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Sumner's "On Testing the Sense of Smell" Revisited

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The routine test of olfaction need not lead to an ambiguous outcome, a rather widely held notion. A multiple-choice test of odor identification that avoided the difficulty of retrieving odor names yielded excellent resolution among the categories normosmic, hyposmic, and anosmic. The outcome agreed almost perfectly with a more complicated test of threshold and offered much encouragement for the use of odor identification in rapid screening of olfaction.

In 1962, Sumner [1] stated that "The recognition and identification of test substances still remains the only practical means of testing olfaction in the wards, for the quantitative [threshold] method[s] . . . [are] too time-consuming for routine screening . . . [and] far too elaborate for anything but the research laboratory" (p. 896). Sumner expressed these sentiments in a report that revealed how poorly normal patients and medical personnel could identify the odors used to test olfaction. The remedy for poor performance seemed elusive. For example, only 75 out of 200 normal persons could identify all four of Sumner's most identifiable odors (coffee, almond, tar, and lemon oil). He therefore concluded that "Even the use of test substances which can be identified more readily will never make the qualitative testing of olfaction wholly easy or accurate, for, as we are all aware . . . our language has hardly any words which characterise odours" (p. 896). Neurology manuals published in the last two decades have proffered no antidote to the frustration of olfactory testing [2].

Sumner's concern with verbal factors was correct, though somewhat out of focus. For the substances coffee, tar, almond, and lemon oil, the odor names are identical to the names of the stimulus objects. Nevertheless, verbal factors, specifically unsuccessful retrieval of well-known names (e.g., orange, tobacco, leather, and rubber), do limit performance [3]. Persons will often block on the names of these everyday odors. When given help with retrieval of the names, most persons exhibit an unexpected facility of identification. A multiple-choice test, for instance, where name retrieval poses no limitation, yields identification of many odors [3]. Accordingly, Cain and Krause [2] developed a brief multiple-choice test as one procedural option for use in the clinic. This test circumvents the problem of odor naming; a normative group of 20 young adults scored 99 percent.

Recently, more than 40 patients have come to our laboratory for evaluation. This group has made it possible to decide: (*1*) whether our test yields adequate results in

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actual clinical circumstances, and (*2*) whether the outcome of the identification test agrees with another measure, namely the absolute threshold. As Sumner [1] observed, a threshold test requires more time than customarily available in the clinical setting. Nevertheless, the threshold for olfaction, like that for hearing measured in the audiometric examination, presumably serves as a highly sensitive index of loss. Insofar as the threshold test and the identification task yield the same fundamental outcome, then the clinician could feel some security in the use of only one task, presumably the more convenient identification task.

METHODS

Patients

The 43 patients (eight to 60 years old) were generally referred by physicians in the region. The patients included primarily victims of head trauma, of occupational exposure to caustic chemicals, of viral infections that had apparently affected olfaction, and of hormonal disorders. The largest category comprised adolescents suspected of having the hormonal disorder Kallmann's syndrome and their siblings. Inclusion of the siblings fortunately guaranteed a reasonable number of normosmic patients for comparison with anosmics and hyposmics. All 43 patients served in the threshold test described below and 33 served in the identification task.

Procedure

The identification task entailed use of 10 or 11 substances chosen for high identifiability: (*1*) baby powder (Johnson), (*2*) fruit-flavored chewing gum, (*3*) chocolate, (*4*) cinnamon, (*5*) coffee (ground), (*6*) leather (excluded sometimes), (*7*) mothballs, (*8*) peanut butter, (*9*) potato chips, (*10*) soap (Ivory), and (*11*) wintergreen. These names appeared along with 11 distractors on a list available to the patient. Distractors included (*1*) burnt paper, (*2*) garlic, (*3*) ketchup, (*4*) orange, (*5*) pepper (black), (*6*) rubber, (*7*) sardines, (*8*) spoiled meat, (*9*) tobacco, (*10*) turpentine, and (*11*) wood shavings. The terms burnt paper, garlic, rubber, sardines, and spoiled meat represented odor qualities that might occur in parosmia.

Samples were contained in opaque jars covered with gauze. When presented a substance, the patient scanned the 22-item list for the correct answer. If incorrect, the patient received corrective feedback for future reference. Some patients with normal functioning managed to achieve a perfect (10/10, 11/11) or nearly perfect (9/10, 10/11) score in one pass, which typically took five to ten minutes. Testing might then cease. Patients who performed less well had the opportunity to profit from corrective feedback on a second and, if necessary, a third pass.

Threshold testing employed the odorant 1-butanol (woody-alcohol smell) presented in 60-ml glass vessels such as shown in Fig. 1. The patient placed a nosepiece onto the top port of the vessel. A sniff would draw off the headspace above a cotton ball that sat on a perforated filter disc. The cotton ball was impregnated with 1 ml of an aqueous solution of 1-butanol.

Threshold was measured by a two-alternative, forced-choice procedure [4]. On each trial, the patient smelled from two bottles successively and had to decide which contained odorant and which contained just water, guessing if necessary. From trial to trial, concentration increased by a factor of three from the lowest, 10^{-5} M, toward the highest, 6×10^{-1} M. Such an ascending series ceased before reaching the maximum concentration if the patient achieved three or four correct choices in succession. The concentration that fell at the geometric midpoint between the last *miss* and

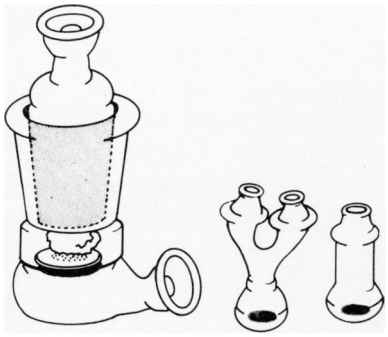

FIG. 1. Odor test vessel shown along with nosepieces for one nostril and two nostrils. The nosepiece was placed on the top of the vessel. A sniff drew air through the bottom port and into the section that contained an odorant-soaked cotton ball.

first of the string *hits* was taken as one estimate of threshold. A total of four or six such estimates, averaged geometrically, became the net estimate of threshold. This test took about one-half hour per patient.

Some of the variations in procedure, namely, use of four versus six ascending runs, the criterion of three versus four correct responses, and inclusion of ten versus 11 substances in the identification task, actually represented evolution in procedures. The protocol in effect during the testing of the final patients called for four ascending runs (two per nostril), a criterion of four correct per run in the threshold testing, and identification of ten substances (tested with each nostril). In the absence of any categorical difference in sensitivity between the nostrils in this sample of patients, threshold was computed across the nostrils

RESULTS

Figure 2 depicts the distribution of thresholds rounded off to the nearest dilution step, where step 0 equalled 6×10^{-1} M. The majority of patients had normal thresholds. These formed a rather coherent distribution. About a quarter of the patients appeared anosmic. The classification into normal, anosmic, hyposmic, represented the decision reported to the referring physician at the time of testing rather than a post-hoc analysis of the aggregate data. Decisions regarding the status of the patient came about from three sources: the threshold test itself, the odor identification test (if given), and the patient's answers to key questions concerning the sensations experienced during threshold testing.

One reason to have chosen butanol for the threshold test is that it can yield two

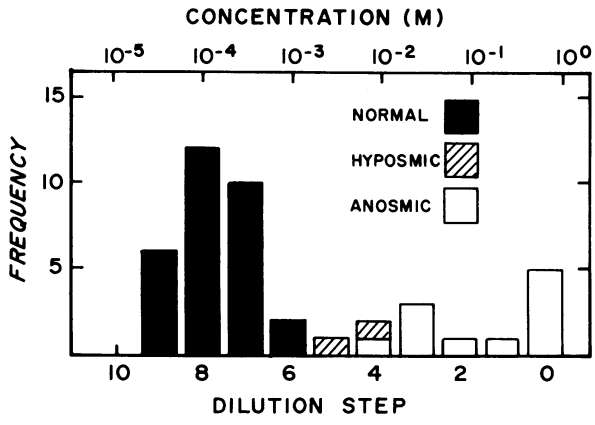

FIG. 2. Showing the number of patients with average thresholds at each of the various concentrations of 1-butanol. The bar plotted at dilution step 0, i.e., the highest concentration, included patients with indeterminately high thresholds. Total number of patients equalled 43.

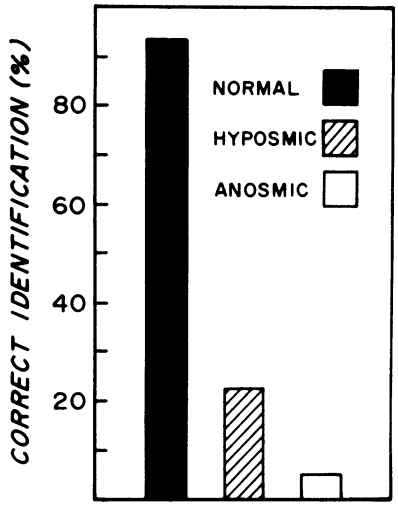

FIG. 3. Showing the performance of normosmic, hyposmic, and anosmic patients in the odor identification test (n = 33).

thresholds, an olfactory (odor) and a trigeminal (pungency) threshold. Anosmic patients will often notice pungency at the higher concentrations (dilution steps 3, 2, 1, or 0). In the case of the patient (Kallmann's candidate) classified as anosmic with a threshold at dilution step 4 (Fig. 2), he claimed to detect the stimulus only by "feel" (pungency).

Figure 3 depicts performance in the identification task. Average performance of the normosmics fell between 90 and 100 percent, as expected. In 15 of 23 cases, the normosmics achieved 100 percent. In only two cases did performance of normosmics dip below 80 percent. In one case, the patient had exhibited parosmia and was considered normosmic only from the standpoint of sensitivity. The parosmia altered odor quality noticeably. The other normosmic patient with poor identification, the sibling of a Kallmann's patient, had no other anomalous sign. Of two other patients with the complaint of parosmia, one appeared hyposmic by the threshold test and could identify only three of 11 substances in the identification task. The other had normosmic sensitivity, but scored third poorest among normosmics in the identification test (80 percent). Parosmia and hyposmia often go hand in hand [5].

DISCUSSION

The brief identification test can fare as well as or better than the more cumbersome and time-consuming threshold test. The segregation among normosmics, hyposmics, and anosmics appears entirely adequate in this instance of the identification test, where verbal factors played no limiting role. The success of the test in the assessment of normosmia, hyposmia, and anosmia presumably has perceived intensity at its base. That is, as perceived intensity fades, odor quality desaturates and, though the patient with poor sensitivity may detect something, he cannot name it reliably. We can therefore offer the present test as a reasonable way for the physician to test olfaction routinely. Whereas Sumner could voice only pessimism about the testing of smell, we can now voice considerable optimism.

ACKNOWLEDGEMENT

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