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Olfactory acuity test while pre-symptomatic for COVID-19

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Abstract

An easily-constructed and self-administered olfactory acuity test for pre-symptomatic indication of infection by COVID-19 is described. This paper offers a simple test of smell threshold, which can be made and conducted at home and re-tested on oneself or others sharing isolation, and producing numerical data to indicate whether smell ability has decreased. During the COVID-19 pandemic, and until a vaccine is developed and available, becoming aware immediately of a loss of the important chemical sense, olfaction, can signal sufficient concern in individuals to self-isolate for the requisite period. The risk of COVID-19 spreading through communities can be reduced by promoting smell awareness by everyone, using simple, inexpensive measures, suggested in this paper.

Introduction

Recent clinical reports indicate that a high proportion of COVID-19 patients experience smell loss (anosmia), partial smell loss (hyposmia) and/or taste loss (dysgeusia) (Bagheri, et al., 2020; Carney, 2020; Meixner, 2020; Philpott, 2020; Roberts, 2020). Despite these reports being mainly anecdotal, support for a call for anosmia to be treated as a symptom of COVID-19 grew in the early months of the pandemic (O'Donovan et al., 2020, Gane et al., 2020).

Ear, nose and throat physicians in the UK, USA and elsewhere were very concerned by medical reports that smell loss and resultant dysgeusia are symptoms of COVID-19 infection, heralding important potential for reducing spread of the virus and early testing of those not showing other symptoms (Lewin, 2020; AAO-HNS, 2020).

New loss of smell or taste has become an officially recognised symptom of COVID-19 infection by the U.S. Centers for Disease Control and Prevention (CDC) (Fritz et al., 2020; Rashid, 2020). Supporting the CDC announcement has been a stream of reports by medical practitioners emphasising the prevalence and importance of the symptom occurring often before any other (Lutz, 2020, Hopkins and Kumar, 2020; Miller et al, 2020). Data from recently published surveys of large numbers of people, showed that chemosensory disturbance of olfaction (smell), gustation (taste) and chemesthesis (cooling or burning sensations carried by the trigeminal nerve), without blockage of the nasal passages, is common in at least two thirds of people testing positive for the virus (Menni et al., 2020; Parma et al., 2020). These findings render obsolete the earlier assertions by the UN World Health Organisation (WHO) that loss of smell or taste is a not a symptom of COVID-19 (Ault, 2020; Meixner, 2020) or is a "less common" COVID-19 symptom (Sae, 2020). After a relatively long period of ignoring the chemical senses, the U.K. health authorities announced acceptance of loss of smell or taste as a "key symptom" (Boyle, 2020; Bundock, 2020). In contrast, Australia changed minimally, listing loss of smell or taste as "less common".

Of crucial importance for managing the COVID-19 pandemic is the possibility that smell loss can begin as the only symptom in a person who is otherwise well (Carney, 2020). That person might be an unaware carrier and potential spreader of the virus. By detecting the loss of smell acuity as early as possible, society is better armed to defeat the virus.

The significant change in official position of health authorities in the U.S.A. and U.K. should go some way to reducing cases going undiagnosed and spreading the virus in people with no other symptom but loss of chemical sensory perception (Boseley, 2020; Fahey, 2020).

A loss of smell sense often accompanies nasal congestion with common colds and influenza, and can have several other causes, including hay fever, sinusitis and head injury. Sudden or unexpected smell loss, particularly in the *absence* of other symptoms such as raised temperature and cough, should be taken seriously by both citizens in communities at risk, and by clinicians.

A symptom of COVID-19, anosmia, offers the opportunity for easy self-monitoring by people currently self-isolating or "locked down."

Remote physical examination is now a common feature in the medical approach to the COVID-19 pandemic and it is recommended that patients take readings from instruments they have at home, including temperature, pulse, and blood pressure (Greenhalgh et al., 2020). These authors also note that loss of appetite (indicating possible dysgeusia) occurs in many patients and that anosmia is widely reported anecdotally as a common and early symptom of COVID-19 infection. Testing for smell loss can be added to remote physical examination by means described here.

This paper offers a simple test of smell threshold, which can be made and conducted at home and retested on oneself or others sharing isolation, and producing numerical data to indicate whether smell ability has decreased.

How can anosmia be measured?

Several rough screening methods are available for people wanting to self-monitor for changes in smell ability:

- *Introspection*: Sniff any household item or plant part that you know has an odour. Is your expectation met? If not, try another and another. This can be repeated at intervals, say at mealtimes or while gardening. If the items are not delivering their usual smell experience (orthonasal olfaction), there is reason to be concerned: contact your medical professional and request a COVID-19 test.
- *Perform the "jelly-bean test"*: Hold your nose and pop a jelly bean (or small piece of food or candy) into your mouth. With the nose blocked, all you should perceive is sweetness and perhaps some sourness or saltiness. Release the nose and immediately the flavour (orange, raspberry, etc) is perceptible (retronasal olfaction contributing to flavour perception). This test can be repeated at intervals to monitor onset of anosmia. If the return of flavour is not experienced, then there is reason to be concerned: contact your medical professional and request a COVID-19 test.

Early onset of anosmia can also be monitored to improve early detection of viral infection. Fundamental ability to detect a very faint odour can be determined as a change in smell detection threshold. This provides a more sensitive method than introspective sniffing or the jelly bean test.

There are two available test kits for measuring smell threshold used by clinicians:

1. An olfactory threshold test developed by Sensonics International (Snap & Sniff®): It involves a set of 20 tubes ("wands") containing systematically diluted odorants, including tubes with no odour, such that a person's odour detection threshold may be determined as a numerical score based on the point in the dilution series at which a smell cannot be detected. This kit currently sells for US$1259.
2. The "Sniffin' Sticks" olfactory threshold test available from Burghardt, Wedel, Germany: It also involves a set of pen-like odour dispensers containing a systematic dilution series of either of two odorants: n-Butanol and 2-Phenylethanol (Hummel, et al., 1997). Numerical scores are obtained and compared with data obtained from heathy people and those with clinical conditions. The two forms of the test sell for €334 and €471 respectively.

While useful, these tests are intended for clinicians. Clearly, what is needed in the COVID-19 crisis is an inexpensive, easily constructed, self-administered smell detection threshold test which would provide numerical information over repeated tests, and thereby show up a sudden or emerging pre-clinical onset of anosmia. Such a test is described here and is affordable for most people.

The "Ozzie" smell detection threshold test

Aim of the test

The test intends to measure an individual's olfactory threshold, and whether it is changing, by having the person sniff a series of odours decreasing in perceived intensity, by

Figure 1: Examples of the test materials with sample jars (12 needed) and items that could be used to make the primary test solution (rose water, orange blossom water, lemon or lime rind using the grater shown).

half in each sample, to zero (no odour). It is not intended to give a comparison against a population norm. Why? Chemical sensory science has shown that there is great variation (orders of magnitude differences) within individuals for a specific odour molecule and between species of molecules. What is intended here is to measure one person's threshold for a random smelly molecule and see if that value changes upon retest. Those values, for that person, are important.

In order to make this test easy to construct and self-administer, while remaining valid, strict methodologies used in sensory psychophysics can be overlooked. What is crucial is for you to find a numerical value for your detection threshold that you can then assess. What is required is that an unskilled person can make and obtain scores for themselves to tell if their ability to smell is changing detrimentally during the COVID-19 crisis.

	Jar No.											
	1	2	3	4	5	6	7	8	9	10	11	12
Odorant (mL)	100	50	25	12	6	3	1.5	0.8	0.4	0	0	0
Equivalent to:							32 drops	16 drops	8 drops			
Water (mL)	0	50	75	88	94	97	98.5	99.2	99.6	100	100	100

This test will give better information to the user than the jelly-bean test or sniffing random items in the house or garden because a threshold test addresses basic sensory sensitivity in numerical terms. The value of this in-home test, is *to find smell loss as soon as it starts to happen*, under COVID-19 social distancing and isolation, so that further action to prevent COVID-19 spread and its consequences can follow.

Test materials

- 12 small jars or bottles. They should have lids, wide mouths, be clean and dry and be identical in size and appearance. In the example described here, the jars (150mL) were bought from a homewares supply store ("two dollar" shop) and cost AUD$1.50 (approx. US$0.80 or one €) a piece. You can use the small jars (identical ones) you have collected in normal kitchen activity.
- A volumetric jug or measuring flasks for liquid marked in mL (optional)
- An eye dropper (optional)
- Another jug for filling the jars with water
- A marker pen that can write on glass
- A ruler
- Approx. 200 mL of *the primary odour solution*. This should be a clear water-soluble liquid which has a medium-strength, recognisable odour. In the example described here, a 200 mL bottle of Rose Water was obtained from the family pantry. Other flavour essences, or herbal infusions, could be made up in a water solution as the primary solution. Avoid any substance with a strong pungent "smell" such as alcohol, chilli, peppermint, oil or bleach. On no account must this, or any other sniff sample be sipped or drunk. Do not use anything poisonous, corrosive or flam-

mable. Your choice of primary odour is ideally of something pleasant smelling, lacking in pungency (sting) and mildly intense in its undiluted form.

- Two sheets of kitchen paper towel
- Pencil and paper for recording results

Making the serial dilution of odorants

Write the numbers 1 to 12 on the bottom of each jar and place them in order on the table.

The jars must be large enough to take the liquids and leave a couple of centimetres for the headspace (the gap between the lid and the liquid) which will contain smelly molecules released by the liquid.

Figure 2: Jars 1 to 12 filled with a dilution series of odorant solution — in this example, rose water.

Fill the 12 jars with the primary odorant solution and/or clean water jars using the measuring jug/flask and eye-dropper, as shown in the following table (based on a total liquid of 100 mL/jar):

Pen-and-ruler method

No volumetric measurement tools will be needed:

Mark the glass with the marker pen to show where to fill them with odorant solution and water. Using the black pen, mark the sides of the jars with a dot to indicate the top (maximum) level of the final solution for each jar. Simply choose the level that suits your jar and amount of primary solution available. The top level does not have to represent an exact volume, but all bottles should have the same top level. Leave a centimetre or two for the headspace between the top level and the lid.

The headspace is important *because you will be sniffing the molecules in the headspace.*

There will be four jars (Numbers 1, 10, 11 and 12) with only the top-level mark. Set these aside once the top level is marked onto them.

Figure 3: The 12 bottles, shuffled and ready to begin the test. The paper towel behind the jars shows where to place the jars after judging them.

The other jars will have a second (dilution) mark denoting the fraction of primary odour solution they will need. The fraction reduces by half with each successive jar. That is, after Jar 1, each successive jar, from 2 to 9 will have half the amount of primary odour solution of the preceding jar. So, Jar 2 will have a second mark showing half the amount of Jar 1; Jar 3 will have a mark showing half that of Jar 2, Jar 4, half that of Jar 3, and so on to Jar 9. Use the ruler to help set these dilution marks.

The marks for Jars 7, 8 and 9 will be so close to the bottom of the jar that exactness will be difficult. This doesn't matter greatly. What does matter is to halve the amount of primary odorant going into each jar as you progress down the series.

Jars 10, 11 and 12 will have only the top level indicated and these will be filled to that level with clean water at room temperature. These are your blank controls. If you can smell something in these, the jar is not clean, or the water is not pure.

Filling the jars: Next, for Jar 1, fill it to the top level with your strongest odorant (the primary odour solution). Then add half that amount of primary solution to the next jar (No 2), reducing by half the amount for each successive jar (jars 2,3,4 ... 9). At the higher jar numbers (7, 8, 9), estimate the number of drops to be added: halving the drops as the jar number becomes higher. If you estimate that Jar 6 received 20 drops of primary solution, then deliver 10 drops to Jar 7, 5 drops to Jar 8 and 2 drops to Jar 9. Use an eye-dropper or carefully tilt and pour drops from the primary solution container.

When jars 1 to 9 have their sample amounts in them, *add clean water* to bring the solution in each up to the top level.

Figure 4: Test subject performing the olfactory threshold detection test ("Ozzie").

Whichever method you have used, all jars should now look identical. Rub off the lower level dots to remove clues to what the jar contains. Put a few marks and squiggles around the numbers under the jars to disguise the identity of the jar (if visible through the glass when sniffing). The number must still be easy to read when the jar is inverted (with lid on). Do not write the jar numbers on the wall or lid of the jar. On one sheet of the paper towel, write "SMELL" and on the other sheet, "NO SMELL" (Fig.3).

Lids should all be closed on the jars. Thoroughly clean up any odorant spill from the table and sides and lids of the jars. (If you are careful there will have been no spillage). Wash and dry your hands.

Shuffle the jars, into a random bunch, in front of you on the table.

The dilution series is now ready for testing.

Administering the test

Take the jars one at a time (start with any jar) and carefully open it and sniff the headspace. Do not dip your nose into the solution. Close the lid and put the jar on the sheet marked SMELL or NO SMELL according to your smell judgement of whether you could smell *anything* or not. Pause for 15 to 20 seconds before sniffing the next jar. Continue until all jars have either been judged and assigned to the SMELL group or the NO SMELL group. The test is now complete. Upon completion of the test, a result might look like this, for example:

- SMELL: Jars 1, 2, 3, 4, 5, 6, 7, **8**
- NO SMELL: Jars **9**, 10, 11, 12

Note the highest number on the bottom of the jar in the SMELL group (e.g. 8) and the lowest number in the NO SMELL group (e.g. 9).

In this example, the threshold lies between 8 and 9. Score yourself as having a detection threshold between the two: 8.5. Make a note of this result and the time and date of testing.

Interpretation of results

In this example, 8.5 is the numerical value of your smell detection threshold.

If you are becoming anosmic, this number will increase upon retest (or the liquids are losing their smell — see further detail below). In healthy people with normal olfactory acuity there should be *no change* in threshold score.

If you find you have all the bottles in the NO SMELL group, it suggests either that you didn't use an actual smell as a primary sample *or* you (already) have *anosmia*. If you think that your condition has come on recently and cannot be explained by nasal congestion or other causes, and you decide on the *anosmia* interpretation, first confirm your interpretation with the jelly-bean test (see above), then consult your health professional for a COVID-19 test.

Retesting

The jars can stand at room temperature for two or three hours.

Shuffle the jars and retest yourself after a chosen interval.

Prolonged use of the test for retesting up to 7 days: Put the jars on a small tray (e.g. a baking dish) and place them in your refrigerator (*not* in the freezer). If you wish to monitor for longer than seven days, make up a fresh set of liquids.

For retesting (say twice daily) remove the set of jars and allow to stand (lids on) for an hour to reach room temperature. Note your scores and any change between them.

If you find the scores have changed:

- A single-digit change may be inconsequential (measurement error) but a change in the direction of a *higher score* of two or more digits is indicative of a detrimental change. Retest twice after intervals of two or three hours to confirm or refute the "change" interpretation.

Conclusion

The current status of concern by medical scientists, about the role of the chemical senses in the COVID-19 pandemic, reinforces the need for authorities as well as individuals to promote and practice conscious awareness of smell and taste, in everyday life. Although the sense of smell plays an important part in our lives, we tend to ignore it. This means that we can be unaware of onset of the COVID-19 symptom, new loss of smell or taste, and crucially, our being contagious with it, until it is too late and the virus has been spread into the community. The risk of COVID-19 spreading through communities can be reduced by promoting smell awareness by everyone, using simple, inexpensive measures, suggested in this paper.

If you are losing/have lost your sense of smell as determined by change in smell threshold, consult your doctor/health service for a COVID-19 test.

If you have used this test and found yourself to be anosmic, *and* you test positive to COVID-19, or wish to communicate with the author, or share your experiences with the test and COVID-19, please post a comment to the *Ozzie Smell Test Group on Facebook*.

Disclaimer

The "Ozzie" test is free for use by all members of the global public currently concerned about their health in the time of

the COVID-19 pandemic. Use of the test and interpretation of results are undertaken entirely at your own risk. No company or institution associated with the author has any claim to or responsibility for the test.

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References

AAO-HNS. (2020) "COVID-19 Anosmia reporting tool for clinicians." *American Academy of Otolaryngology-Head and Neck Surgery*, https://www.entnet.org/content/reporting-tool-patients-anosmia-related-covid-19

Ault, A. (2020) "Sudden loss of taste and smell should be part of COVID-19 screen." *Medscape*, April 21, 2020. https://www.medscape.com/viewarticle/929116

Bagheri, S.H., Asghari, A., Farhadi, M. Shamshiri, A.R., Kabir, A., Kamrava, S.K., Jalessi, M., Mohebbi, A., Alizadeh, R., Honarmand, A.A., Ghalehbaghi, B., and Salimi, A. (2020) "Coincidence of COVID-19 epidemic and olfactory dysfunction outbreak." *Medrxiv*. DOI:1101/2020.03.23.20041889.

Boseley, S. (2020) "Thousands of Covid-19 cases missed due to late warning on smell loss, say experts." *The Guardian*, May 19. https://www.theguardian.com/world/2020/may/18/uk-coronavirus-tests-advised-for-people-who-lose-taste-or-smell

Boyle, D. (2020) "Self-isolate if you lose sense of smell and taste." *The Telegraph*, May 18. https://www.telegraph.co.uk/news/2020/05/18/monday-evening-news-briefing-new-virus-symptoms/

Bundock, L. (2020) "Coronavirus: Loss of taste and smell added to official symptom list." Sky News, May 18. https://news.sky.com/story/coronavirus-loss-of-taste-and-smell-to-official-symptom-list-11990305

Carney, S. (2020) "Loss of smell sense first sign of COVID-19." *Neuroscience News*, https://neurosciencenews.com/covid-19-loss-smell-15964/

Fahey, R. (2020) "Two thirds of coronavirus cases in Britain are undiagnosed because government refuses to recognise symptoms like loss of taste or smell, leading epidemiologist claims." *Mailonline*, May 9. https://www.dailymail.co.uk/news/article-8302467/Two-thirds-coronavirus cases-bri-going-undiagnosed.html

Fritz, A., Brice-Saddler, M. and Judkis, M. (2020) "CDC confirms six coronavirus symptoms showing up in patients over and over." *The Washington Post*, April, 27. https://www.washington-post.com/health/2020/04/27/six-new-coronavirus-symptoms/

Gane, S.B., Kelly, C. and Hopkins, C. (2020). "Isolated sudden onset anosmia in COVID-19 infection. A novel syndrome?" *Rhinology* Apr.2, DOI:10.4193/Rhin20.114.

Greenhalgh, T., Koh, G.C.H., and Car, J. (2020). "COVID-19: A remote assessment in primary care." *The BMJ* 2020:368:m1182.

Hopkins, C. and Kumar, N. (2020) "Loss of smell as marker of COVID-19 infection." *ENTUK*. https://www.entuk.org/sites/default/files/files/Loss%20of%20sense%20of%20smell%20as%20marker%20of%20COVID.pdf

Hummel, T., Sekinger,B., Wolf, S.R. Pauli, E and Kobal, G. (1997) "'Sniffin' Sticks': Olfactory performance assessed by the combined testing of odor identification, odor discrimination and olfactory threshold." *Chemical Senses*, **22**, 39-52.

Lewin, E. (2020) "Push to include anosmia as recognised COVID-19 symptom." Royal Australia College of General Practitioners. https://www1.racgp.org.au/newsgp/clinical/push-to-include-anosmia-as-recognised-covid-19-sym

Lutz, R. (2020) "More evidence backs loss of smell as an early symptom of COVID-19." *Contagion Live*, April, 20. https://www.contagionlive.com/news/more-evidence-backs-loss-of-smell-as-an-early-symptom-of-covid19

Menni, C, Valdes, A.M., Freidin, M.B., Sudre, C.H., Nguyen, L.H., Drew, D.A., Ganesh, S., Varsavsky, T., Cardoso, M.J., Moustafa, J.S.E.-S., Visconti, A., Hysi, P., Bowyer, R.C.E., Mangino, M., Falchi, M., Wolf, J., Ourselin, S., Chan, A.T., Steves, C.J. & Spector, T.D. (2020). "Real-time tracking of self-reported symptoms to predict potential COVID-19." *Nature Medicine*. https://doi.org/10.1038/s41591-020-0916-2

Meixner, S. (2020) "Should a loss of smell and taste be added to Australia's recognised coronavirus symptoms?" *ABC News*. https://www.abc.net.au/news/2020-04-03/coronavirus-covid-19-loss-of-taste-smell-sense-testing-criteria/12115022

Miller, C., Bowden, J., and Dono, J. (2020) "What is the prevalence, positive predictive value, negative predictive value, sensitivity and specificity of anosmia in the diagnosis of COVID-19?" *COVID-19 Evidence Update from SAHMRI, Health Translation SA and the Commission of Excellence and Innovation in Health, Government of South Australia*. 2nd Ed., May, 4.

O'Donovan, J., Tanveer, S., Jones, N., Hopkins, C., Senior, B. A., Wise, S.K., Brassey, J. and Greenhalgh, T. (2020) "What is the evidence for anosmia (loss of smell) as a clinical feature of COVID-19?" *Oxford COVID-19 Evidence Service*, https://www.cebm.net/covid-19/what-is-the-evidence-for-anosmia-loss-of-smell-as-a-clinical-feature-of-covid-19/

Parma, V., Ohla, K., Veldhuizen, M.G. et al.[1] (2020) "More than just smell. COVID-19 is associated with severe impairment of smell, taste, and chemesthesis." Global Consortium for Chemosensory Research (GCCR). *medRxiv* 2020.05.04.20090902; DOI: https://doi.org/10.1101/2020.05.04.20090902

Philpott, C. (2020) "Coronavirus: loss of smell and taste reported as early symptoms of COVID-19." *The Conversation*. https://theconversation.com/coronavirus-loss-of-smell-and-taste-reported-as-early-symptoms-of-covid-19-134564

Rashid, A. (2020) "Loss of smell and taste added to the CDC's list of COVID-19 symptoms." *Xtalks*, April 24. https://xtalks.com/loss-of-smell-or-taste-added-to-the-cdcs-list-of-covid-19-symptoms-2222/

Roberts, M. (2020) "Coronavirus: Are loss of smell and taste key symptoms?" *BBC News*. https://www.bbc.com/news/health-52111606

Saey, T.H. (2020) "Loss of smell and taste may actually be one of the clearest signs of COVID-19." *Science News*, May 11. https://www.sciencenews.org/article/coronavirus-covid-19-symptoms-signs-loss-smell-taste

Sensonics International (2020) https://sensonics.com/smell-identification-test-international-versions-available.html

1 See the publication for the full list of 114 authors. [Ed.]