Supplemental Online Content

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This supplemental material has been provided by the authors to give readers additional information about their work.

eTable. Performance of 45 Items on Household Survey

Cluster	Item	Availability	Comparison to UPSIT			Comparison to CGI-S		
		of item (%)						
			Sensitivity ^a	Specificity ^a	Youden's J	Sensitivity b	Specificity b	Youden's J
4	soap	99%	0.67	0.93	0.60	0.86	0.92	0.77
2	disinfectant	98%	0.71	0.76	0.48	0.86	0.86	0.72
7	fresh butter	97%	0.89	0.29	0.18	0.94	0.36	0.30
8	vinegar	97%	0.62	0.93	0.55	0.73	0.95	0.68
6	black pepper	97%	0.75	0.88	0.63	0.69	0.82	0.50
7	peanut butter	97%	0.68	0.90	0.59	0.83	0.86	0.69
3	cheese	96%	0.81	0.68	0.50	0.80	0.65	0.45
6	herb (eg. rosemary, thyme, basil)	95%	0.67	0.93	0.60	0.71	0.91	0.62
7	cinnamon	95%	0.77	0.87	0.64	0.57	0.86	0.44
7	burnt candle	95%	0.82	0.85	0.66	0.86	0.80	0.66
8	garlic	95%	0.67	0.91	0.58	0.77	0.89	0.66
7	vanilla	94%	0.73	0.70	0.43	0.85	0.83	0.68
7	spice (eg. tarragon, turmeric, paprika)	93%	0.76	0.83	0.60	0.73	0.78	0.52
3	peppermint (or other mint, menthol)	92%	0.64	0.95	0.60	0.64	0.92	0.56
7	maple syrup	92%	0.92	0.75	0.67	0.62	0.76	0.38
8	seasoning (for meat)	92%	0.85	0.94	0.78	0.79	0.86	0.64
8	onion	91%	0.64	0.89	0.54	0.69	0.84	0.53
1	fruit/citrus additive	90%	0.75	0.92	0.67	0.82	0.86	0.68
7	honey	90%	0.92	0.61	0.53	0.92	0.66	0.57
7	chocolate	90%	0.86	0.65	0.50	0.83	0.72	0.56
1	lemon	88%	0.77	0.80	0.57	0.77	0.84	0.61
2	rubbing alcohol	88%	0.64	0.90	0.54	0.77	0.89	0.66
3	tea leaves	88%	0.80	0.75	0.55	0.69	0.77	0.46
7	coffee	88%	0.67	0.94	0.61	0.78	0.91	0.69
6	fresh green vegetables	85%	0.92	0.35	0.27	1.00	0.47	0.47
7	melted butter/buttery popcorn	85%	0.67	0.77	0.44	0.93	0.79	0.73
4	perfume	83%	0.62	0.92	0.54	0.92	0.94	0.85
2	nail polish remover	82%	0.47	0.89	0.36	0.91	0.96	0.86

5	banana	80%	0.77	0.76	0.53	0.92	0.80	0.72
2	gasoline	76%	0.62	0.87	0.48	0.89	0.88	0.76
8	apple (fruit)	75%	0.85	0.83	0.68	0.92	0.72	0.64
6	raw potato	73%	0.84	0.43	0.27	1.00	0.50	0.50
1	orange	72%	0.64	0.83	0.48	0.82	0.88	0.70
8	raw meat	71%	0.77	0.38	0.15	0.92	0.54	0.46
3	caraway (or fennel, cumin)	66%	0.82	0.86	0.68	0.70	0.82	0.52
4	cologne	65%	0.56	0.82	0.37	0.82	0.91	0.73
6	green pepper	64%	0.73	0.63	0.35	0.75	0.62	0.37
4	flowers	61%	0.83	0.14	-0.02	1.00	0.60	0.60
7	clove	58%	0.63	0.93	0.56	0.86	0.94	0.80
5	strawberry	55%	0.75	0.69	0.44	0.70	0.75	0.45
2	paint	53%	0.64	0.70	0.34	0.78	0.80	0.58
8	wet dog	46%	0.88	0.63	0.50	1.00	0.61	0.61
6	cut/crushed grass	43%	0.86	0.50	0.36	1.00	0.68	0.68
6	baby powder	41%	0.80	0.75	0.55	1.00	0.76	0.76
5	peach (fruit)	27%	0.75	0.60	0.35	0.75	0.67	0.42

UPSIT = University of Pennsylvania Smell Identification Test, *CGI-S* = Clinical Global Impression-Severity scale on current ability to smell, ^a Calculated by comparing participants with anosmia or normosmia on the *UPSIT* to participants who could not smell the item at all or smelled it normally on Household Survey, ^b Calculated by comparing participants who reported an absent sense of smell or not on the *CGI-S* to participants who could not smell the item or smelled it normally/less strong than normally on Household Survey

The items are ranked in terms of availability. Sensitivity, specificity, and Youden's J were calculated for each item in comparison to the *UPSIT* and the *CGI-S*. Items with less than 88% availability were excluded from consideration (gray). Face and content validity were used to exclude 10 more items (blue), leaving the final list of 14 used to develop *NASAL*.

eFigure 1. Clusters of 174 Smell Descriptors

Cluster 1: Citrus

fruity/citrus, lemon, grapefruit, orange

Cluster 2: Acerbic/synthetic

nail polish remover, mothballs, alcoholic, etherish, anaesthetic, cleaning fluid, gasoline, solvent, turpentine (pine oil), leather, tar, creosote, disinfectant, carbolic, medicinal, chemical, ammonia, new rubber, kerosene, paint, varnish, metallic

Cluster 3: Leafy

tea leaves, caraway, minty, peppermint, camphor, eucalyptus, anise (licorice), cheesy, cool, cooling

Cluster 4: Floral

floral, rose, violets, lavender, cologne, musk, perfumery, fragrant, aromatic, soapy, incense, light

Cluster 5: Fruity/non-citrus

fruity/other than citrus, pineapple, grape juice, strawberry, pear, cantaloupe, honey dew, melon, peach (fruit), banana, cherry (berry), sweet, raisins

Cluster 6: Woody

laurel leaves, black pepper, green pepper, dill, oak wood, cognac, woody, resinous, cedarwood, geranium leaves, celery, fresh green vegetables, crushed weeds, crushed grass, herbal, green, cut grass, raw cucumber, cardboard, rope, wet paper, musty, earthy, moldy, raw potato, mushroom, beany, bark, birch bark, cork, dry, powdery, chalky

Cluster 7: Spicy/smoky/nutty

honey, almond, nutty (walnut, etc.), spicy, clove, cinnamon, chocolate, vanilla, maple syrup, caramel, malty, molasses, coconut, hay, bakery (fresh bread), peanut butter, burnt, smoky, fresh tobacco smoke, coffee, stale tobacco smoke, burnt paper, burnt milk, burnt candle, oily, fatty, buttery, fresh butter, popcorn, fried chicken, warm

Cluster 8: Heavy/rotten

apple (fruit), seasoning (for meat), grainy (as grain), yeasty, sour milk, fermented (rotten), fruit, beery, wet wool, wet dog, dirty linen, stale, mouse, eggy (fresh eggs), burnt rubber, bitter, sharp, pungent, acid, sour, vinegar, sauerkraut, urine, cat urine, fishy, kippery (smoked fish), seminal, sperm, sooty, meaty (cooked, good), soupy, cooked vegetables, rancid, sweaty, household gas, sulfidic, garlic, onion, blood, raw meat, animal, sewer, putrid, foul, decayed, fecal (like manure), cadaverous (dead animal), sickening, heavy

These eight clusters of smell descriptors were adapted from classification of a monomolecular odorant database derived from non-negative matrix factorization.

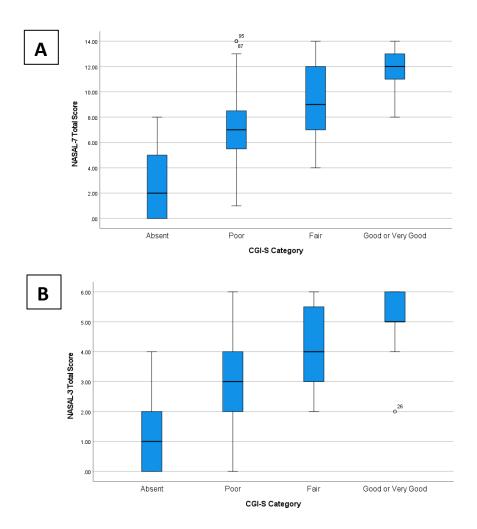
- 1. Castro JB, Ramanathan A, Chennubhotla CS. Categorical Dimensions of Human Odor Descriptor Space Revealed by Non-Negative Matrix Factorization. PLOS ONE. 2013;8(9):e73289.
- 2. Patnaik B, Batch A, Elmqvist N. Information Olfactation: Harnessing Scent to Convey Data. IEEE Transactions on Visualization and Computer Graphics. 2018;PP:1-1.

eFigure 2. 45-Item Household Survey Experience



A household items survey was developed with 45 items, each with specific instructions on how to smell the item and with a standardized 5-option response. Items were separated by location: kitchen, vanity/bathroom, or garage/outdoor. Performance of each item was used to determine its usefulness in an at-home diagnostic tool for olfactory dysfunction.

eFigure 3. Boxplots of the CGI-S Response Categories with Total NASAL-7 and NASAL-3 Scores



The distribution of participant scores forms a natural gradient that helped to form the scaling system for each NASAL instrument.