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Women's perception of body odor: the role of donors' gender

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Abstract

Disgust has a protective function as both a reflex and an emotion, helping individuals avoid threats and tailor mating preferences. It is closely related to the sense of olfaction, signaling information about potential mates and social dynamics. Research consistently demonstrates that women are generally more smell-oriented than men, outperforming them in olfactory tests and showing greater sensitivity to disgust. This study serves as an exploratory investigation into the mechanisms influencing women's responses to relational avoidance and attraction, specifically by examining their preferences for male versus female body odor.

Thirty participants (15 male) were selected as body odor donors, while thirty-one women were recruited to rate these odors based on perceived intensity, disgust, and pleasantness. In the end, they were also asked to complete the Disgust Propensity and Sensitivity Scale – Revised. The results revealed an interaction between disgust sensitivity and sample sex, with female odor samples being perceived as less disgusting than male odor samples, but only by participants with high disgust sensitivity. Separate correlation analyses for male and female odor samples, demonstrated that for male samples, intensity was positively associated with disgust while in female samples, intensity was positively associated with both disgust and pleasantness.

These findings provide new insights into how olfactory cues influence mating and social relationships from the perspective of women, highlighting the complex interplay between disgust and attraction based on body odor perception and the donors' gender.

Resumo

O nojo tem função protetiva tanto como um reflexo quanto uma emoção, ajudando no evitamento de potenciais ameaças e modelando preferências de relacionamento. É estreitamente ligado ao sentido de olfato, sinalizando informações sobre potenciais parceiros e dinâmicas sociais. Estudos demonstram, consistentemente, que mulheres são geralmente mais atentas aos cheiros que homens, superando-os em testes olfativos e demonstrando maior sensibilidade ao nojo. Este estudo é uma investigação exploratória nos mecanismos que influenciam as respostas de atração e evitamento, especificamente examinando a preferência de mulheres a odores femininos e masculinos.

Trinta participantes (15 homens) foram selecionados como dadores, enquanto trinta e uma mulheres foram recrutadas para avaliar estes odores com base na sua percepção de intensidade, nojo e agradabilidade. Ao fim, também pedimos que preenchessem a Escala de Propensão e Sensibilidade ao Nojo – Revisada. Os resultados revelaram uma interação entre a sensibilidade ao nojo, com amostras femininas sendo avaliadas como menos nojentas do que as amostras masculinas, mas apenas para as participantes com alta sensibilidade ao nojo. Ao analisar as amostras femininas e masculinas separadamente, as amostras masculinas mostraram uma correlação negativa entre intensidade e nojo, enquanto as amostras femininas mostraram correlações positivas tanto com nojo como agradabilidade.

Esses resultados fornecem novas considerações na forma como pistas olfativas influenciam o comportamento sexual e relações sociais da perspectiva de mulheres, acentuando a complexa relação entre nojo e atração, baseado na percepção de odores corporais e o gênero dos dadores.

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Introduction

Disgust and sexual activity represent two opposing forces within the spectrum of human survival, as noted by Zsok et al. (2017). While disgust functions as a defense mechanism, protecting individuals from contaminants and diseases, sexual activity is essential for reproduction and the continuation of the species. This dichotomy becomes particularly interesting when we consider that certain stimuli, such as sweat, saliva, or body odors, which typically evoke disgust in everyday contexts, can become acceptable, and even appealing, in a reproductive context (Wen et al., 2023). This dissertation seeks to contribute to the research on how olfactory cues influence the delicate balance between disgust and attraction, particularly in relation to body odor perception. It aims to explore how individual differences in disgust sensitivity, cultural conditioning, and sexual orientation impact this dynamic, furthering our understanding of the psychological and biological processes that underpin these contrasting responses to similar stimuli.

Disgust is both a primary emotion and a fundamental reflex in humans and other mammals, playing a crucial role in adaptation and survival (Sinha, 2014). Stafford et al. (2018) and Borg, de Jong and van Overveld (2013) both note that disgust operates across three distinct domains: pathogen disgust, sexual disgust, and moral disgust. Pathogen and sexual disgust are collectively known as "disease avoidant disgust," as they involve the avoidance of potential threats like spoiled food or contact with infected individuals. These forms of disgust trigger immediate physiological reactions — such as wrinkling the nose, nausea, gagging, and turning away — designed to protect against harm (Smith, 2007). In turn, moral disgust functions to enforce social norms by promoting the avoidance and punishment of social transgressors (Stafford et al., 2018).

Sexual activity, on the other hand, challenges feelings of disgust by involving body parts prone to contamination, such as the mouth, vagina, and anus, as well as by exchanging bodily fluids that are typically considered repulsive in non-sexual contexts, like semen and vaginal secretions (Wen et al., 2023). Individuals respond uniquely to sexual stimuli, depending on factors such as context, personal history, and the influence of emotions and expectations (Pawlowska, Borg, & de Jong, 2021). Bancroft and Janssen's (2000) Dual Control Model provide a theoretical framework for understanding this dynamic, explaining how sexual arousal is the result of a balance between two opposing processes: one that promotes arousal (excitatory) and one that inhibits it (inhibitory) (Bancroft et al., 2009). This model illustrates

how disgust responses are often suppressed during arousal, allowing sexual engagement to occur.

In 2011, Janssen described sexual arousal as an emotional state activated by physiological, cognitive, affective and behavioral processes, which vary between individuals (Janssen, 2011). Like other emotions, it involves an array of bodily reactions, such as increased heart rate, blood flow to genital areas and other autonomic responses. Another aspect of sexual arousal is the subjective experience, shaped by personal, social, and cultural factors (such as past experiences and societal norms) which will influence the perception and intensity of the arousal (Toates, 2009). Among the various factors contributing to this subjective experience, olfactory cues play a critical role in sexual arousal, as smell is closely linked to the brain's emotional and memory centers (Calvi et al., 2020). Body odor was even rated as the most important trait considered when choosing a partner by heterosexual women (White and Cunningham, 2017; Doty & Cameron, 2009; Havlíček et al., 2008;).

The sense of olfaction is unique in its processing, as it is the sense most connected to emotional processing and memory retrieval through its direct projections to the amygdala and orbitofrontal cortex (Calvi et al., 2020). The volatile organic compounds (VOCs) in body odor transport chemical sensory information – chemosignals –, subconsciously perceived in humans to indicate an individual's health status and emotional state (Calvi et al., 2020, de Groot et al., 2012). Each person's body odor is defined by genetic and metabolic factors, creating a unique signature of individuality (Havlicek et al., 2017; Wyatt, 2020). This distinctiveness plays a significant role in social interactions, influencing behaviors such as parental bonding and mate selection (Havlicek et al., 2017; Lubke and Pause, 2015).

Contrary to popular belief, the human sense of smell is well developed, and we possess sophisticated cortical regions that interpret olfactory inputs, allowing for the contextualization and integration of this sensory stimuli (McGann, 2017). Humans are able to follow scent trails, demonstrating the functional significance of olfaction in guiding behavior and its influence on ingestive behavior and food detection (Stevenson, 2010). McGann (2017) further asserts that humans are just as capable of discriminating odors as other mammals, but the difference lies in the criteria by which humans engage with olfactory stimuli. Unlike many animals that rely on scent for survival-based tasks such as hunting or territorial marking, humans use olfaction in a more complex and contextual manner, often influenced by social, cultural, and personal factors. This approach to scent perception accentuates the human ability to integrate olfactory

information into broader cognitive processes, demonstrating that olfaction is not a rudimentary sense but an integral part of how humans interact with their surroundings.

For Zheng et al. (2018), disgust is considered an ancient, instinctual response that evolved to protect humans from ingesting harmful substances, particularly through the senses of smell and taste. This reaction is especially relevant to avoiding spoiled or contaminated food, with olfaction playing a critical role in signaling danger before anything reaches the mouth. The sense of smell often serves as the body's first line of defense, alerting individuals to potentially dangerous substances through the detection of foul odors that suggest decay or contamination. For example, when people encounter smells associated with organic decay, such as rotting meat or sour milk, the olfactory system rapidly triggers an aversive reaction, producing the familiar feeling of disgust. This response isn't just limited to unpleasant smells related to food; it's an evolutionary mechanism designed to protect the body from pathogens and toxins. Stafford et al. (2018) emphasizes that odors are often powerful indicators of microbial activity, prompting a protective response before any physical contact with the potentially dangerous substance occurs.

Research consistently shows that women outperform men on olfactory tests (Sorowski, 2019). Another well-established finding is that women exhibit higher sensitivity to disgust when compared to men (Fleischman, 2014). Fleischman attributes this heightened sensitivity to an evolutionary need for self-protection and safeguarding of the offspring. Women are biologically at greater risk of contracting sexual pathogens due to having more mucous membranes and potential tissue damage during sexual activity, which increases vulnerability. Heightened sensitivity can, then, be attributed to the increased risk of infection associated with sexual intercourse and the potential dangers of pregnancy, which require more protective measures for both mother and child (Oaten, Stevenson and Case, 2009). Additionally, there is a possibility to pass infections during pregnancy and post-natal care. As a result, heightened disgust sensitivity may have evolved as a protective mechanism to reduce exposure to potential contaminants and safeguard both maternal and infant health (Fleischman, 2014).

In many cultures, women are still the primary caregivers, which often places them in roles that require heightened olfactory abilities, particularly in tasks like food preparation where the sense of smell is crucial for detecting freshness and spoilage. Sorokowski et al. (2019) note that this cultural role, in combination with biological factors, might contribute to women's greater olfactory sensitivity. The link between smell and disgust sensitivity further suggests that

women have evolved to be more disgust-sensitive, as a protection to avoid contaminants or harmful substances, especially in contexts related to food and caregiving. The connection between olfaction and disgust extends beyond food, influencing women's sexual inhibitory mechanisms. Bancroft et al. (2009) argues that women's greater sensitivity to disgust could also serve as a form of sexual inhibition, where certain odors — like those indicating poor hygiene or ill health—activate disgust responses that inhibit sexual desire. This aligns with findings from Oaten, Stevenson, and Case (2009), who found that women who were less sensitive to disgust also exhibited less sexual inhibition, suggesting that disgust plays a significant role in moderating sexual behavior.

This study was designed as an exploratory investigation into the mechanisms that influence women's relational avoidance and attraction mating responses, specifically by examining women's preferences for male versus female body odor. We invited women to smell a series of body odor samples and to rate them based on intensity, pleasantness, and disgust. Our aim was to explore whether women would show congruency between sexual orientational preferences and the gender of body odor samples. By focusing on the participants' ratings, we hoped to shed light on how olfactory cues can influence women's mate preferences. Given the exploratory nature of the study, we hope our findings can generate insights for future research into how body odors might impact emotional and social interactions.

Methodology

This study was made in collaboration with the Faculty of Pharmacy of the University of Porto (FFUP) - which was responsible for the sample collection - and was approved by the ethics committee of the Faculty of Psychology and Educational Sciences of the University of Porto (CEFPCEUP, ref^a 2023/09-04b). For both donors and raters, participation was voluntary, with no available rewards, and could be revoked at any time

Donors / sampling

Individuals aged between 18 and 40, not pregnant and non-smokers were eligible for collection. Thirty people were selected as donors, based on their predisposition and availability for collection. The sweat samples were taken from participants' armpits, as it is the area with the highest concentration of apocrine glands (Lubke and Pause, 2015). Each donor received a kit containing materials, instructions and a consent form to collect the samples at their own homes and take them to FFUP for analysis.

The kit contained: a white, 100% cotton T-shirt; a darker 100% cotton long-sleeved shirt; one 100% cotton towel; odorless, hypoallergenic shower gel; cotton balls wrapped in aluminum foil; 2 strips of medical adhesive tape; a pair of latex gloves and two test tubes, each with the corresponding sample number. To ensure the towels and shirts were clean, all of them were washed with odorless baby detergent. The kit also contained written, detailed instructions for the day before and the collection process. On the day before, donors were instructed to avoid consuming aromatic foods (e.g., garlic, chili peppers) and drinking alcohol. For the collection process, donors should shower and use the provided shower gel, dry themselves with the provided towel, tape the cotton balls to each axilla, and put on both provided shirts. After showering, they should refrain from using deodorants, scented hydrating lotions and perfumes to avoid contamination of the natural body odor.

During the four-hour sampling collection, participants were instructed not to eat, smoke, drink coffee or exercise. To remove the cotton balls, donors were instructed to wear the gloves, remove the tapes and place the cotton in the containers. The final samples had one cotton ball from each axilla, which were kept frozen at -20°C until one hour before the lab session of the rating experiment. In total, there were 30 odor samples (15 male) and one containing only cotton (a “dummy” sample, for control), resulting in a total of 31 samples. During the data collection, one of the vials broke and the sample was eliminated.

Participants

Thirty-three cisgender women, between the ages of 18 and 40 ($M = 26.73$, $SD = 6.08$), were recruited via questionnaire (appendix) to rate the samples. Two participants (one who identified as Arab and one who identified as Japanese) had to be excluded given the lack of

ethnic representation. Selected raters identified as white (84.84%) or latina (9.09%). The final sample size was thirty-one participants.

Criteria for participation also included: nonsmokers, either heterosexual or bisexual, no current use of medication or drugs, not being pregnant and no (self-reported) respiratory deficits or allergies – listed in the questionnaire. Upon submission, participants received an automatic confirmation e-mail containing instructions for the task, the informed consent (appendix) and a link to schedule the appointment. Following the methodology used in previous studies, we assumed that hormonal contraceptive use does not significantly impact olfactory ability, therefore, it was not considered as a factor for this task (Hoffman, 2019). The instructions were limited to the day of the task: refrain from using deodorants, perfume and/or scented hydrating lotions; and on the hour before the scheduled appointment, participants should refrain from eating, drinking coffee and/or chewing gum, so there wouldn't be any interference with their olfactory perception of the samples.

Procedure

The experiment took place at the Sexlab (Faculty of Psychology and Educational Sciences, University of Porto). Upon arrival, participants were asked to read and sign the informed consent and wash their hands (with the same shower gel provided to the donors) to prevent odor contamination.

The samples were kept in a freezer at -20°C, to preserve their quality and prevent bacterial degradation, taken to room temperature an hour before the first rating session and frozen again at the end of the day (Lenochova, Roberts and Havlicek, 2009). Between each session, the room stayed open for ventilation and the samples were cleaned with gauze and alcohol to remove possible residues from the previous participant. The order of the samples was randomized and different for each participant (appendix). In total, there were 12 collection dates throughout the month of April.

The task was designed within the Qualtrics platform and included three main sections: sociodemographic questions, the rating task and the Portuguese version of the Disgust Propensity and Sensitivity Scale – Revised. The sociodemographic questions included the assigned participation number, age, gender and ethnicity.

Instructions were physically demonstrated as well as written on the platform:

- Step 1: take the vial and enter its number.
- Step 2: open the vial and smell the sample for a maximum of 3 seconds, following the countdown displayed on the screen.
- Step 3 Rate the sample based on perceived intensity, pleasantness, and disgust.

Between each loop, there was a blank slide displayed for 10 seconds, so participants could breathe and “clean” their olfactory receptors. All instructions were displayed in a loop throughout the task to ensure participants could follow them. Given the volatile nature of the samples, we insisted that participants respect the displayed countdown and secure the vial caps after each sample.

As previously mentioned, the dimensions assessed were intensity, pleasantness, and disgust. Participants rated each dimension using a visual analog scale (VAS), ranging from 0 (not at all) to 100 (extremely).

In the end, participants answered the Portuguese version of the Disgust Propensity and Sensitivity Scale (appendix). Disgust sensitivity and propensity are two different constructs. While propensity describes how quickly a person reacts with disgust, sensitivity describes how unpleasant a person considers the experience of disgust (van Overveld, de Jong, and Peters, 2010). In other words, disgust propensity is about how easily someone is triggered by something they find disgusting — how fast or frequently they react. Disgust sensitivity, however, focuses on the intensity of that emotional response. A person with high disgust sensitivity might find the experience of disgust overwhelming or particularly distressing, even if they aren’t easily triggered by disgust-inducing stimuli. These constructs capture different dimensions of how we experience disgust: one determines how likely we are to react, and the other reflects how strongly we feel about that reaction once it occurs. Together, they provide a fuller picture of individual differences in disgust responses.

Data analysis

All the analyses were done using JASP (v. 0.19.0). In order to consider individual differences between raters and between samples, analyses were performed using the absolute rating values each participant gave to each odor sample.

During the analysis, we were able to categorize raters into three distinct groups based on their disgust sensitivity levels: less sensitive, moderately sensitive, and highly sensitive. This distribution allowed for a more nuanced examination of how varying degrees of disgust sensitivity influenced the ratings and contributed to the overall findings.

Each participant submitted multiple rating assessments which could be mistakenly analyzed as independent observations (i.e. pseudoreplication) (Winter, 2013). To prevent this, we analyzed the data through linear mixed models, which account for the correlation of repeated measures within participants. This analysis model acknowledges individual differences and avoids treating each assessment as entirely independent, providing a more accurate analysis by separating within-participant variation from overall trends.

Linear mixed models allow for fixed and random effects. Fixed effects represent systematic variables that apply across all participants, while random effects represent individual variability between participants (Winter, 2013). In this analysis, fixed effects included sample sex (male or female), disgust propensity and disgust sensitivity, while random effects included rater and sample.

Results

The dummy sample (cotton ball without any scent) proved to be a good control, as it did not elicit any notable emotional response. In other words, the results indicated that participants exhibited a neutral – and in some cases, a somewhat pleasant – reaction to the odorless sample, suggesting that the absence of odor may be perceived as more desirable than an intense scent.

For disgust, results indicate that there was an interaction between disgust sensitivity and sample sex [$F(1, 810) = 4.66, p = .031$]. When decomposing the interaction, results revealed female samples ($M = 13.81, SE = 5.16$) are perceived as less disgusting than male samples ($M = 26.26, SE = 5.06$), but only on raters who demonstrated more disgust sensitivity ($M = 12.45$,

SE = 5.41, $p = .042$). Additionally, there was a significant main effect of disgust propensity on the level of disgust felt [$F(1, 27) = 5.67, p = .025$].

For pleasantness, results also indicate an interaction effect between sample sex and disgust sensitivity [$F(1, 810) = 5.85, p = .016$]. However, when decomposed, the results showed no significant difference between disgust sensitivity groups. We also found a marginal effect of sample sex [$F(1, 317) = 3.84, p = .051$], with female samples ($M = 42.39, SE = 1.11$) being rated as more pleasant than male samples ($M = 38.05, SE = 1.16$).

For intensity, we did not find main nor interaction statistically significant effects. Although mean values differ when considering male and female samples, with male odors ($M = 34.09, SE = 1.55$) being perceived as more intense than female odors ($M = 22.92, SE = 1.29$), such difference did not reach statistical significance [$F(1, 141) = 3.11, p = .08$].

To further analyze the effects of sample sex, we performed correlations for male and female odor samples separately, testing correlations between rating dimensions (disgust, pleasantness and intensity). Male odor samples show a positive correlation between intensity and disgust ($r = 0.64, p < .001$), and a negative correlation between pleasantness and disgust ($r = -0.50, p < .001$). Female odor samples show a positive correlation between intensity and disgust ($r = 0.51, p < .001$) but also (albeit weaker) between pleasantness and intensity ($r = 0.22, p < .001$).

These results indicate that intense odors are perceived as more disgusting (and less pleasant) particularly for male odor samples. In contrast, for female odors, while increased intensity also correlates with heightened disgust, the association between intensity and pleasantness is also positive, as stronger female odors can sometimes be perceived as slightly more pleasant.

Discussion

Our study aimed to contribute to the body of knowledge showing odor cues to influence social relationships and interactions, particularly through feelings of avoidance and attraction. We wanted to understand the preferences of women for body odors of their own and the

opposite gender, and explore individual differences based on disgust sensitivity and propensity. By investigating how certain smells trigger disgust, while others may be perceived as neutral or even pleasant, we hoped to gain insight into the role of olfactory signals in shaping social dynamics. These findings help highlight the subtle but important role that body odors play in either drawing individuals closer or pushing them apart, depending on their individual sensitivities and the gender of the odor sender.

Interestingly, while female odors were perceived as less disgusting overall, their intensity was sometimes positively associated with pleasantness, suggesting a more complex relationship between odor strength and emotional responses than what we previously anticipated. This may indicate that, in social or reproductive contexts, intense female odors can carry positive social cues, such as signaling health or reproductive fitness (Havlicek & Roberts, 2009). While our findings suggest that women exhibit reduced disgust responses to female odors, there is limited research on evolutionary factors to explain this relationship; but it might be associated with social bonding and cooperative caregiving within female groups (Bedrov and Gable, 2023).

Considering this evolutionary perspective of female social bonding, there's evidence suggesting that female mammals who synchronize pregnancies are more likely to succeed in raising their offspring, thanks to the support they receive from others in the group (Spencer, 2004). Spencer and colleagues (2004) found that exposure to breastfeeding chemosignals could significantly increase sexual desire and fantasies in women, regardless of their relationship status. The socialization with pregnant or lactating women possibly signals good environmental conditions to reproduce (Lubke and Pause, 2015), further confirming that olfactory signals not only influence aspects of sexual attraction but also foster social bonds. While much of the research on odor perception focuses on sexual attraction, it's equally important to consider how gendered odors influence non-sexual social interactions. Female odors, often linked to traits like caregiving and empathy, may evoke positive social reactions in non-romantic settings. Women, regardless of their sexual orientation, may perceive female odors as pleasant because these scents are associated with supportive social roles within communities (Bedrov & Gable, 2023).

In a study by Martins et al. (2005) comparing the olfactory perception of heterosexual men and women, gay men, and lesbians, there was an almost unanimous preference for

heterosexual female odors across all groups — except for heterosexual men, who did not share this preference. This suggests that the pleasantness associated with female odors might be more connected to their role in social bonding, trust, and familiarity, rather than directly linked to sexual attraction. This aligns with our findings, where most participants identified as heterosexual yet still showed a consistent preference for female odors, likely driven by these non-sexual associations. Interestingly, the lack of preference among heterosexual men suggests that their perception of female odors might be more context-dependent, potentially aligning with sexual attraction rather than non-sexual cues like familiarity or trust. This divergence highlights how gender and sexual orientation play crucial roles in shaping olfactory perception, as homosexual men were more likely to prefer female odors (Martins, 2005).

Sergeant et al. (2007) investigated whether there were distinct differences in how heterosexual and homosexual men responded to body odors. They found that while heterosexual men were more likely to associate feminine scents with attractiveness, homosexual men displayed a more nuanced range of preferences, potentially reflecting both biological and cultural influences on sexual orientation and olfactory sensitivity. Novaková, Valentová, and Havlíček (2013) offered a different perspective, arguing that it is not sexual orientation itself that predicts olfactory preferences, but rather "sex-atypicality" or gender non-conformity. According to their findings, males who display gender non-conforming traits (behaviors or preferences that deviate from traditional gender norms) since childhood, may have olfactory preferences that differ from those who conform more closely to gender expectations. It did not seem to affect females' olfactory performance or development.

Aligning with this idea, Havlíček et al. (2017) suggests that odors contribute to more than just reproductive or sexual functions — they serve as social cues for identifying kin or members of close social groups. This can be another explanation as to why certain odors are consistently rated favorably across different sexual orientations, even when sexual attraction is not a driving factor. Such preferences indicate that olfactory signals help individuals navigate both romantic and non-romantic social interactions. Additionally, odors are often linked to emotional responses and memory, reinforcing their role in non-romantic relationships. Doty et al. (2009) showed that certain body odors can trigger positive memories or associations, influencing how individuals perceive and interact with one another in non-sexual contexts. These associations indicate that olfactory signals play a subtle role in maintaining social networks

The strong correlation between disgust and odor intensity in male odors emphasize the role of olfactory cues as a protective mechanism in mate selection, discouraging potential partners who may signal poor health or genetic unfitness (Fleischman, 2014). This heightened disgust response toward male odors likely reflects an evolutionary adaptation designed to minimize health risks and avoid mating with incompatible individuals, reinforcing the idea that disgust functions as part of a disease-avoidance system (Stafford et al., 2018). Another possible explanation for the increased sensitivity to male odors is the menstrual cycle phase of raters, as research shows that disgust sensitivity tends to fluctuate throughout the cycle, particularly during phases where the body is less receptive to mating (Olatunji, Cox and Li, 2020; Sergeant et al., 2007, Mutic et al., 2016). This suggests that hormonal fluctuations may amplify disgust as part of an inhibitory mechanism that helps regulate reproductive behavior.

Building on this, the interaction effects between disgust sensitivity and sample sex are further complicated by the role of odor intensity, since more intense odors are typically perceived as less pleasant (Havlicek & Roberts, 2009). As stated before, women with higher disgust sensitivity also exhibit more inhibited sexual behavior and while the difference in intensity between male and female odors did not reach statistical significance, male odor samples were still rated as more intense and disgusting. There might be biological differences such as larger apocrine glands in males, leading to higher sweat production (Roberts et al., 2022) as well as social stereotypes (Mutic et al., 2016; Carrito et al., 2017). Research by Mutic and collaborators (2016) supports this, demonstrating a masculinity bias in body odor perception, wherein any human body odor — regardless of the actual source — is often associated with the male gender. This bias could exacerbate disgust reactions toward male odors, as the olfactory system may unconsciously link intensity with masculinity,

These results, particularly those concerning female odor samples, highlight the nuanced relationship between attraction and avoidance, where the same olfactory stimulus can elicit both positive and negative reactions, depending on individual sensitivities. This duality in response aligns with the notion that olfactory cues do not provoke uniform reactions but are instead shaped by an intricate web of biological, social, and psychological influences. For some individuals, female odors may be associated with positive social cues like health, fertility, or reproductive fitness, which can enhance their perception of the odor as pleasant and inviting (Havlicek & Roberts, 2009). In these cases, olfactory signals can serve to reinforce social bonds, facilitate mate selection, or even foster group cohesion through their association with

cleanliness and feminine ideals (Smith, 2008). However, for others, these same odors might evoke discomfort or even mild disgust, reflecting the influence of personal experience, cultural background, or heightened disgust sensitivity.

Our results also reflect a biological predisposition, particularly disgust sensitivity, in modulating individual disgust reactions. Some individuals might be more predisposed to experiencing body odors as aversive while others may not find them unpleasant. This variability reinforces the idea that the interplay between attraction and avoidance is not binary but rather exists on a continuum, shaped by both innate tendencies and external circumstances (Tybur, Lieberman and Griskevicius, 2009). The same stimulus may evoke different reactions depending on how the individual appraises its significance—whether as a social signal of health and compatibility or as a warning signal for potential contamination or conflict.

Sex-specific differences in odor perception are largely influenced by biological factors, especially hormonal differences between males and females. According to the meta-analysis by Sorokowski et al. (2019), women consistently outperform men in various aspects of olfactory function, including odor detection, discrimination, and identification. This difference is most evident in reproductive-age women, where heightened olfactory sensitivity is likely influenced by estrogen. Estrogen levels fluctuate throughout the menstrual cycle, with higher concentrations during ovulation leading to increased sensitivity to smells.

Another important factor to consider is how psychological conditioning and social expectations influence women's odor perception. Cultural stereotypes around masculinity and femininity seem to affect how odors are interpreted. Carrito et al., (2017) did an online survey where they asked female participants to associate smells with masculinity/dominance and concluded that more masculine or dominant men were associated with intense and unpleasant odors. This may be a result of social stereotypes of what is considered to be feminine or masculine. Historically, women are encouraged to adopt more self-grooming habits and cosmetics – particularly to mask their natural scent – while men are often taught that their actions, rather than their appearance, define their worth (Smith, 2008). This reinforces the belief that sweat and strong body odors are signs of hard work and masculine strength (Smith, 2008).

One unexpected outcome of the study was the exclusion of two participants due to a lack of ethnic representation. Their results differed significantly from the rest of the sample, suggesting potential ethnic variations in olfactory perception that were not fully accounted for

in the study. This suggests that ethnic and cultural factors may influence how odors are perceived. While the literature on this topic is still limited, existing research indicates that factors such as diet, environment, and cultural practices can affect both body odor production and odor perception (Parma et al.,). These influences might explain why certain ethnic groups exhibit distinct olfactory responses to the same odors, highlighting the importance of incorporating more ethnically diverse samples in future research. By doing so, we could gain a deeper understanding of how ethnicity and culture shape olfactory experiences and the broader biological and social factors that govern our responses to odors. Addressing this limitation in future studies could provide valuable insights into the complex interplay between culture, biology, and olfactory perception.

Limitations

Although the sample collection kit included a long-sleeved, dark-colored shirt to standardize the process and stimulate sweat production, it did not control for the presence of armpit hair, which plays a role in odor dispersion. Research by Lubke and Pause (2015) shows that armpit hair aids in the diffusion and retention of body odor by increasing the surface area for bacteria to grow. This can intensify the scent and affect how odors are perceived. Not controlling this factor may have introduced variability, with participants who had more armpit hair potentially producing stronger odors and thus influencing the ratings.

We also did not account for the menstrual cycle of raters. Olfactory (and disgust) thresholds are lower in the fertile phase when compared to non-fertile phases, which could influence the raters' perceptions of either dimension (intensity, pleasantness and disgust) (Nováková, Havlicek and Roberts, 2014; Doty and Cameron, 2009; Fleischman, 2014). The data collection also did not control for hormonal contraception which has also been linked to odor detection and chemosensory production (Doty and Cameron, 2009). For donors, hormonal contraception was noted, but there were no differences found between the odor samples of women on or off the pill.

Another possible limitation in the data collection was that we did not control for previous COVID-19 infections. Since one of the common symptoms of COVID-19 is the loss of smell (anosmia), the long-term effects of these symptoms could have influenced participants' ability to detect and evaluate odors. Studies have shown that many individuals experience prolonged olfactory dysfunction even after recovering from COVID-19, reporting persistent distortions in smell or reduced sensitivity to odors (Parma et al., 2020; Lechien et al., 2020). Given the importance of accurate odor detection in our study, the failure to control for previous COVID-19 infections may have introduced variability into the data, as some participants could have been unknowingly affected by diminished or altered olfactory capabilities.

Finally, the exclusion of two participants due to a lack of ethnic representation highlights a broader limitation of this study — the relatively homogenous pool of raters. The lack of diversity may have limited the generalizability of our findings, as olfactory perception can be influenced by cultural and ethnic factors (Parma et al., 2019). By not incorporating a more ethnically diverse sample of raters we may have missed important nuances in how odors are evaluated, which could differ significantly across cultural and ethnic groups.

Conclusion

Research on the relationship between olfaction and sexuality, particularly regarding sexual orientation, is indeed limited and occupies a niche within broader olfactory studies. However, there is an additional gap when we consider ethnicity in relation to olfactory perception and sexual orientation. Most existing studies tend to focus on Western, predominantly Caucasian populations, often overlooking how cultural and ethnic differences may impact olfactory perception and preferences, including in the context of sexual attraction.

Studies have shown that diet and climatic conditions can affect body odor composition, which may lead to varying perceptions of pleasantness or disgust across different ethnic groups (Sorokowska et al., 2019). Moreover, cultural practices and societal norms around hygiene and grooming can shape how odors are interpreted in different ethnic contexts. What one group perceives as an attractive or neutral body odor might be perceived differently by another group due to differing cultural connotations around cleanliness and social behavior. These factors,

when combined with sexual orientation, create a complex intersection of olfactory sensitivity, ethnic diversity, and sexual preference, which is largely under-researched. Given that body odor plays an important role in mate selection and social bonding, understanding how olfactory cues are perceived across different ethnic groups and sexual orientations could offer richer insights into the universality and diversity of human sexual behavior.

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Appendix

COMISSÃO DE ÉTICA

PARECER (Ref.º 2023/09-04b)

A Comissão de Ética (CdE) da Faculdade de Psicologia e de Ciências da Educação da Universidade do Porto, tendo reapreciado os documentos do projeto de investigação denominado «***O desejo está no ar: o papel de chemosignals na excitação sexual***», submetidos para apreciação ética pela mestranda **Flávia Botto**, com orientação da **Doutora Mariana Carrito** e do **Prof. Doutor Pedro Nobre**, emite um **parecer favorável** à realização da pesquisa.

Parecer favorável

A CdE é favorável à realização do projeto tal como apresentado.

FPCEUP, 13 de dezembro de 2023

A Presidente da CdE,



Prof.ª Doutora Carlinda Leite

O cheiro do desejo

Bem vinda!

Esta investigação tem como objetivo compreender se uma pessoa é capaz de perceber as emoções de outra pessoa, através do cheiro. Isto é, iremos investigar o impacto do odor corporal na percepção emocional.

A experiência consistirá em cheirar algumas amostras de odores (contidas em frascos) e avalia-las em várias dimensões.

Para participar, é necessário:

- ser do sexo feminino e identificar-se com o género feminino;
- falar/entender português;
- ter entre 18 e 40 anos;
- não ter problemas de olfato;
- ser heterossexual;
- não ser fumadora;
- ser de etnia caucasiana;
- não estar grávida;

O estudo irá decorrer na Faculdade de Psicologia e de Ciências da Educação da Universidade do Porto,

Rua Alfredo Allen, 4200-135 Porto. Se estás interessada em participar nesta investigação e cumpres os requisitos, preenche o formulário abaixo de forma a podermos contactar-te e agendar a tua sessão.

Os dados aqui recolhidos serão guardados em confidencialidade. Estes dados sobre a sua identidade/contato não serão utilizados após a marcação da sessão, e não serão associados às respostas que vieres a dar no momento da tua participação. A tua participação será anónima e voluntária, não existindo quaisquer compensação nem consequências em casos de remarcação ou desistência.

Este estudo enquadra-se no âmbito da dissertação de mestrado da estudante Flávia Botto, orientada pela Dra. Mariana Carrito, investigadora do Laboratório de Investigação em Sexualidade Humana, na Faculdade de Psicologia e de Ciências da Educação da Universidade do Porto em parceria com a Faculdade de Farmácia da Universidade do Porto.

1. Nome *

2. Idade *

3. Sexo *

☐ Feminino

☐ Masculino

☐ Outra

4. Género *

☐ Feminino

☐ Masculino

☐ Outro

5. És fumadora?

☐ Sim

☐ Não

6. Orientação sexual *

☐ Héterossexual

☐ Outra

7. Tens problemas olfativos? *

☐ Sim

☐ Não

8. Falas e entendes português? *

☐ Sim

☐ Não

9. Tens alguma doença respiratória? *

☐ Não

☐ Outra

10. Tens alguma outra doença crónica? *

☐ Não

☐ Outra

11. Estás grávida? *

☐ Sim

☐ Não

☐ Talvez. Não tenho a certeza.

12. Caso mantenhas interesse em participar, indica por favor o teu contacto de email para agendarmos a sessão. *

Formulário de Consentimento Informado

O presente estudo faz parte do projeto de Mestrado em Psicologia, pela Faculdade de Psicologia e de Ciências da Educação da Universidade do Porto, da aluna Flávia Gois Botto Soares, sob orientação da investigadora Dra. Mariana Carrito. Este obteve um parecer favorável da Comissão de Ética da FPCEUP.

O objetivo desta investigação é recolher avaliações de odores corporais. Para participar é necessário ter entre 18 e 40 anos, não estar doente ou grávida; não usar medicamentos ou drogas.

Este estudo pressupõe que cheire alguns odores e os avalie quanto a várias dimensões, sem que existam respostas certas ou erradas ao fazê-lo. Algumas questões poderão parecer mais difíceis, por isso, se não tiver a certeza em relação à resposta mais precisa, assinale a que melhor ilustra a sua opinião. A sua participação, que será individual e demorará aproximadamente 30 minutos.

Uma hora antes do teste, pedimos que se abstenha de comer, fumar, beber café ou usar quaisquer produtos perfumados que possam interferir com a sua capacidade olfativa.

Riscos e Desconfortos Resultantes da Investigação:

Os riscos do presente estudo são mínimos, no entanto, é possível que sinta algum desconforto caso alguns odores sejam percebidos como mais desagradáveis. Se desejar, e caso sinta esta necessidade, poderá ser agendada uma segunda sessão não experimental onde poderão ser discutidas questões relacionadas com a sua experiência e resultados.

Tratamento Médico de Emergência:

Na remota eventualidade de mal-estar, reação alérgica ou outra situação em que sinta necessidade de interromper sua participação durante o estudo, será providenciado todo o tratamento médico de emergência sem qualquer custo para o participante. Para tal, é fundamental que comunique ao investigador, de forma imediata, a ocorrência do incidente.

Confidencialidade:

A informação obtida neste estudo será tratada como confidencial. As suas respostas serão codificadas com um número e nunca terão o seu nome. Os seus resultados serão identificados com um número (o número de registo) que corresponderá número do dia do aniversário do seu pai, o número do mês de aniversário da mãe e os últimos dois números do ano do seu nascimento. Exemplo: 220867.

Relembramos que este número nunca será associado à sua identidade, tratando-se de um codificador das suas respostas. Esta informação estará guardada em segurança no laboratório, e só será do conhecimento das pessoas ligadas à investigação. Todas as informações relacionadas com a identificação dos participantes nesta investigação serão destruídas após 3 meses da conclusão do estudo. Qualquer e-mail que nos envie será também destruído após a realização do estudo. Quando os resultados deste estudo forem publicados, não haverá qualquer forma de ser identificado. No caso de querer nos contactar, disponibilizamos o contacto do nosso laboratório: 220 428 908. Se tiver alguma questão a colocar acerca deste estudo ou dos seus procedimentos, poderá fazê-lo em qualquer altura através do mesmo contacto, ou através dos emails: marianacarrito@fpce.up.pt ou sexlab@fpce.up.pt.

Caso deseje esclarecer alguma dúvida adicional ou para conhecer os resultados, poderá enviar e-mail para: marianacarrito@fpce.up.pt. Acrescentamos que não há nenhuma forma de associar as suas respostas ao e-mail que nos será enviado.

Consentimento

Foi-me prestada uma explicação integral acerca da natureza e objetivos do estudo, sendo concedida a possibilidade de esclarecer todos os aspetos que considere pertinentes. Se assim o desejar, sei que sou livre de abandonar o estudo em qualquer momento. Não serão recolhidos dados que permitam a minha identificação, permanecendo confidenciais. Confirmo que não tenho nenhuma dificuldade olfativa que seja do meu conhecimento. Concordo que estes sejam analisados pelos investigadores responsáveis pelo estudo, sob autoridade delegada do investigador principal, e que sejam posteriormente partilhados com outros investigadores para fins de ciência aberta. Além disso, não procurarei restringir o uso dos dados para os quais o estudo se dirige.

Declaro ainda que sou maior de idade e que li o formulário de consentimento, pretendendo prosseguir e participar no presente estudo.

Participante_____data_____

Investigador_____data_____

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Escala de propensão e sensibilidade ao nojo revisto (DPSS-R; Fergus & Valentiner, 2009)

Versão Portuguesa: Ferreira, Soares, Bem-Haja, Alho, Rocha, Madeira & Silva (2016)

Instruções

Este questionário consiste em 11 afirmações sobre o nojo. Por favor, leia cuidadosamente cada afirmação e pense quão frequente é verdadeira para si, assinalando a opção que melhor representa a sua opinião.

	Nunca	Raramente	As vezes	Frequentemente	Sempre
Evito coisas nojentas.					
Quando me sinto enojado(a), preocupa-me que possa desmaiar.					
Assusto-me quando sinto náuseas.					
Sinto repulsa.					
Coisas nojentas dão-me voltas ao estômago.					
Faço cara de nojo quando algo me enoja.					
Quando reparo que estou nauseado, preocupa-me se vou vomitar.					
Sinto nojo.					
Assusto-me quando me sinto a enfraquecer ou a desmaiar.					
Acho algo nojento.					
Sinto-me envergonhado(a) quando me sinto enojado(a).					

FACULDADE DE **PSICOLOGIA** E DE CIÊNCIAS DA EDUCAÇÃO

