

- T: 36–55 versus >55 years, $P=0.033$; 18–35 versus >55 years, $P=0.040$; 18–35 versus 36–55 years, $P=0.040$;
- D: 36–55 versus >55 years, $P=0.001$; 18–35 versus >55 years, $P=0.012$; 18–35 versus 36–55 years, $P=0.012$;
- TDI: 36–55 versus >55 years, $P=0.000$; 18–35 versus >55 years, $P=0.010$; 18–35 versus 36–55 years, $P=0.010$.

Analysis of gender effects on T, D, I and TDI scores found a significant difference only for I ($P=0.018$).

The identification test showed that banana, garlic, fish, pineapple, rose, mint, apple, coffee and lemon odors had identification rates $>60\%$, while cinnamon, turpentine, clove, aniseed and licorice had rates $<40\%$; these 5 were therefore changed for Study 2 (Fig. 2).

3.2. Study 2. Adaptation of the Sniffin' Sticks test to the normal South-Kivu population

150 subjects were included in Study 2: 76 (50.7%) male, 74 (49.4%) female; mean age, 35.8 ± 15.1 years (range, 18–75 years).

3.2.1. Test 1: Changes in distractors

Keeping the original Sniffin' Sticks odors, distractors were changed for the 5 poorly identified odors ($<40\%$: cinnamon, turpentine, clove, aniseed and licorice), in favor of distractors that would be more familiar in South Kivu (Fig. 2, Table 1).

Mean TDI score was 26.7 ± 5.4 : 28.7 ± 5.0 for 18–35 year-olds, 24.8 ± 4.8 for 36–55 year-olds and 23.2 ± 4.8 for >55 year-olds (Table 2).

Analysis of age effects on T, D, I and TDI scores found significant differences for T ($P=0.055$), D ($P<0.001$) and TDI ($P<0.001$). For TDI, post-hoc analysis found a significant difference between 36–55 and >55 year-olds ($P<0.001$). There was no significant age effect on I.

No scores were affected by gender (Table 2).

Modifying the distractors improved odor identification: licorice, 32% vs. 47%; aniseed, 23% vs. 47%; clove, 15% vs. 39%; turpentine,

Table 1

Odors and distractors in the final adapted version of the Sniffin' Sticks test.

Odor	Distractor #1	Distractor #2	Distractor #3	Distractor #4
Orange	Orange	Mango	Strawberry	Pineapple
Leather	Smoke	Glue	Leather	Grass
Honey	Avocado	Peanut	Chocolate	Honey
Mint	Incense	Mint	Cypress	Onion
Banana	Coconut	Banana	Peanut	Guava
Lemon	Mango	Apple	Lemon	Grapefruit
Ginger	Ginger	Guava	Mint	Biscuit
Eucalyptus	Celery	Rubber	Menthol	Eucalyptus
Garlic	Onion	Chilli	Garlic	Carrot
Coffee	Cigarette	Coffee	Wine	Smoke
Apple	Tomato	Mango	Orange	Apple
Onion	Onion	Pepper	Honey	Celery
Pineapple	Papaya	Plum	Mango	Pineapple
Rose	Tea	Strawberry	Rose	Guava
Smoked meat	Smoked meat	Beer	Coffee	Cypress
Fish	Bread	Fish	Cheese	Sausage

14% vs. 30%; and cinnamon, 5% vs. 57%); Even so, clove, lemon and turpentine failed to reach 40% identification.

3.2.2. Test 2: Changes in odors

The 5 odors with $I < 40\%$ (cinnamon, turpentine, clove, aniseed and licorice) were replaced by 5 odors better known in South Kivu: ginger, honey, eucalyptus, onion, smoked meat), with new distractor responses (Fig. 2, Table 1).

Overall mean TDI was 28.5 ± 6.0 : 30.4 ± 6.0 for 18–35 year-olds, 26.2 ± 5.3 for 36–55 year-olds and 25.6 ± 5.0 for >55 year-olds (Table 2).

Analysis of age effects on TDI found a significant difference ($P<0.001$). Post-hoc analysis found a significant difference between 36–55 and >55 year-olds ($P=0.002$).

There was no significant impact of age on I.

I scores were significantly better in females (Table 2).

After replacing the 5 problematic odors by 5 adapted odors, all odors were identified by $>40\%$ of subjects.

4. Discussion

The present results agree with the literature that olfactory capacity declines with age and is generally better in females.

Age significantly impacted odor detection threshold, discrimination, identification and overall olfactory capacity (TDI), with significant decline after 55 years of age. This is borne out by similar studies in various countries (Germany [10], Poland [11], Turkey [12], Greece [13], China [14] and Australia [15]), with TDI scores significantly lower in older than younger subjects.

There was also a significant gender effect, with women showing significantly better odor identification. This likewise was confirmed elsewhere [10,12–15].

The identification test needed to be adapted, as it is obvious that this is strongly dependent on culture, odor familiarity and dietary habits. For example, several odors are familiar in Europe (e.g., clove) but not in Africa. The present results (Fig. 2) showed very poor identification of odors unfamiliar to Sub-Saharan populations: cinnamon, 5%; turpentine, 14%; clove, 15%; aniseed, 23%. It is also interesting that some other odors, although familiar, scored poorly: orange, 43%; leather, 45%; lemon, 55%. The problem here was not the odor itself, but distractors that were unknown or confusing.

The detection threshold test was not altered, as it entails little in the way of cognitive processing and is unlikely to show major cultural influence. The discrimination test was not altered either, although discrimination tests are known to involve high-level cognitive processing, to form a transient odor representation

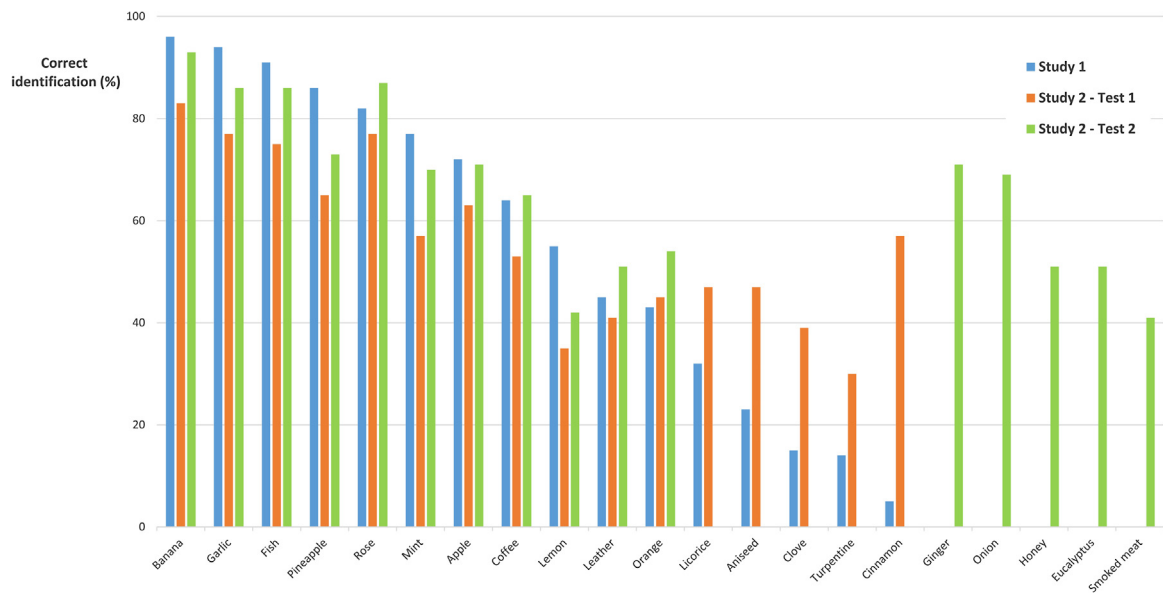


Fig. 2. Odor identification rates.

Table 2 Descriptive statistics for threshold (T), discrimination (D), identification (I) and overall TDI scores in study 2.

	Male						Female					
	T	D	I (test1)	I (test2)	TDI (test1)	TDI (test2)	T	D	I (test1)	I (test2)	TDI (test1)	TDI (test2)
18-35 years												
1 N	43	42					8,6	11	8	11	27	30
2 Mean	8.5	11.2	11	11	30	31	8,6	11	8	11	27	30
3 Standard deviation	3	3	3	3	5	6	2,3	3	4	3,4	5	6,4
4 Median	8	11	12	11	30	30	8	12	7	11	27	29
5 Minimum	3	6	2	7	17	18	5	3	2	4	17	17
Maximum	15	16	15	16	45	46	15	15	14	16	43	42
36-55 years												
1 N	21	20					8	9,2	10	11	26	28
2 Mean	7,2	8,2	8,6	10	24	24	8	9,2	10	11	26	28
3 Standard deviation	2,4	3	2,3	2	5	6	3	3	3	2,3	5	4
4 Median	8	8	8	10	24	25	8	9	10	11	26	27
5 Minimum	2	3	4	6	16	7	1	4	1	7	14	22
Maximum	11	15	14	14	32	32	11	15	15	15	35	39
≥56 years												
1 N	12	12					8	8	8	10	24	26
2 Mean	7	7	7	10	22	25	8	8	8	10	24	26
3 Standard deviation	3	2	2	2	5	5	3	3	2	2	5	5
4 Median	9	7	8	10	23	26	7	8	8	11	22	25
5 Minimum	2	4	3	6	13	14	5	5	5	7	21	21
Maximum	11	11	10	13	27	30	14	15	11	14	39	40

for comparison and use it to select an odor among the distractors. This involves semantic and executive memory [16]. Moreover, in qualitative discrimination tests, identifying odor quality may be a prerequisite for effective discrimination. It is thus possible that the discrimination capacity of the present study population was slightly poorer than in a European population. This is why it is important to use adapted normative values.

Various studies have developed culturally adapted versions of the Sniffin' Sticks test, modifying either the distractors or unfamiliar odors in the identification test. Studies in British [17], Greek [18], Turkish [12], Taiwanese [19], Asian [5] and Egyptian populations [20] adapted the identification test by changing problematic distractors, without changing the odors. Studies in Korea [21,22], on the other hand, adapted the identification test by replacing unfamiliar odors by culturally adapted ones. Whatever the methodology, all these studies showed that cultural adaptation improves results compared to using the original test. Normative values have been determined for these various populations.

We used a similar approach to adapt the Sniffin' Sticks test to South Kivu, and determined normative values for this population. Like in the above-mentioned adaptation studies, we found that:

- providing familiar distractors, without changing the odor;
- replacing problematic odors by familiar ones significantly improved identification scores.

Odor replacement was more effective than simply changing distractors: in study 2, the TDI score was better on test 2 than test 1. We therefore took the test 2 values as normative for our population: 30.4 ± 6.0 for 18-35 year-olds, 26.2 ± 5.3 for 36-55 year-olds, and 25.6 ± 5.0 for > 55 year-olds.

These values are very close to those recently reported in a large Caucasian population, which confirms the changes made to improve test quality, adapting it socioculturally to the study cohort [10].

5. Conclusion

The present study was the first to assess the applicability of the Sniffin' Sticks test in a Sub-Saharan African population. We created a culturally adapted version, with normative values specific to South Kivu in the Democratic Republic of Congo. This opens the way for future clinical studies. It would, however, be useful to confirm the present results in a larger sample.

Disclosure of interest

The authors declare that they have no competing interest.

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