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Development of a Simplified 12-Odor Santo Tomas Smell Identification Test

Cedric Jonathan C. Ng, MD
Lloyd Paolo R. Crizaldo, MD
Ryan U. Chua, MD

Department of Otorhinolaryngology
Head and Neck Surgery
University of Santo Tomas Hospital

ABSTRACT

Objective: To develop a shorter, culturally relevant set of candidate odorants from the Santo Tomas Smell Identification Test (ST-SIT) for contemporary Filipino adults using odor familiarity, correct identification performance, and descriptive item-discrimination analysis, and to update its scoring framework.

Methods:

Design: Cross-Sectional Study

Setting: ORL-HNS Outpatient Clinics (private and clinical divisions) in a Tertiary Private University Hospital

Participants: Patients aged ≥ 5 years, born and raised in the Philippines, with no olfactory complaints seen at the University of Santo Tomas Hospital outpatient clinics were included. Those with altered consciousness, psychiatric illness, allergy to the underlying material where odorants are sourced, on oxygen supplementation, known olfactory dysfunction, nasal symptoms or treatments affecting smell (e.g., rhinitis, chronic rhinosinusitis, recent URTI), prior head and neck surgery or injury, history of radiotherapy or chemotherapy, and pregnancy were excluded. Primary item-retention analysis was restricted to adults aged ≥18 years; participants younger than 18 years were retained only for descriptive developmental analyses.

Results: A total of 90 participants were included, 54 women and girls (60.00%) and 36 men and boys (40.00%) with a mean age of 38.28 (SD=19.65). Four participants were aged 5–11 years (4.44%), 10 were aged 12–17 years (11.11%), and 76 were adults aged ≥18 years (84.44%). Regardless of age group, the most familiar odors were orange ($\bar{x}$=6.76, SD=0.43), vinegar ($\bar{x}$=6.71, SD=0.64), onion (*Allium cepa*) ($\bar{x}$=6.47, SD=1.00), fish sauce (*patis*) ($\bar{x}$=6.44, SD=1.10), banana ($\bar{x}$=6.42, SD=1.05), garlic (*Allium sativum*) ($\bar{x}$=6.41, SD=0.92), chocolate ($\bar{x}$=6.38, SD=0.93), soy sauce ($\bar{x}$=6.36, SD=1.09), pineapple ($\bar{x}$=6.29, SD=0.93), and fermented shrimp paste (*bagoong)* ($\bar{x}$=6.27, SD=0.92). On the other hand, the least familiar odors were tea ($\bar{x}$=3.96, SD=1.20), povidone-iodine ($\bar{x}$=4.02, SD=1.24), hot sauce ($\bar{x}$=4.07, SD=1.14), mustard ($\bar{x}$=4.12, SD=1.36), vitamin C syrup ($\bar{x}$=4.36, SD=1.28), almond ($\bar{x}$=4.50, SD=1.42), laurel leaf *(Laurus nobilis)* ($\bar{x}$=4.58, SD=1.85), caramel ($\bar{x}$=4.94, SD=1.20), vanilla ($\bar{x}$=5.11, SD=1.73), and brandy ($\bar{x}$=5.14, SD=1.48). Among the most correctly identified odorants were garlic (n=85, 94.44%), fish sauce (*patis*) (n=85, 94.44%), orange (n=85, 94.44%), onion (n=83, 92.22%), and chocolate (n=83, 92.22%). The odors that were least correctly identified included almond (n=40, 44.44%), povidone-iodine solution (n=42, 46.67%), vitamin C syrup (n=44, 48.89%), tea (n=45, 50.00%), and sampaguita (*Jasminum sambac*) (n=45, 50.00%). In the adult analysis (participants aged ≥18 years), 13 odorants had a mean familiarity rating ≥6.0; 12 of these also had correct-identification rates ≥70% and formed the provisional candidate panel: orange, banana, pineapple, chocolate, vinegar, soy sauce, fish sauce (*patis*), apple, onion, pepper, fermented shrimp paste (*bagoong*),

Correspondence: Dr. Lloyd Paolo R. Crizaldo
Department of Otorhinolaryngology
Head and Neck Surgery
University of Santo Tomas Hospital
España Blvd., Sampaloc, Manila 1015
Philippines
Phone: +63 917 566 4676
Email: lloydpao@gmail.com

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and garlic. Quartile-based discrimination indices among adults ranged from –0.125 to 0.250, with substantial ceiling effects for several highly familiar, frequently identified items.

Conclusion: The simplified 12-odor ST-SIT is a practical, culturally updated screening instrument based on the original 45-odor version. Adult-based screening identified a culturally relevant 12-odor candidate set for further ST-SIT refinement. A simple equal-weight raw score (0 – 12) is proposed for subsequent validation, but currently no diagnostic cut-off has been established. Because item discrimination was limited by ceiling effects in this asymptomatic cohort and no clinically confirmed olfactory dysfunction group or external reference test was included, the candidate panel should not yet be considered a finalized or diagnostic instrument. Prospective validation, test–retest and inter-administrator reliability assessment, perceptual-intensity standardization, and diagnostic-accuracy testing are required before clinical cutoffs or routine diagnostic use are proposed.

Keywords: *olfaction; smell; olfactory disorders; odorants; anosmia; cultural characteristics*

The sense of smell plays an important role in our daily life. Olfaction contributes to personal safety, nutrition, and quality of life; yet patients may not easily recognize or accurately report olfactory impairment.[1-3] Regalado and colleagues found that while self-reported olfactory dysfunction (OD) approximates objective testing, discrepancies remain that limit its diagnostic accuracy.[2] Furthermore, other local literature shows that Filipinos with OD – even in those with mild cases – experience a diminished quality of life.[3] Standardized quantitative psychophysical testing is therefore important in clinical and research assessment.[1-3]

Widely used instruments include the Sniffin' Sticks Test Battery and the University of Pennsylvania Smell Identification Test (UPSIT).[4,5] Odor identification, however, depends on prior exposure and semantic familiarity to the stimuli. Consequently, culturally unfamiliar odorants may lower performance irrespective of peripheral olfactory function. Culturally adapted tests have, therefore, been developed in several countries worldwide.[4-10] The 45-odor Santo Tomas - Smell Identification Test (ST-SIT) was developed in 1994 specifically for Filipino patients.[11] Since its development, it has been the only locally-produced smell identification test used in Philippine ENT practice and research.[12,13] However, changes in consumer products and dietary exposure, the presence of potentially noxious items, seasonal availability of several odorants, the administration burden of a 45-odor test and its arbitrary probability-weighted scoring system have reduced its practicality. Shorter odor-identification tests may improve feasibility when item selection is empirically informed.[14] To date, no such revision has been performed on the ST-SIT.

This study aimed to develop a simplified version of the ST-SIT by identifying candidate odorants through reassessing familiarity and identification performance in a contemporary Filipino outpatient sample and by removing odorants that were hazardous, outdated, inconsistently available, poorly familiar and or poorly identified. In response to developmental differences in odor familiarity and identification, final item screening was conducted only for adults aged ≥18 years, while pediatric observations were retained descriptively. The study was designed as an item-reduction and preliminary psychometric evaluation, not as a diagnostic accuracy study.

METHODS

With the University of Santo Tomas (UST) Research Ethics Committee approval (REC-2021-06-078-TR-FR), this cross-sectional study considered for inclusion individuals who were born in the Philippines and considered the Philippines as their primary country of residence, were aged 5 years and older, who consulted at the ORL-HNS outpatient clinics of the private and clinical divisions of the UST Hospital between August and September 2022. Those with, known psychiatric problems**,** known allergy to any of the odorant source materials, who were oxygen supplemented**,** with subjective hyposmia or anosmia, history of nasal symptoms and or those currently being treated for such problems that could interfere with olfactory performance (e.g. allergic and non-allergic rhinitis, chronic rhinosinusitis, recent upper respiratory tract infection, or any other sinonasal conditions such as benign and malignant sinonasal masses), history of previous head and neck surgeries or injuries, history of radiotherapy and chemotherapy, and pregnant patients, were excluded. Participants were instructed to report nasal or upper-airway irritation or discomfort during testing, and testing was to be stopped if such symptoms occurred.

Sample Size

Sample size determination for one-way analysis of variance (ANOVA) was conducted using G*Power version 3.1.9.4. (Heinrich Heine University, Düsseldorf, Germany).[15] Based on the effect-size estimate used in the study protocol (f=0.434),[7] 80 participants were required for at least 80% power at a two-sided α of .05; the target was increased to 90 to allow for 10% nonresponse.

Candidate Odorants and Familiarity Assessment

The original 45-odor ST-SIT was reviewed. *(Table 1)* Eleven (11) potentially hazardous or noxious items were removed: floor wax, thinner, insecticide, mothballs, rubbing alcohol, Merthiolate® (Thiomersal, Eli Lilly and Co.), paint, motor oil, kerosene, contact cement adhesive (*Rugby®*, Bostik Philippines Inc.), and disinfectant spray (*Lysol®* Reckitt, Inc.). Four (4) seasonally unavailable items – soursop or guyabano *(Annona muricata)*, chico *(Manikara zapota)*, lime (*Citrus aurantifolia*), and durian *(Durio zibethinus)* – were also removed, leaving 30 candidate odorants.

Participants rated their familiarity with each of the 30 candidate odorants using a 7-point Likert scale, from 1 (not familiar) to 7 (extremely familiar). Familiarity values were summarized as means and standard deviations. The most familiar and least familiar odorants across age groups were noted. Adult mean familiarity ratings ≥6.0 were considered for inclusion in the simplified version.

Odorant Preparation and Test Administration

Each candidate odorant was prepared using the source material and quantity listed in *Table 2,* and placed in a clean, 120-ml amber Polyethylene Terephthalate (PET) Boston squeeze bottle with a perforated flip-top cap (Product ID 1794; Radcom Packaging Pvt. Ltd., Vasai Road East, Thane [Mumbai], India). *(Figure 1)* Solid materials were presented in physical form and were not dissolved in a solvent or moistened. Bottles were coded SB01 to SB30, labeled with preparation date, and stored in an opaque container away from direct heat and sunlight. A single batch was used during the one-month data collection period, consistent with the replacement interval used in the original protocol. In their original validation study, prepared odorants stored under controlled conditions were used for up to 4 weeks.[11] Formal headspace measurements and perceptual isointensity calibration were not performed.

A single trained investigator (CJN) administered all sessions using a standardized presentation sequence. The bottle was held approximately 2 cm from the nostrils and gently squeezed once; where each presentation was separated by a 15-second interstimulus interval. Testing occurred in a standardized, well-lit, and well-ventilated room. Participants and co-investigators (LPC and RUC) were blinded to the odor identities. The code key was kept separately and accessed by CJN only after responses were recorded. Bottle order was randomized for each participant using an online randomizer (URL: https://www.randomizer.org/).

For each odorant, participants selected the closest descriptor from a master list of 30 choices and were required to respond even when uncertain. Descriptors could be selected more than once. Responses could not be changed after recording. Administration of the 30-odor test took approximately 15-20 minutes. The most correctly identified and least correctly identified odorants across age groups were noted. Odors with adult correct-identification rates of ≥70% were also considered for inclusion in the simplified version.

Item Reduction

Item reduction proceeded in three steps. *(Figure 2)* First, the original 45-item ST-SIT was reduced to 30 candidate odorants after removal of 11 potentially noxious or hazardous items and 4 seasonally unavailable items. Second, item screening was restricted to adults aged ≥18 years (n=76), because odor identification and semantic familiarity change across childhood and adolescence. Odorants were provisionally retained when both the adult mean familiarity rating and the adult correct-identification rate were ≥6.0 and ≥70%, respectively. These two values were used as the operational definition of high familiarity and correct identification for the item-screening analysis. Twelve odorants met both criteria: orange, banana, pineapple, chocolate, vinegar, soy sauce, fish sauce (*patis*), apple, onion, pepper, fermented shrimp paste (*bagoong*), and garlic. *(Table 3)* Third, item discrimination was examined descriptively in the adult sample. Each adult participant's raw 30-item correct-identification score was calculated, and participants were ranked by total raw score. The first and third quartiles were 21 and 25, respectively; to avoid arbitrary splitting of tied scores, all participants scoring ≤21 were included in the low-scoring group (n=20) and all scoring ≥25 in the high-scoring group (n=24). For each retained item, the discrimination index was calculated as the proportion correct in the high-scoring group minus the proportion correct in the low-scoring group. *(Table 4)* Because the cohort consisted of participants without known olfactory dysfunction and many retained items showed ceiling effects, discrimination indices were interpreted descriptively rather than used as a sole exclusion rule. For the provisional 12-item panel, the authors revised the previous probability-weighted scoring framework to an equal-weight scoring system – assigning one point for each correct response and zero for an incorrect response – yielding a transparent raw score from 0 to 12. No item-specific weights or diagnostic cutoffs were assigned in this developmental study.

Table 1. Original 45-Odor Santo Tomas Smell Identification Test (ST-SIT)

Odorants		
1. Orange	16. Thinner	31. Laurel Leaf (Laurus nobilis)
2. Vanilla	17. Insecticide	32. Hot Sauce
3. Banana	18. Mustard	33. Peanut Butter
4. Melon	19. Fish Sauce (Patis)	34. Motor Oil
5. Pineapple	20. Vitamin C Syrup	35. Tomato Catsup
6. Caramel	21. Apple	36. Kerosene
7. Chocolate	22. Mothballs	37. Povidone-Iodine
8. Tobacco	23. Onion (Allium cepa)	38. Tea
9. Brandy	24. Alcohol	39. Garlic (Allium sativum)
10. Almond	25. Durian (Durio zibethinus)	40. Cola
11. Vinegar	26. Thiomersal (Merthiolate®)	41. Contact Cement Adhesive (Rugby®)
12. Soy Sauce	27. Pepper	42. Disinfectant Spray (Lysol®)
13. Lime (Citrus aurantifolia)	28. Paint	43. Chico (Manikara zapota)
14. Guyabano (Annona muricata)	29. Fermented Shrimp Paste (Bagoong)	44. Rose (Rosa centifolia)
15. Floor Wax	30. Strawberry	45. Sampaguita (Jasminum sambac)

Table 2. Odorant Preparation and Commercial Source Information

Bottle	Odorant	Preparation	Brand / Exact product variant	Product no./SKU	Manufacturer /Source and Location
SB01	**Orange**	30 mL orange flavor	McCormick Orange Flavor 20 mL (x2)	16990044347_PH-7301628776	McCormick & Company, Inc., Maryland, USA
SB02	**Vanilla**	30 mL vanilla flavor	McCormick Vanilla Flavor 20 mL (x2)	5086953304_PH-30001225138	McCormick & Company, Inc., Maryland, USA
SB03	**Banana**	30 mL banana flavor	McCormick Banana Flavor 20 mL (x2)	5010799906_PH-29565151109	McCormick & Company, Inc., Maryland, USA
SB04	**Melon**	30 mL melon flavor	McCormick Melon Flavor 20 mL (x2)	4621675787_PH-26523533942	McCormick & Company, Inc., Maryland, USA
SB05	**Pineapple**	30 mL pineapple flavor	McCormick Pineapple Flavor 20 mL (x2)	4621798186_PH-26523496806	McCormick & Company, Inc., Maryland, USA
SB06	**Caramel**	30 mL caramel sauce	Torani Puremade Caramel Sauce 473 mL	1373880661_PH-5075974646	R. Torre & Company, Inc., San Leandro, California
SB07	**Chocolate**	30 mL chocolate sauce	Torani Puremade Dark Chocolate Sauce 473 mL	5234541883_PH-31010352123	R. Torre & Company, Inc., San Leandro, California
SB08	**Tobacco**	Shreds from 2 cigarettes	Winston Red Regular 10 packs	2469879266_PH-11303430037	Japan Tobacco International, Geneva Switzerland
SB09	**Brandy**	30 mL brandy	Rémy Martin VSOP 50 mL	03024482205446	E. Rémy Martin & Co., Cognac, France
SB10	**Almond**	30 mL almond- flavored gelatin	Alsa Carte D'Or Gulaman Almond Flavor 1 kg	227735617_PH-10276775711	Unilever, Inc., Taguig City, Philippines
SB11	**Vinegar**	30 mL vinegar	Datu Puti White Vinegar 200 mL	4801668602225	Nutri-Asia, Inc., Taguig City, Philippines
SB12	**Soy Sauce**	30 mL soy sauce	Silver Swan Soy Sauce Regular Budget Pack 100 mL	4800344001963	Nutri-Asia, Inc., Taguig City, Philippines
SB13	**Mustard**	30 mL mustard	McCormick Prepared Yellow Mustard 200 g	1171174046_PH-410282004	McCormick & Company, Inc., Maryland, USA
SB14	**Fish Sauce *(Patis)***	30 mL fish sauce	Lorins Patis Puro 310 mL	100000075078	Lorenzana Food Corporation, Sto. Tomas, Batangas, Philippines
SB15	**Vitamin C Syrup**	30 mL orange-flavored vitamin C syrup	Ceelin Ascorbic Acid Syrup Orange Flavored 120 ml	BP_10000158	Unilab, Inc., Mandaluyong, Metro Manila Philippines
SB16	**Apple**	30 mL apple-scented shampoo	Palmolive Kids Happy Apple 3- in-1 Shampoo 350 ml	8850006493205	Colgate-Palmolive Philippines, Inc., Taguig, Metro Manila
SB17	**Onion**	30 g diced white onion	Fresh white onion *(Allium cepa)*	Not applicable	Purchased from a local public market in Manila, Philippines
SB18	**Pepper**	30 g ground black pepper	McCormick Ground Black pepper *(Piper nigrum) 35 g*	4011334201_PH-21665043098	McCormick & Company, Inc., Maryland, USA
SB19	**Fermented Shrimp Paste *(Bagoong)***	30 mL fermented shrimp paste	Tita Yollie's Sweet and Spicy Alamang 420 g	764460791167	Imrich Food Products Laguna, Philippines
SB20	**Strawberry**	30 mL strawberry-scented hand lotion	Marks & Spencer Nature's Extracts Blissful Strawberry Moisturising Hand and Body Lotion 300 mL	T200394B	Marks & Spencer p.l.c., London, United Kingdom
SB21	**Laurel Leaf**	3 dried leaves	McCormick Dried Bay Leaves *(Laurus nobilis)* 6 g	3902199634_PH-20906371369	McCormick & Company, Inc., Maryland, USA
SB22	**Hot Sauce**	30 mL hot sauce	Mother's Best Hot Sauce 95 g	3182412720_PH-15883839602	HDR Foods Corporation, Quezon City, Philippines
SB23	**Peanut Butter**	30 mL peanut butter	Lady's Choice Sweet and Creamy Peanut Butter 340 g	2207080463_PH-9922282716	Unilever Philippines, Inc., Taguig City, Philippines
SB24	**Tomato Catsup**	30 mL tomato catsup	Del Monte Tomato Ketchup Original Blend 320 g	5215028300_PH-30904182420	Del Monte Philippines, Inc., Taguig City, Metro Manila
SB25	**Povidone-Iodine**	30 mL povidone-iodine solution	Betadine Povidone-Iodine Wound Solution 10% Antiseptic 60 mL	378634013_PH-861072530	Pascual Laboratories, Inc., Quezon City, Philippines
SB26	**Tea**	30 g tea leaves soaked in 10 ml water	Lipton Yellow Label Black Tea International Blend Box of 25	1773342268_PH-7571548628	Lipton Teas and Infusions, Amsterdam Zuidas, Netherlands

Bottle	Odorant	Preparation	Brand / Exact product variant	Product no./SKU	Manufacturer /Source and Location
SB27	**Garlic**	3 fresh cloves	Fresh garlic *(Allium sativum)*	Not applicable	Purchased from a local public market in Manila, Philippines
SB28	**Cola**	30 mL cola	Coca-Cola Original Taste 500 mL	15432217753_PH-132810831358	The Coca-Cola Company, Atlanta, Georgia
SB29	**Rose**	30 g rose potpourri shavings	Better Shea Butter Dry Red Rose (Rosa Centifolia) Petals Extra Fragrant 50 g	5077594490_PH-29928450805	Better Shea Butter, Austin Texas, USA
SB30	**Sampaguita**	30 mL sampaguita essential oil	Asteria Apothecary No. 12071 Sampaguita (Jasminum sambac) 100% Pure Fragrance Oil 30 mL	4192738966_PH-23245035011	Asteria Apothecary, Pasig, Metro Manila

Container specification: 120-mL amber Boston PET bottle with 24/410-mm neck finish and a black flip-top cap

Table 3. Adult Familiarity and Correct-Identification Screening of the 30 Candidate Odorants (n=76)

Odorant	Adult familiarity $\bar{x}$ (SD)	Adult correct identification n (%)	Mean familiarity ≥6.0	Identification ≥70%	Provisionally retained
Orange	**6.76 (0.43)**	**73 (96.05%)**	**Yes**	**Yes**	**Yes**
Vanilla	5.58 (1.24)	42 (55.26%)	No	No	No
Banana	**6.38 (1.12)**	**54 (71.05%)**	**Yes**	**Yes**	**Yes**
Melon	5.96 (1.25)	69 (90.79%)	No	**Yes**	No
Pineapple	**6.34 (0.97)**	**62 (81.58%)**	**Yes**	**Yes**	**Yes**
Caramel	5.03 (1.24)	41 (53.95%)	No	No	No
Chocolate	**6.29 (0.98)**	**69 (90.79%)**	**Yes**	**Yes**	**Yes**
Tobacco	5.37 (1.80)	56 (73.68%)	No	**Yes**	No
Brandy	5.39 (1.18)	51 (67.11%)	No	No	No
Almond	4.66 (1.41)	34 (44.74%)	No	No	No
Vinegar	**6.72 (0.67)**	**72 (94.74%)**	**Yes**	**Yes**	**Yes**
Soy Sauce	**6.33 (1.17)**	**70 (92.11%)**	**Yes**	**Yes**	**Yes**
Mustard	4.34 (1.17)	50 (65.79%)	No	No	No
Fish Sauce *(Patis)*	**6.42 (1.18)**	**74 (97.37%)**	**Yes**	**Yes**	**Yes**
Vitamin C Syrup	4.41 (1.31)	40 (52.63%)	No	No	No
Apple	**6.12 (1.26)**	**65 (85.53%)**	**Yes**	**Yes**	**Yes**
Onion	**6.42 (1.06)**	**72 (94.74%)**	**Yes**	**Yes**	**Yes**
Pepper	**6.26 (1.10)**	**71 (93.42%)**	**Yes**	**Yes**	**Yes**
Fermented Shrimp Paste *(Bagoong)*	**6.37 (0.92)**	**74 (97.37%)**	**Yes**	**Yes**	**Yes**
Strawberry	5.80 (1.37)	68 (89.47%)	No	**Yes**	No
Laurel Leaf	4.99 (1.56)	53 (69.74%)	No	No	No
Hot Sauce	4.22 (1.09)	55 (72.37%)	No	**Yes**	No
Peanut Butter	5.64 (0.93)	66 (86.84%)	No	**Yes**	No
Tomato Catsup	5.12 (1.21)	59 (77.63%)	No	**Yes**	No
Povidone- Iodine	4.01 (1.18)	36 (47.37%)	No	No	No
Tea	4.17 (1.14)	40 (52.63%)	No	No	No
Garlic	**6.42 (0.98)**	**74 (97.37%)**	**Yes**	**Yes**	**Yes**
Cola	5.32 (1.01)	50 (65.79%)	No	No	No
Rose	5.76 (1.19)	48 (63.16%)	No	No	No
Sampaguita	6.09 (1.01)	41 (53.95%)	**Yes**	No	No

Data Analysis

Statistical analyses were performed using STATA Statistical Software, version 13, (StataCorp LP, College Station, TX, USA), followed by participant-level reanalysis of the study dataset. Continuous variables were summarized using means and standard deviations, and categorical values reported using frequencies, percentages, and 95% confidence intervals. Developmental-group comparisons across participants aged 5–11 years, 12–17 years, and ≥18 years were performed exploratorily: familiarity ratings were compared using one-way ANOVA, while correct-identification proportions were summarized using Pearson chi-square statistics. Because expected cell frequencies were <5 in the 3×2 identification tables owing to the small 5–11-year subgroup, statistical significance for identification was based on Fisher–Freeman–Halton exact p-values. All p-values were two-sided; p<.05 was considered statistically significant.[16,17] These age-group categories were selected by the authors to distinguish younger children from adolescents and adults because odor-identification performance is influenced by age-related differences in familiarity, language, semantic development, and cumulative environmental exposure.[18-27] These developmental comparisons, however, were not used to determine item retention. The primary item-retention analysis was restricted to adults aged ≥18 years and required both mean familiarity ≥6.0 and correct identification ≥70%. Quartile-based item discrimination was calculated among adults from raw 30-item correct-identification scores as described.

RESULTS

The analysis included 90 participants: 54 women and girls (60%) and 36 men and boys (40%). Mean age was 38.28 years (SD=19.65). Four participants were aged 5–11 years (4.44%), 10 were aged 12–17 years (11.11%), and 76 were adults aged ≥18 years (84.44%). All enrolled participants completed the single-session assessment, and no serious adverse events were reported in this study.

Across the total sample, the 10 highest-rated odorants in familiarity assessment were the following (in descending order): orange ($\bar{x}$=6.76,

Table 4. Adult Item-Discrimination Results for the 12 Provisional Candidate Odorants (N=76)

Odorant	Adult Correct Identification n (%)	High-Scoring Group Correct (%)	Low-Scoring Group Correct (%)	Discrimination index*
Orange	73 (96.05%)	87.5%	100.0%	-0.125
Banana	54 (71.05%)	83.3%	90.0%	-0.067
Pineapple	62 (81.58%)	87.5%	75.0%	0.125
Chocolate	69 (90.79%)	100.0%	95.0%	0.050
Vinegar	72 (94.74%)	100.0%	90.0%	0.100
Soy Sauce	70 (92.11%)	87.5%	90.0%	-0.025
Fish Sauce *(Patis)*	74 (97.37%)	100.0%	90.0%	0.100
Apple	65 (85.53%)	100.0%	75.0%	0.250
Onion	72 (94.74%)	100.0%	100.0%	0.000
Pepper	71 (93.42%)	87.5%	90.0%	-0.025
Fermented Shrimp Paste *(Bagoong)*	74 (97.37%)	100.0%	90.0%	0.100
Garlic	74 (97.37%)	100.0%	90.0%	0.100

*Discrimination index = proportion correct in the high-scoring adult group (raw 30-item score ≥25; n=24) minus the proportion correct in the low-scoring adult group (score ≤21; n=20). All ties at quartile cut points were retained. Indices were interpreted descriptively because of ceiling effects in the asymptomatic cohort.

SD=0.43), vinegar ($\bar{x}$=6.71, SD=0.64), onion ($\bar{x}$=6.47, SD=1.00), fish sauce *(patis)* ($\bar{x}$=6.44, SD=1.10), banana ($\bar{x}$=6.42, SD=1.05), garlic ($\bar{x}$=6.41, SD=0.92), chocolate ($\bar{x}$=6.38, SD=0.93), soy sauce ($\bar{x}$=6.36, SD=1.09), pineapple ($\bar{x}$=6.29, SD=0.93), and fermented shrimp paste (*bagoong)* ($\bar{x}$=6.27, SD=0.92). The 10 lowest-rated odorants were (in ascending order): tea ($\bar{x}$=3.96, SD=1.20), povidone-iodine ($\bar{x}$=4.02, SD=1.24), hot sauce ($\bar{x}$=4.07, SD=1.14), mustard ($\bar{x}$=4.12, SD=1.36), vitamin C syrup ($\bar{x}$=4.36, SD=1.28), almond ($\bar{x}$=4.50, SD=1.42), laurel leaf *(Laurus nobilis)* ($\bar{x}$=4.58, SD=1.85), caramel ($\bar{x}$=4.94, SD=1.20), vanilla ($\bar{x}$=5.11, SD=1.73), and brandy ($\bar{x}$=5.14, SD=1.48)**.** Meanwhile, the five most frequently identified odorants were: garlic (n= 85, 94.44%), fish sauce *(patis)* (n=85, 94.44%), orange (n=85, 94.44%), onion (n=83, 92.22%), and chocolate (n=83, 92.22%). On the other hand, the five least frequently identified were almond (n=40, 44.44%), povidone-iodine solution (n=42, 46.67%), vitamin C syrup (n=44, 48.89%), tea (n=45, 50.00%), and sampaguita (n= 45, 50.00%).

Table 5. Exploratory Developmental-Group Comparisons of Familiarity and Correct Identification for the 30 Candidate Odorants (N=90)

Odorant	Familiarity F(2,87)	ANOVA p-value	Correct Identification $\chi^2(2)$	Exact p-value*
Orange	0.09	.911	16.02	.023
Vanilla	36.45	<.001	5.20	.067
Banana	0.39	.678	1.20	.494
Melon	0.85	.432	15.38	.008
Pineapple	1.01	.369	6.59	.025
Caramel	1.64	.200	7.42	.018
Chocolate	2.33	.103	1.40	1.000
Tobacco	11.98	<.001	10.48	.010
Brandy	26.61	<.001	7.99	.020
Almond	4.47	.014	4.18	.125
Vinegar	1.15	.321	10.68	.021
Soy Sauce	0.29	.752	7.49	.069
Mustard	15.95	<.001	8.73	.011
Fish Sauce *(Patis)*	0.18	.836	8.10	.035
Vitamin C Syrup	3.57	.032	4.57	.136
Apple	0.84	.436	2.39	.425
Onion	0.51	.602	4.41	.088
Pepper	17.20	<.001	23.06	.004
Fermented Shrimp Paste *(Bagoong)*	5.09	.008	45.98	<.001
Strawberry	10.04	<.001	2.13	.268
Laurel Leaf	16.97	<.001	15.78	<.001
Hot Sauce	6.44	.002	10.01	.013
Peanut Butter	1.35	.265	1.00	.791
Tomato Catsup	3.65	.030	2.65	.285
Povidone-Iodine Solution	0.34	.709	4.23	.162
Tea	9.62	<.001	4.21	.195
Garlic	0.06	.937	16.67	.006
Cola	1.35	.265	5.52	.030
Rose	16.93	<.001	6.32	.049
Sampaguita	24.81	<.001	4.87	.110

*Pearson χ^2 statistics are shown for identification. Because expected cell frequencies were <5 in all 3×2 identification tables due to the small 5–11-year subgroup, p values for identification are Fisher–Freeman–Halton exact p-values. Developmental-group analyses were exploratory and were not used for item retention.

Exploratory Developmental-Group Findings

Children aged at least 5 years were included this study because odor-identification tasks can generally be completed reliably from this age, although pediatric performance remains influenced by developmental and experiential factors.[19] Exploratory comparisons across participants aged 5–11 years (n=4), 12–17 years (n=10), and ≥18 years (n=76) are summarized in *Table 5* and *Figures 3* and *4.* Mean familiarity differed significantly among developmental groups for 15 of the 30 odorants. The largest familiarity differences were observed for vanilla (F[2,87]=36.45, p<.001), brandy (F[2,87]=26.61, p<.001), and sampaguita (F[2,87]=24.81, p<.001). Mean familiarity increased across the three groups for vanilla (1.00, 3.20, and 5.58, respectively), brandy (1.00, 4.90, and 5.39), and sampaguita (2.00, 5.10, and 6.09), illustrating marked developmental and experiential differences in familiarity.

Correct-identification proportions differed significantly among the developmental groups for 16 of 30 odorants based on Fisher–Freeman–Halton exact testing; corresponding Pearson chi-square statistics ranged from $\chi^2(2)$=5.52 to 45.98, with exact p values from .049 to <.001. The largest differences were observed for fermented shrimp paste (*bagoong*) (χ^2[2]=45.98, p<.001), pepper (χ^2[2]=23.06, p=.004), garlic (χ^2[2]=16.67, p=.006), orange (χ^2[2]=16.02, p=.023), and laurel leaf (χ^2[2]=15.78, p<.001). Correct identification of *bagoong* increased from

0% among participants aged 5–11 years to 60% among those aged 12–17 years and 97.37% among adults. Corresponding rates were 25%, 100%, and 93.42% for pepper; 50%, 90%, and 97.37% for garlic; 50%, 100%, and 96.05% for orange; and 0%, 20%, and 69.74% for laurel leaf. Because of the very small pediatric subgroups, these developmental findings were considered exploratory and were not used for item-retention decisions.

The **12–17-year age group** showed particularly high identification of several familiar food and beverage odors, with 100% correct identification for orange, chocolate, pepper, strawberry, and cola. Among the four participants **aged 5–11 years**, chocolate, apple, and peanut butter were identified correctly by all participants, whereas several less familiar adult-oriented or cooking-related items were poorly identified. These descriptive patterns further supported restricting primary item selection to adults rather than pooling children and adults.

Adult Familiarity and Identification Screening

Among the 76 adults, mean familiarity ratings across the 30 candidate odorants ranged from 4.01 for povidone-iodine solution to 6.76 for orange. *(Table 3; Figures 3 and 4)* Thirteen (13) odorants reached the prespecified adult familiarity criterion of ≥6.0: orange, vinegar, fish sauce (*patis*), onion, garlic, banana, fermented shrimp paste (*bagoong*), pineapple, soy sauce, chocolate, pepper, apple, and sampaguita. Adult correct-identification rates ranged from 44.74% for almond to 97.37% for fish sauce (*patis*), fermented shrimp paste (*bagoong*), and garlic. Eighteen (18) odorants were correctly identified by at least 70% of adults. Twelve (12) odorants met both criteria and were provisionally retained: orange, banana, pineapple, chocolate, vinegar, soy sauce, fish sauce (*patis*), apple, onion, pepper, fermented shrimp paste (*bagoong*), and garlic. *(Table 3)*

The study results also revealed several informative familiarity-identification mismatches. Sampaguita was highly familiar in adults ($\bar{x}$=6.09) but was correctly identified by only 41 of 76 participants (53.95%) and therefore did not meet the identification criterion. Conversely, six odorants were correctly identified by at least 70% of adults despite mean familiarity ratings below 6.0: melon (90.79%; mean familiarity=5.96), tobacco (73.68%; 5.37), strawberry (89.47%; 5.80), hot sauce (72.37%; 4.22), peanut butter (86.84%; 5.64), and tomato catsup (77.63%; 5.12). These items were not retained because they did not meet both adult item screening criteria. *(Table 3)*

The strongest adult identification performance was observed for commonly encountered kitchen and food-related odorants. Fish sauce (*patis*), fermented shrimp paste (*bagoong*), and garlic were each correctly identified by 74 of 76 adults (97.37%); orange by 73 (96.05%); vinegar and onion by 72 each (94.74%); pepper by 71 (93.42%); soy sauce by 70 (92.11%); and chocolate by 69 (90.79%). The lowest adult identification rates were observed for almond (34/76, 44.74%), povidone-iodine



Figure 1. 120-mL amber Polyethylene Terephthalate (PET) Boston squeeze bottles with perforated flip-top cap; 24/410-mm neck finish, 15.5 g. Bottles were coded SB01- SB30 and labeled with preparation date.

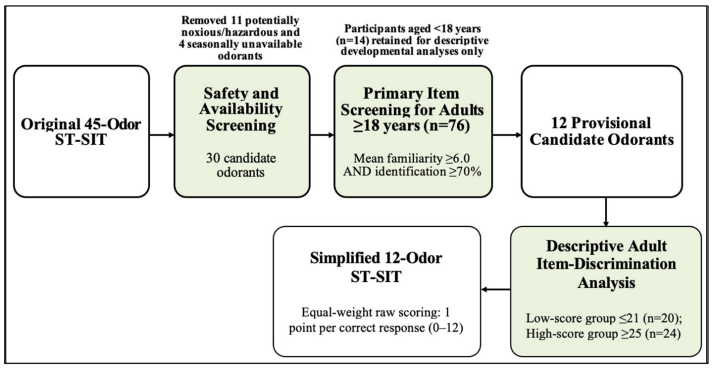


Figure 2. Structured item-reduction process for the Santo Tomas Smell Identification Test

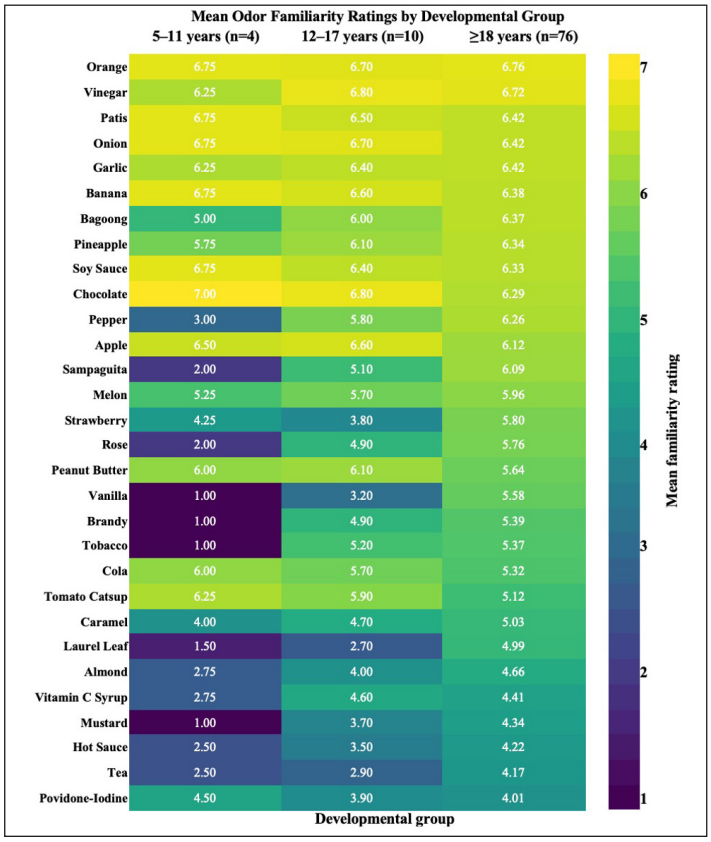


Figure 3. Mean odor familiarity ratings by developmental group. Each cell shows the mean familiarity rating on the 1–7 scale for participants aged 5–11 years (n=4), 12–17 years (n=10), or ≥18 years (n=76). Pediatric results are descriptive; adult familiarity was used for item-retention decisions.

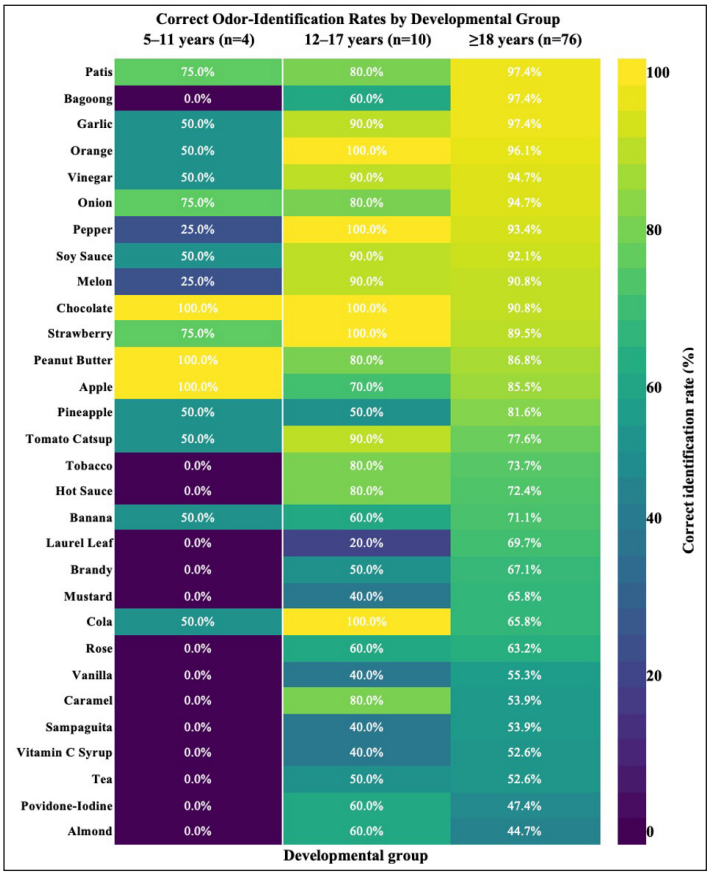


Figure 4. Correct odor-identification rates by developmental group. Each cell shows the percentage of participants in the corresponding developmental group who correctly identified the odorant. Pediatric results are descriptive; adult identification performance was used for item-retention decisions.

solution (36/76, 47.37%), vitamin C syrup and tea (40/76 each, 52.63%), and caramel and sampaguita (41/76 each, 53.95%). *(Table 3)*

Item Discrimination and Candidate Panel

Adult raw 30-item correct-identification scores ranged from 16 to 28 ($\bar{x}$=22.75; SD=2.53; median=23). The lower-score group comprised adults scoring ≤21 (n=20), and the higher-score group comprised those scoring ≥25 (n=24). Among the 12 provisionally retained items, discrimination indices ranged from −0.125 to 0.250. *(Table 4)* Apple had the largest positive discrimination index (0.250), followed by pineapple (0.125). Vinegar, fish sauce (*patis*), fermented shrimp paste (*bagoong*), and garlic each had an index of 0.100; chocolate 0.050; onion 0.000; soy sauce and pepper −0.025; banana −0.067; and orange −0.125. Several of the low, zero, or negative indices occurred among odorants already identified correctly by more than 90% of adults, indicating substantial ceiling effects in this *asymptomatic* cohort rather than a demonstrated lack of diagnostic value.

The final developmental output of the present analysis is therefore a simplified 12-odor candidate panel rather than a diagnostically validated test. For subsequent validation, the revised scoring framework treats all retained items equally: one point is assigned for each correct identification and zero for an incorrect response, producing a possible raw score of 0–12. No diagnostic categories or cutoff values were derived from the present cohort.

DISCUSSION

This study reassessed the original 45-odor ST-SIT and identified a shorter set of culturally relevant candidate odorants using explicit adult-based criteria. After removal of potentially hazardous and inconsistently available items, 12 odorants—orange, banana, pineapple, chocolate, vinegar, soy sauce, fish sauce (*patis*), apple, onion, pepper, fermented shrimp paste (*bagoong*), and garlic—met both an adult mean familiarity rating of ≥6.0 and a correct-identification rate of ≥70%. The principal outcome is a reproducible 12-odor candidate panel for further development of the ST-SIT, together with a transparent equal-weight 0–12 raw scoring framework, rather than a finalized diagnostic instrument.

The predominance of food- and household-related odors in the candidate panel is consistent with the established influence of culture and prior exposure on odor identification. Cross-cultural modifications of established smell-identification tests have shown that odorants that are readily recognized in one population may be unfamiliar or difficult to name in another, even in individuals without olfactory impairment.[6–10] In the present study, culturally embedded food odors such as *patis*, *bagoong*, garlic, vinegar, soy sauce, and onion were both highly familiar and correctly identified by more than 90% of adults. Such performance may reflect repeated exposure in everyday Filipino food preparation and well-established semantic associations for these odors. This is consistent with psychophysical literature emphasizing that odor identification depends on both sensory input and access to learned semantic information.[18,28]

An equally informative finding was that familiarity and identification were not always concordant. Sampaguita, for example, exceeded the adult familiarity criterion ($\bar{x}$=6.09) but was correctly identified by only 53.95% of adults. Conversely, melon, strawberry, peanut butter, tomato catsup, hot sauce, and tobacco exceeded the 70% adult identification threshold despite familiarity means below 6.0. These discrepancies illustrate that knowing or recognizing an odor concept is not equivalent to correctly assigning its verbal label to a presented stimulus. Differences in semantic accessibility, characteristics of the actual odor source, and the structure of the response alternatives may all contribute. Larsson and Bäckman demonstrated that both familiarity and naming are related to odor recognition and that access to verbal labels can account for substantial age-related differences in recognition.[28] The 30-alternative response format used in the present study may also have affected performance. Cued odor-identification tasks are sensitive to procedural characteristics, including the number and similarity of response alternatives; increasing the number of

alternatives may increase cognitive and semantic demands and reduce identification accuracy, while the composition of distractors can also influence performance.[24,25] Consequently, some differences in correct identification rates in the present study may reflect characteristics of the response format in addition to odor familiarity and olfactory function.

The developmental findings further support the decision to use adults for primary item screening. Familiarity differed significantly among developmental groups for half of the candidate odorants, with particularly large differences for vanilla, brandy, and sampaguita. Identification also differed for 16 of 30 odorants, including pronounced gradients for *bagoong*, pepper, garlic, orange and laurel leaf. Although the pediatric subsamples were small, the 12–17-year group showed 100% identification of orange, chocolate, pepper, strawberry, and cola, while adults demonstrated especially consistent identification of common condiments and cooking-related odors. These patterns are biologically and cognitively plausible because odor-identification tasks require not only detection but also accumulated environmental exposure, mature vocabulary, semantic memory, and response selection. Pediatric studies have shown progressive development of odor-identification ability and the importance of age-appropriate odor sets,[19,22,23] while large normative datasets demonstrate that olfactory performance is strongest in early adulthood and subsequently declines with advancing age.[20] Fusari and Ballesteros likewise found that young and young-old adults performed similarly on many common odors, whereas the oldest group showed poorer odor identification.[27] These observations support adult-based item selection while underscoring the need for separately powered pediatric and older-adult normative studies.

Another notable finding was that several pungent or chemesthetic odorants were highly recognizable to adults. Vinegar and pepper were correctly identified by 94.74% and 93.42% of adults, respectively, while hot sauce remained identifiable by 72.37% despite a relatively low mean familiarity. These stimuli may provide sensory information through both olfactory and trigeminal pathways. Acetic acid, the principal volatile compound responsible for vinegar pungency, is a recognized trigeminal stimulus, and elderly participants have been shown to retain meaningful perception and discrimination of trigeminal chemosensory qualities despite some age-related decline.[29] Odors perceived as highly intense or irritating have also been reported to be remembered better across adulthood, with a particular benefit for irritating stimuli among older adults, suggesting that trigeminal information can provide an additional cue when olfactory processing is less robust.[30] Black pepper provides an especially relevant example: experimental work using piperine and pepper-derived odorants demonstrates overlapping but distinct activation of trigeminal and olfactory processing networks.[31] Thus, the strong recognition of vinegar and pepper in the present cohort may reflect, in part, additional chemesthetic salience. This interpretation remains a hypothesis because the study did not directly measure nasal pungency, trigeminal activation, or perceptual intensity.

The item-discrimination analysis provided a complementary perspective. Apple showed the largest positive discrimination index (0.250), followed by pineapple (0.125), whereas several highly familiar and frequently identified items showed small, zero, or negative indices. This apparent conundrum is expected when items are very easy in an asymptomatic cohort: participants in both the high- and low-scoring groups answer them correctly, leaving little variance from which discrimination can be estimated. A low within-cohort discrimination index for orange, onion, *patis*, *bagoong*, or garlic should therefore not be interpreted as evidence that these are intrinsically poor screening items. Rather, they may function as culturally familiar easy items, while moderately difficult items such as apple or pineapple may contribute more to score differentiation. Classical item-discrimination methods are most informative when the sample spans a broad range of the ability being measured.[17,21] A clinically characterized olfactory dysfunction group is therefore required to determine whether the retained odorants discriminate normosmia from clinically meaningful olfactory impairment.

These findings also support modernization of the ST-SIT scoring framework. The previous p-value–based weighting method is mathematically normalized but does not provide a direct psychometric measure of item difficulty, discrimination, or diagnostic importance. For the provisional 12-item panel, an equal-weight raw score—one point per correct identification, with a possible total of 0–12—is more transparent and reproducible. This approach separates scoring from item-quality evaluation and permits future studies to estimate item difficulty and discrimination directly. No diagnostic cutoff should be assigned at this stage because the present cohort excluded known olfactory dysfunction and lacked an external reference standard. Sensitivity, specificity, predictive values, and clinically meaningful thresholds must therefore be derived prospectively rather than inherited from the original 45-item instrument.

This study, however, is not without limitations. Participants were recruited from a single tertiary hospital, limiting geographic, linguistic, socioeconomic, and cultural generalizability. The 5–11-year and 12–17-year subgroups were small; developmental comparisons were therefore exploratory and should not be regarded as normative. The adult familiarity and identification thresholds were applied during the revised analysis to make item selection explicit and reproducible but require prospective confirmation. Item discrimination was estimated only in adults without clinically confirmed olfactory dysfunction and was affected by ceiling effects. The 30-choice response format imposed substantial semantic and cognitive demands that may have influenced identification independent of olfactory perception.[24,25,32] Administration by a single investigator precluded assessment of inter-administrator reliability, and the test–retest reliability was also

not evaluated. In addition, the amount of odorized air released by each squeeze was not instrumentally controlled, solid and liquid odor sources were not calibrated for perceptual isointensity, and differences in volatility or moisture could have altered odor strength.[26] These methodological factors are particularly relevant when interpreting strongly pungent or potentially trigeminal stimuli.

Future studies should prospectively evaluate the 12 candidate odorants in larger and geographically diverse Filipino cohorts, with separately powered developmental and older-adult strata. Testing should include clinically characterized participants across the spectrum of olfactory function and comparison with an established reference instrument to determine diagnostic item discrimination, sensitivity, specificity, and appropriate cutoffs for the equal-weight score. Test–retest reliability, inter-administrator agreement, standardized odor delivery and perceptual intensity, and a smaller controlled distractor set should also be evaluated. Measurement of perceived pungency or trigeminal activation may clarify whether chemesthetic cues contribute to the strong identification of stimuli such as vinegar and pepper. Overall, the present study demonstrates that adult familiarity and correct-identification performance can systematically reduce the original ST-SIT candidate pool to a culturally relevant 12-odor set, but its scoring thresholds, age-specific interpretation, and diagnostic accuracy remain to be established through independent prospective validation.

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