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PAPER

GENERAL

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Do Trained Dogs Discriminate Individual Body Odors of Women Better than Those of Men?*

ABSTRACT: Scent identification lineups using dogs are a potentially valuable forensic tool, but have been dismissed by some critics because of cases where a false identification was shown to have occurred. It is not known, however, why dogs appear to make more false indications to the odors of some persons than of others. In this study, human genders were compared as to the degree their individual odors are distinguishable or "attractive" to dogs. Six dogs were trained to smell an individual's hand odor sample and then find the matching hand odor sample in a lineup of five odors. Using one-gender lineups and two-gender lineups with different gender ratios, it was found that dogs trained for the study identified individual women's hand odors more accurately than those of men. It is hypothesized that this is either because of differences in chemical compounds making discrimination of women's odors easier, or because of greater "odor attractiveness" of women's scents to dogs.

KEYWORDS: forensic science, individual human odor, identification, gender differences, canines, scent lineups

It is widely accepted that human body odor is individually specific (1–4), and this specificity may be retained despite such factors as menstrual cycles, emotional states, health, and possibly age (5–7). Studies on "odor fingerprints" applying chemical analytical methods such as gas chromatography–mass spectrometry (GC–MS) (3,8) or ultra performance liquid chromatography (9) are relatively new although it has been assumed by those interested in using odor detection canines to identify perpetrators that individual human odor fingerprints exist (10,11). A number of studies have demonstrated that individual body odor is genetically determined (12), in particular by the highly polymorphic major histocompatibility complex loci (6,13,14).

Individually specific body odors have been described as "odortypes" (14). Analytical chemistry techniques, especially GC–MS, have shown that human sweat contains a complex mixture of volatiles (15–17). Therefore, it is not clear whether individual and genetically determined odor variation is of a discontinuous character, and hence whether the term "odortype" is appropriate. In a study using GC–MS profiles, no evidence for discontinuous variation of human odor was found (3). According to this study, there is a continuous phenotypic variation of human odor, suggesting quantitative differences between individuals. Genetically, the individual odor would be influenced by many loci and therefore, using the terms "chemical signature," "odor signature," (18) "chemical fingerprints," or "odorprints" for the description of the individual character of human odor seems to be more appropriate (3). Controversies as to the variation of chemical compounds making individual human odor, existence of the "odor attractiveness" of some individuals, and a need to prove this by analytical methods have prompted a study on the occurrence of chemical compounds in human odor across a population, which found that, of 63 compounds extracted, 79.4% were present in less than one-third of the individuals sampled (19).

For forensic purposes, human hand odor is more interesting than axillary odor, as perpetrators usually touch objects at the crime scene with their hands and hand odor is the most common human odor collected as forensic evidence (19).

Canine lineups have consisted of collecting samples of odors left at a crime scene and matching these samples to odor samples taken from suspects. The identification of individual humans by dogs was accepted on the hypothesis that human odor is stable over time and distinguishable between individuals (11). The assumption that dogs can reliably distinguish individual humans on the basis of odor was based on "popular wisdom" but had not been sufficiently supported by scientific studies using other analytical tools. The results of canine identification have been admitted in some countries as evidence in courts of law (20,21), despite significant criticism from legal scholars (22). A 1991 study cast doubt on whether there are individual human odors identifiable by dogs because dogs trained to discriminate odors obtained from persons' hands were unable to distinguish odors obtained from the crook of their handler's arm from the odors of strangers (23). Ideally, for admission of evidence in courts, dogs should only match crime scene odors to perpetrators, but a sufficiently high accuracy rate might be acceptable with a judicial requirement that there be corroborating evidence for the conviction of a suspect (24). Unfortunately, a number of research studies have produced rather weak results. A 1994 study looking at

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matching scent from different body parts found that dogs were correct in matching a scent from a person's hand to his elbow 73% of the time if the individual was known to them, but only 25% of the time when the scent was that of a complete stranger (25). Another study (26) found much better results for dogs selecting from two rows of scent cloths (80% correct matching, against a random score of 17%), and even better (85%) when steel tubes were used. In a comparison of four experimental designs, Schoon (10) observed that dogs retrieved the correct tube 31%, 47%, 58%, and 55% of the time but were wrong, respectively, 60%, 45%, 18%, and 21% of the time. In another study, Schoon (11) observed that dogs matched a "perpetrator" only 36.5% of the time, while when there was no proper match to be made, correctly retrieved no tube 47.4% of the time. Nevertheless, adjusting for certain factors, she argued that a "realistic" level of matches, where a match was possible, would have been about 60%. With such adjustments, she calculated that every 13.6 times a dog could identify a perpetrator by retrieving a tube in a line up, the dog would be wrong once (i.e., falsely identify someone who was innocent), while in every 2.6 cases, a person would not be identified though guilty (11). Another study found that errors increased in training phases for a dog, indicating that accuracy in past performance does not predict accuracy in future performance (27). It has been argued by a legal scholar that the percentage of false alerts (FAs) made by dogs in lineups, and the subsequent false identifications leading to false accusations in courts, was too high to be accepted as valid judicial evidence (22). Yet experiments conducted on monozygotic twins and nonrelated persons showed that dogs rely heavily on genetic cues when differentiating between people (28–30).

Attempts to improve the reliability of canine lineups by modifying the experimental design (10,11,31) or by monitoring of the performance of particular dogs (32) did not satisfy many judicial experts. As a result, the practical application of the identification of perpetrators by dogs has been substantially reduced or withdrawn from the forensic practice in some countries, such as the Netherlands (33). An individual component of human odor is potentially a valuable biological trace left at the scene of crime, and dismissal of this identification method seems premature for three reasons: first, the number of scientific studies on human odor differences is limited; second, the methodology used to collect and handle samples is so variable that it may obscure relevant patterns; and third, some research has indicated that error rates can be substantially reduced by particular protocols.

An ideally reliable forensic identification method depends upon all human subjects being equally identifiable. In canine lineup methodology, the term, "odor attractiveness" has been introduced to explain a higher ratio of dogs' FAs toward the odor of particular persons (34). In scent lineup protocols, this has resulted in excluding persons (perpetrators) whose odors are "attractive" to dogs (i.e., where dogs show special interest to a given odor manifested by frequent false indications of this odor during control trials), but this does not seem to guarantee that the dogs would not show special interest and false indications during real actual (postcontrol) trials (32,34). From the forensic point of view, a low rate of FAs in a lineup is crucial for the reliability of canine identification of perpetrators on the basis of odors left at the crime scene.

The authors have found no experimental studies on reasons why scent-identification dogs ("ID dogs") make more false indications to the odor of some persons than to the others. We hypothesize that dogs may be either attracted to the odor of some persons because of particular volatile organic compounds or may not discriminate an individual's specific odor because of its similarity to odors of other persons because of similar chemical compounds that comprise this odor. It is also possible that the odor of some persons is repulsive to dogs and that where a repulsive odor is the correct choice in a scent lineup, the dogs may instead indicate falsely to the odor of another person. Inter individual variability or intra individual consistency of odors may be involved as well. It is known that because of variation in chemical cues, mosquitos are more attracted to some individuals than others (35,36).

The gender differences in odor quality as perceived by canines may have implications in using dogs for forensic identification purposes and in the detection of persons carrying narcotics or explosives (37). The aim of this work was to compare the ability of dogs used for forensic identification to discriminate individual odors of male and female human subjects and to assess the attractiveness of male compared with female odors.

Material and Methods

Six trained dogs (German Shepherds, four males and two females) were used for the experiment. The dogs were *c.* 12 months old at the beginning of the training.

The dogs were maintained in individual kennels and fed with standard pet dog food, with constant access to water. The daily feed ration comprised 1200 *g* moist food given after the training session at 2:00 PM and 250 g dry food in the evening. Independently of the individual specialist training in the sniffing room, dogs were walked 2–3 times daily for *c.* 30 min. Four handlers trained and took care of the dogs for the whole period of the study. Each handler trained 1–2 dogs.

The dogs were trained to sniff an odor sample at the starting point and to find the matching odor sample (of the same person) placed in a lineup of five odors and to indicate the matching sample by sitting or lying down in front of the sample. Operant conditioning with a food reward was used in the training. The details of this training of naïve dogs up to the expertise level have been described elsewhere (27,38).

Odor Samples

Terms used in the paper are defined in Table 1. Donors of the odor samples were informed about the aim and principles of the study and consented to having their odor samples tested. The donors were Caucasians aged 20–60 and recruited with no special preconditions. Approximately 20 min before the odor samples were taken, donors were asked to wash and dry their hands and not to use any cosmetics. The samples were taken by holding/squeezing two sterile cotton cloths (10 × 15 cm) in hand palms for 15 min, continuously. The samples were then put in sterile glass jars, closed, sealed, and stored at room temperature for a period of 1–20 weeks before use. Samples were taken 3–4 times on consecutive days to obtain enough samples for the tests.

The donors of the odor samples were alien to the dogs. A different set of donors were used on each testing day. No twins or closely related persons were used in the same set of donors. Odor samples from 170 men and 80 women were used as decoys only. For target samples to be identified by dogs, samples from 70 men and 45 women were obtained, from which samples of 54 men and 34 women were used first as decoys and, thereafter, as target samples.

Testing Procedure

ID tests were conducted indoors, in a 7 × 7-m room isolated from external distracting stimuli, equipped with a washable floor and heated in winter.

TABLE 1—*Definitions of some terms used.*

Term	Definition
Correct indication	An operationally conditioned response where the dog is trained to exhibit a specific behavior (usually sitting or lying down) in front of the target sample
Decoy sample	Human scent sample taken on the similar cotton cloth as the target sample, placed in the lineup but not matching the sample given to sniff at the starting position (the pattern sample); the dog should not indicate to the decoy sample
False alert (FA)	False positive indication by the dog of a decoy in the lineup
Miss (MI)	False negative indication, lack of indication of the target sample in the lineup
Pattern sample	Human scent sample given to the dog to sniff at the starting position before searching in the lineup. This sample matches the target sample in the lineup (both are taken from the same person)
Stands in the lineup	Heavy pots with glass jars containing scent samples, situated in a lineup of five stands on the floor, 80 cm apart, forming an arch fully visible for stationary video recording
Target sample	Human scent sample placed randomly in the lineup, to be indicated by the dog, matching to the sample given to sniff ("taking air") at the starting position (the pattern sample)
Trial	Sniffing the pattern sample at the starting position and walking of the dog along the scent lineup, sniffing the samples, with the indication of the target sample by sitting or lying down

During the tests, only two persons who were well known to the dog were present in the sniffing room. These persons were as follows:

- The experimenter, who put odor samples into five stands of the lineup, signaled the start of dog's searching and gave an acoustic signal, using a clicker, when the dog indicated the target sample correctly. The experimenter remained hidden behind a curtain, thus being invisible to the dog and to the handler during a test and observing the dog's work through a video monitor.
- The dog's handler, who gave the pattern odor sample to the dog to sniff at the starting position, encouraged the dog to sniff all samples in the lineup and rewarded the dog with a food treat after the clicker was activated by the experimenter.

Each dog was tested for 8–10 trials daily, depending on the dog's motivation for work as judged subjectively by the handler. There were 3–4 test days per week. The floor in the test room was washed at the end of each testing day to remove odors that might distract the dogs.

The samples used in the trials were prepared by taking a scented cloth from the storing jar with pincers, cutting two 5 × 10 cm pieces from the cloth and placing these in two separate sterile jars, the first being the "pattern" sniffed by the dog directly before the start of its walk along the lineup and the second being the "target" placed at a random position in the lineup. To assure the randomness, the True random number generator (39) was used.

The jars were sufficient small in diameter (7 cm) and sufficient deep (16 cm) to prevent direct contact of the dog's nose with the scented cloths.

An indication of the target sample was considered to be correct if the dog sat or lay down in front of the target sample, without any FAs (a false positive indication of a decoy sample) and without any hesitations. After the first FA during a trial, the dog was allowed to continue by being given an opportunity to indicate correctly, but the trial was classified as a FA. If the dog made two FAs in a trial or sniffed all samples in the lineup three times without indicating to any of them, the dog was recalled by the handler to the starting position and the trial was classified as a miss (MI).

Altogether, 3675 trials in one-gender (OG) lineups were conducted, consisting of men's odors (2523 trials) and women's odors (1152 trials), along with 996 trials of two-gender (TG) lineups with different ratios of odor samples from both genders (1:4, 2:3, 3:2, and 4:1). In 457 trials in TG lineups, the target was a woman's odor and the gender ratios were the preceding ratios of women to men; in 539 trials in TG lineups, the target was a man's odor and the gender ratios were of men to women.

Ethics

The experimental procedure and keeping conditions for the dogs were approved by the 3rd Local Ethical Commission for Animal Experimentation in Warsaw, Poland.

Statistics

The percentage of correct identifications, FAs, and MIs toward women's or men's odor samples in OG and TG lineups were calculated. For TG lineups, calculations were made across different ratios of women/men if a woman's odor was identified and across different ratios men/women if a man's odor was identified. For the TG lineups, two kinds of FAs were considered as follows: (i) FAs toward the same gender as target and (ii) FAs toward the opposite gender as the target.

For differences in correct responses, FAs and MIs between genders in OG and TG lineups, the ratio within each gender, and for all ratios together, the chi-square test was used. The relationship between correct indications and FAs for the same sample, used first as a decoy and next as a target, was assessed by calculating Spearman correlation coefficients.

Results

In OG lineups, there were significantly more correct indications and fewer MIs if women's odors were tested (Fig. 1, $p < 0.05$). In TG lineups, the percentage of correct indications taking all gender ratios together was higher when women's odors were the target (Fig. 2 and Table 2, $\chi^2 = 16.2$, d.f. = 1, $p < 0.001$). Considering the gender ratios separately, women's odors were significantly more frequently correctly indicated than men's odors at the ratio 1:4, that is, when all odors except for the target odor were of the opposite gender (Fig. 2 and Table 2, $\chi^2 = 4.07$, d.f. = 1, $p < 0.05$); however, the dogs did not identify any more correctly when odors were presented in different ratios of women to men.

The percentage of FAs in TG lineups was calculated separately for the opposite gender and for the same gender as the gender tested (i.e., the gender that was the pattern sample and the target sample) (Figs 3 and 4). It should be mentioned that no FAs were possible for the gender that was identified if the ratio of this gender to the opposite gender was 1:4 because at this ratio, no other individual of the same gender apart of that identified was available in the lineup.

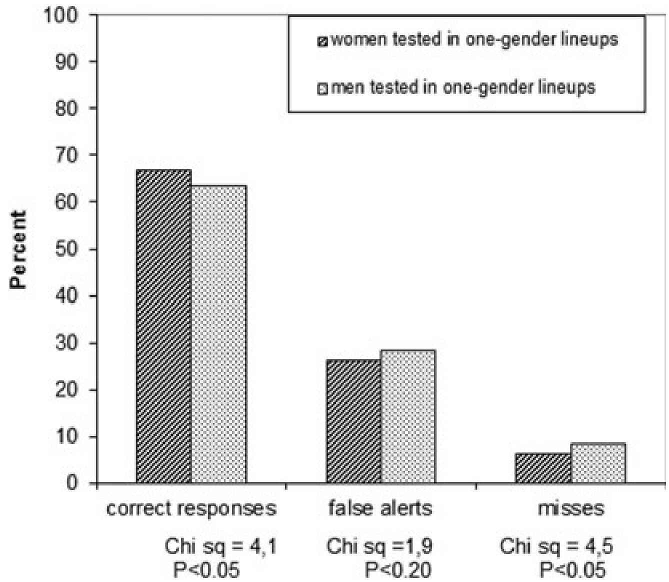

FIG. 1—*Percentage of correct responses, false indications, and misses toward women's and men's odors in one-gender lineups.*

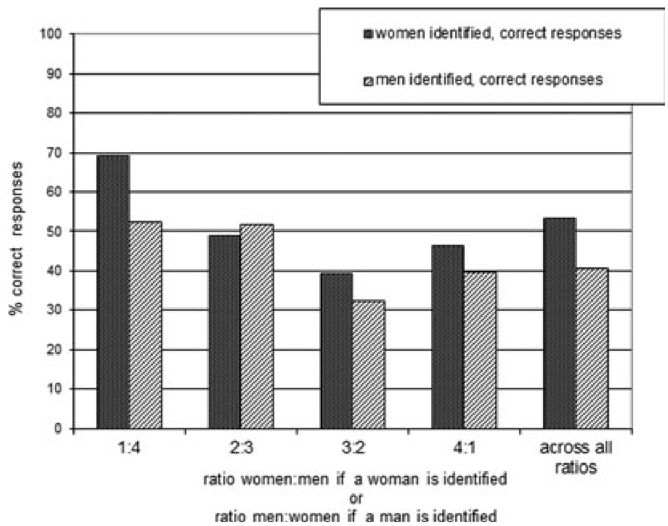

FIG. 2—*Percentage of correct responses in two-gender lineups depending of the gender ratio.*

TABLE 2—*Results of statistical analysis for Fig. 2.*

Gender Ratio	1:4	2:3	3:2	4:1	All Ratios
Differences between genders	$\chi^2 = 4.07$ d.f. = 1 $p < 0.05$	$\chi^2 = 0.18$ d.f. = 1 $p < 0.90$	$\chi^2 = 1.47$ d.f. = 1 $p < 0.30$	$\chi^2 = 1.02$ d.f. = 1 $p < 0.40$	$\chi^2 = 16.2$ d.f. = 1 $p < 0.001$

In TG lineups, the percentage of FAs toward women's odors was generally higher when a man's odor was tested; however, this difference was significant ($p < 0.05$) only at the men/women ratio of 1:4 (Fig. 3 and Table 3). This means that dogs made significantly more FAs toward women when one man's odor was in a lineup with four women's odors. The percentage of FAs toward women's odors, however, tended to decrease with the decreasing ratio of women's odors in TG lineups. On the other hand, a

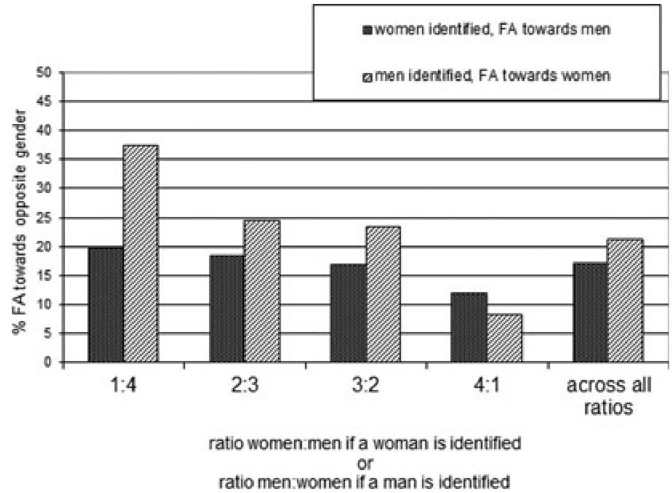

FIG. 3—*Percentage of false indications toward the opposite gender in two-gender lineups depending on gender ratio.*

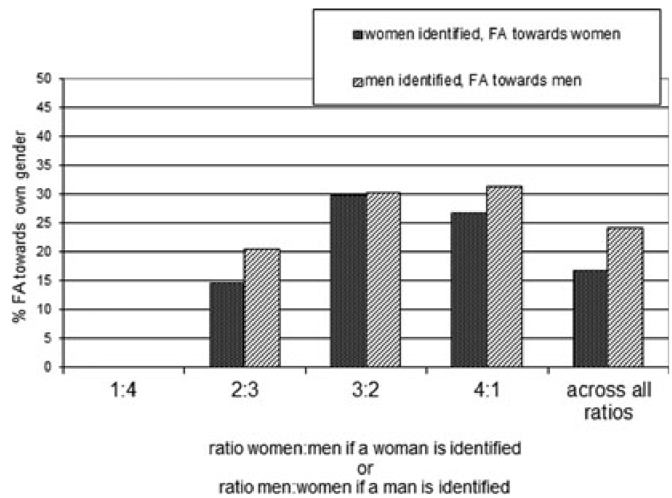

FIG. 4—*Percentage of false indications toward the same gender in two-gender lineups depending on the gender ratio.*

TABLE 3—*Results of statistical analysis for Fig. 3.*

Gender Ratio	1:4	2:3	3:2	4:1	All Ratios
Differences between genders	$\chi^2 = 5.61$ d.f. = 1 $p < 0.05$	$\chi^2 = 1.26$ d.f. = 1 $p < 0.30$	$\chi^2 = 1.61$ d.f. = 1 $p < 0.30$	$\chi^2 = 0.90$ d.f. = 1 $p < 0.50$	$\chi^2 = 2.88$ d.f. = 1 $p < 0.10$

tendency of the FAs toward men's odors to decrease, if the ratio of men's odors in the lineups decreased, was less evident (Fig. 3).

The percentage of FAs toward the same gender as the gender tested was significantly higher taking all gender ratios together if the tested gender was a man. This difference was, however, nonsignificant for particular gender ratios (Fig. 4 and Table 4).

The correlations between the percentage of correct indications when the individual odor was the target odor and the percentage of FAs when this odor was a decoy in a different trial were positive and two times higher for men than for women (Table 5). The percentage of MIs in TG lineups did not differ significantly between genders.

TABLE 4—*Results of statistical analysis for Fig. 4.*

Gender Ratio	2:3	3:2	4:1	All Ratios
Differences between genders	$\chi^2 = 1.35$ d.f. = 1 $p < 0.30$	$\chi^2 = 0.01$ d.f. = 1 $p < 0.90$	$\chi^2 = 0.57$ d.f. = 1 $p < 0.50$	$\chi^2 = 7.94$ d.f. = 1 $p < 0.01$

TABLE 5—*Spearman correlations (rs) and their significance (*p*) between percentage of correct indications of target odor samples and percentage of false alerts (FAs) to the same samples used as decoys.*

	N	rs (*p*)
Both genders together	88	0.18 (0.08)
Females	34	0.10 (0.57)
Males	54	0.22 (0.10)

N, number of donors.

Discussion

In our previous study (34), of 186 persons who were tested more than 30 times each, only 19.3% of persons were never indicated falsely by ID dogs certified by Poland's Police Canine Department and 4.3% of persons were indicated falsely in 25–75% of trials.

The results of the present work show that trained ID dogs identified women better than men on the basis of hand odor, because there were significantly more correct indications and fewer MIs in OG lineups consisting of women's odors. This could be due to a more chemically discrete characteristic or greater intensity of individual women's odors, thus making it easier for dogs to distinguish individual women. This may correlate with a study analyzing hand odor of 30 men and 30 women using micro-extraction GC–MS (19), which revealed more compounds in women (58 compounds with a total frequency of 419) than in men (46 compounds with a total frequency of 326).

In another study (9), it was found that the ratio between the acid precursor, a glutamine conjugate, and the "sulfur" precursor, a cysteinylglycine-S-conjugate, was three times higher in men than in women, with no correlation with either the sweat volume or protein concentration. Although the axillary sweat of men and women have similar GC–MS profiles, one study found that it was possible to discriminate the sexes statistically and to find 12 marker compounds characteristic of gender (3). The authors of the latter study (3) found no marker that was uniquely indicative of gender and assert that the differences between the sexes is characterized by a multivariate distribution of marker compounds, which makes odor difference somewhat analogous to facial features.

Among the six high-frequency compounds for both men and women, including 2-furancarboxaldehyde, 2-furanmethanol, phenol, nonanal, decanal, and hexanedioic acid-dimethyl ester, two compounds, namely nonanal and decanal, showed a high frequency in the headspace above the forearm skin of women (40). Of other compounds, the tetradecane was reported as a high-frequency compound, while 6-methyl-5-hepten-2-one was of low frequency in women (40). It was observed that all these compounds could react with cosmetic products applied to the human skin, and the presence of these compounds could cause differences in the odor perceived (40). This may have implications for the results reported here because women usually use more cosmetics for hand skin care and it is not known whether simple hand washing before taking samples removes all cosmetics odors. Stronger odors were detected in women from ketones, higher levels of aldehydes and branched hydrocarbons, while weaker odors were detected in women that generally came from glycol compounds and some fragrance residuals, which did not exhibit ketones (40). The differences in chemical composition of female versus male skin odor may contribute to better individual discrimination of women by dogs.

In studies on human malodor, the axillary region was of more significance than hand odor (3). The axillary region is characterized by a dense aggregation of eccrine, apocrine, apoeccrine, and sebaceous glands. The microbiota nurtured by products of these glands are thought to play an important role in generating individual odor (3). The compounds making hand odor are products of eccrine as well as sebaceous glands, but apocrine glands do not influence hand odor (19). Thus, axilla and hand odors may be perceived differently, although these odor sources may contain the same individual components. Skin bacteria and bacterial enzymes involved in sweat transformation, sex, and individual odor differences, may affect how odors are different (9). No unique and exclusive odor markers that discriminate the sexes could be found by one team; however, there were differences between males and females in the occurrence of certain compounds (3). Some authors (9) have tried to elucidate the extent to which two odor precursors of the volatile (R)/(S)03hydroxy-3-metylhexanoic acid and the volatile tiol (R)/(S)-3-methyl-3sulfanylhexan-1-oil (human specific)—identified as components of human sweat malodor of axillary secretions—may be implicated in the gender-specific character of body odor. Odors of sweat samples having the highest sulfur intensity were found to be the most intense and the most unpleasant to human perception (9).

A terminology to distinguish components of the human odor that dogs are confronted with when sniffing has been developed (19). "Primary odor" is considered as deriving from odor constituents that are genetically based and stable over time regardless of diet or environmental factors; "secondary odor" contains endogenous constituents influenced by diet and environmental factors; "tertiary odor" contains exogenous constituents, such as lotion, soaps, and perfumes (19). More components should be added to this classification including a "background odor" that is the odor of the sampling material (41) plus other odor molecules that may contaminate odor samples. According to this terminology, ID dogs should indicate the "primary odor" without paying attention to the other odor components. We were able to control the "tertiary" and "background" odors, but the "secondary" odors are more difficult to control. For example, our female odor donors could be at different phases of their menstrual cycles, which may facilitate dogs' differentiation of women's odors. Unfortunately, we were not able to get data on menstrual cycle or on medications the donors may have been taking.

In forensic practice, TG lineups are not advisable because it is supposed that the odor differences between genders may influence the indications. Also in forensic practice, human subjects whose odors are investigated should be of similar age. The results in OG lineups reflect a better discrimination of individual odors of women compared with men, whereas the results in TG lineups reflect rather differences in attractiveness of odors of both genders. The dogs, having sniffed the target odor of a man and four women decoys, made more FAs toward female decoys, whereas having sniffed the target odor of a woman they made significantly fewer FAs toward male decoys. This difference was nonsignificant at other ratios of genders in lineups, that is, when more than one sample of the gender, which was tested, was sniffed in the lineup. When the target odor was a woman's odor in TG lineups, dogs made fewer FAs toward the same gender compared with tests where a man's odor was the target. This difference was significant only when taking all gender ratios together.

Some studies show that dogs react behaviorally differently to men and women: shelter dogs were more relaxed when petted by women than by men, and there are sex differences in the effectiveness of patters in reducing the cortisol response (42). However, this phenomenon was not attributed to differences in women's and men's odors, and the role of odor was not investigated in this study (42). Dogs show a lower incidence of barking and a greater tendency to look at women than men, suggesting that dogs may be more defensive-aggressive toward men than women (43). The authors (43) speculate that natural body odor may account for why dogs differ in their reactions toward men and women. Our work provides the first scientific evidence that female odor may be more "attractive" to dogs; however, it is difficult to speculate whether human female odor is perceived by dogs as more pleasant than a human male odor. It is not known whether human malodor or odor attractiveness, as perceived by human smellers, would correlate with what is unpleasant or "attractive" to dogs. Finally, diet also plays a role in the "attractiveness" of odor. The odor of humans on a diet not containing meat was judged by other humans to be significantly more attractive, more pleasant, and less intense than those whose diet contained meat (2).

The correlation coefficients within genders between the percentage of false and correct alerts, when the same individual hand odor was used as both a decoy and a target sample, may be interpreted as the influence of odor "attractiveness" for dogs. These correlations are positive and higher for men than for women, but of a low to moderate value, which means that individuals who are more often indicated falsely as decoys would be slightly more often indicated correctly as targets.

Macrosmatic animal species are able to distinguish not only individual differences in human odors but also to distinguish the degree of similarity between odors. For example, rats are able to recognize degrees of relatedness between humans based on odors (44). The acuity of the sense of smell of macrosmatic animal species enables them to distinguish more subtle differences in odors than is possible with contemporary analytical methods. Dogs are able to detect molecules of some odorous compounds, for example, *n*-amyl acetate in concentrations as low as 1–2 ppt (45). In the practical use of animals for odor detection or discrimination, the major problem consists not in olfactory acuity but in operant conditioning of animals to match correctly and reliably an odor by a trained behavioral response. Animals can distinguish the odor and odor differences but may ignore it or fail to communicate their findings to the handler if the odor is not relevant to them.

In conclusion, trained dogs identified individual women's hand odors better than men's hand odors. This may be due to gender differences in chemical compounds, making discrimination of individual women's odors easier, or due to a greater "attractiveness" of human female odors. To assess factors making odor of some persons more "attractive" as perceived by dogs, and distinguishable from other individually specific odors, further studies are needed, including parallel tests using canine olfaction and high tech analytical methods.

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