aps ASSOCIATION FOR PSYCHOLOGICAL SCIENCE

Current Directions in Psychological Science
2020, Vol. 29(6) 617–623

DOI: 10.1177/0963721420964175
www.psychologicalscience.org/CDPS
SAGE

What Your Nose Knows: Affective, Cognitive, and Behavioral Responses to the Scent of Another Person

Marlise K. Hofer[1,2], Frances S. Chen[1], and Mark Schaller[1]
[1]Department of Psychology, University of British Columbia, and [2]Department of Psychology, University of Victoria

Abstract
People readily perceive and react to the body odors of other people, which creates a wide range of implications for affective, cognitive, and behavioral responses. In this article, we provide an overview of recent research in this area. We summarize the process by which people associate body odors with different kinds of interpersonally relevant information, briefly review two lines of research on responses to strangers' body odors (research on olfactory cues and emotions, research on olfactory cues and impression formation), and review new research on the psychological consequences of smelling loved ones' odors—including consequences for stress reduction and sleep enhancement. We conclude with a discussion of emerging research questions and methodological considerations that may help guide future inquiry into the various ways that the odors of other people influence one's emotions, cognitions, relationships, and health.

Keywords
health, nonverbal communication, olfaction, person perception, scent

People smell. Every person emits a body odor that lingers even when the person is not physically present. A person's body odor is composed of dozens of distinct chemical compounds (Lundström & Olsson, 2010) and is as much a part of that person's phenotype as his or her physical appearance. Like physical appearance, body odor reflects personal characteristics and temporary circumstances (e.g., people smell differently depending on their sex, age, health, and even transient emotional states; de Groot, Semin, & Smeets, 2017), and like physical appearance, body odor reflects an individual's genome (Natsch & Emter, 2020). Different people smell different.

Can people perceive and differentiate among these different body odors? Yes they can. Although people are popularly presumed to be the olfactory dunces of the animal kingdom, that belief is "a 19th-century myth" (McGann, 2017). Humans have a sophisticated olfactory system that discriminates between a wide range of scents—including the odors of other people. The perceptual processing of body odors occurs through neural mechanisms responsible for the processing of a wide range of social information obtained through various sensory modalities, and this processing typically occurs without conscious awareness (Lundström & Olsson, 2010; Pause, 2012). The implication is that just as the human brain evolved to efficiently extract information from other individuals' appearances, it also evolved to efficiently extract information from their smells.

If so, then functional considerations that govern social perception more generally (e.g., Neuberg & Schaller, 2015) would be expected to apply to the process through which people draw inferences from others' odors. The governing principle here is that human perception is sensitive to social cues that, throughout human evolutionary history, had implications for survival and reproductive fitness. Thus, just as perceivers are sensitive to facial features that identify someone as a friend or relative or that heuristically connote a particular kind of threat or opportunity, so too perceivers are likely to be sensitive to elements of odors that indicate fitness-relevant identities, threats, or opportunities.

Corresponding Author:
Marlise K. Hofer, Department of Psychology, University of British Columbia
E-mail: hofer@psych.ubc.ca

Table 1. Three Categories of Inferences That Perceivers Make on the Basis of Other People's Body Odors and Some of the Psychological Consequences of These Inferences

Functional basis for inference	Inferences	Psychological consequences	Illustrative research example
Different body odors are associated with different emotional states.	Tacit inferences about other individuals' emotional states	Emotion-congruent appraisals of one's environment; responses reflecting those appraisals	The scent of a fearful person enhances perceivers' anxiety and propensity to trust others (Quintana, Nolet, Baus, & Bouchard, 2019).
Different body odors are associated with different personal characteristics.	Tacit inferences about other individuals' personal characteristics	Interpersonal judgments; decisions reflecting those judgments	The scent of a sick person leads to decreased liking by perceivers (Sarolidou et al., 2020).
Different body odors are associated with specific people.	Tacit inferences about the presence of a specific person	Appraisals of and responses to one's environment consistent with the presence of that specific person	The scent of a romantic partner increases perceivers' sleep efficiency (Hofer & Chen, 2020).

Table 1 identifies three broad categories of inferences that perceivers make on the basis of body odor and provides a road map for the rest of this article. In the following two sections, we highlight several lines of research that exemplify the fitness-relevant inferences that people draw from strangers' odors—including inferences about their transient emotional states and about more enduring personal characteristics. We then review research on the psychological consequences of smelling a familiar body odor and highlight new work on the implications of smelling the scent of a loved one—such as stress reduction and improved sleep. Finally, we identify emerging research questions and methodological considerations that may guide future inquiry into the ways that the smell of other people can influence emotions, cognitions, relationships, and health.

Body Odors and Inferences About Emotional States

When someone experiences an emotion, it is typically a response to a functionally relevant event (e.g., threat or opportunity) that may be relevant not only for the person experiencing the emotion but also for people in their immediate environment. The experience of an emotion is associated with distinctive physiological changes in the body that are thought to affect body odor (Kadohisa, 2013). Therefore, just as perceivers can infer someone's emotional state from viewing that person's emotion expressions, perceivers may also infer someone's emotional state from smelling that person's odor (de Groot et al., 2017). These inferences can guide how perceivers respond to these individuals and their shared environment.

The smell of fear may be of particular immediate relevance to perceivers because it connotes potential danger. Olfactory communication of fear has been well documented (for a review, see de Groot & Smeets, 2017). In several studies, people watched either a neutral or a fear-inducing film clip while their body odors were collected on an absorbent material. Later, when new participants smelled that material, they too exhibited responses consistent with fearfulness. For instance, in one recent study, people interacted with a virtual character while smelling body odor collected from either a fearful person or a nonfearful person; participants who smelled the fearful odor experienced greater anxiety themselves and were less trusting of the virtual character (Quintana, Nolet, Baus, & Bouchard, 2019).

Body Odors and Inferences About Personal Characteristics

People engage in many different kinds of interactions with many different people. The outcomes of those interactions depend, in part, on specific characteristics of an interaction partner, including enduring traits (e.g., sex, genetic fitness) as well as more transitory states (e.g., sickness, sexual interest). A person's body odor contains information that can help perceivers identify these characteristics. For example, using cues from odor alone, perceivers can infer a variety of functionally relevant demographic characteristics, such as sex, age, and genetic relatedness (de Groot et al., 2017; Lundström & Olsson, 2010).

In the domain of mating, there is some evidence that body odor may provide clues to variables—such as relationship status and sexual arousal—indicative of another person's potential receptivity to a mating relationship (Mahmut & Stevenson, 2019; Wisman & Shrira, 2020) and to traits or states that might make them more desirable mating partners. For instance, throughout

much of human history, a woman's desirability as a mate is likely to have been influenced, in part, by her capacity to conceive a child. One consequence is that perceivers may be sensitive to body odors that are associated with a woman's likelihood of conception. Consistent with this analysis, findings from several studies have shown that when women have a higher likelihood of conception, their scents are judged by men to be more appealing and stimulate higher levels of male sexual arousal (e.g., Hoffmann, 2019; for a brief review of earlier studies—including nonreplications—see Haselton & Gildersleeve, 2016).

A woman's potential to conceive may also affect her own scent-based inferences about potential mates. It has been hypothesized that when conception risk is higher, women will be more highly attuned to male characteristics that, historically, were associated with greater reproductive fitness (e.g., symmetrical features, dominance; Gildersleeve, Haselton, & Fales, 2014). Some of these characteristics may also be associated with distinctive body odors. One fascinating finding is that when women's conception risk is higher, they prefer the body odors of more highly symmetrical men (Gangestad, Thornhill, & Garver-Apgar, 2005). A note of caution is in order, however: This particular finding has been documented in only a few studies using small samples of participants, and results of a meta-analysis led to the conclusion (which still stands today) that more data are needed to determine the robustness of this effect (Gildersleeve et al., 2014).

In addition to having implications specific to the mating domain, body odors can also provide information about whether another person poses a threat of some kind—such as the threat posed by an infectious disease. Many diseases are associated with changes in body odor (Shirasu & Touhara, 2011), and multiple studies have shown that just as other animals use olfactory cues to identify and avoid infected individuals (Kavaliers & Choleris, 2017), humans also appear to be able to infer illness from body odor (e.g., Olsson et al., 2014). For instance, sick people produce body odors that, compared with odors of healthy individuals, lead perceivers to judge them to be less likeable (Sarolidou et al., 2020).

Body Odors and Inferences About Specific People

The research reviewed thus far focused on the scents of strangers. What happens when people come into contact with the scent of someone they know? Because each individual has a unique body odor, once someone has learned to associate a particular odor with a particular person—such as a lover, friend, or family member—they may use that odor to infer the individual's identity (Lundström & Olsson, 2010). Furthermore, the smell of a particular person may provide tacit evidence of that person's current or recent physical presence with downstream consequences for the perceiver.

One especially close relationship is a mother's connection to her baby. Mothers can readily identify their baby by scent, find this odor pleasant, and prefer it to the scent of an unfamiliar child (Schäfer, Sorokowska, Sauter, Schmidt, & Croy, 2020). Reciprocally, babies benefit from exposure to scents from their mother. In one study, preterm infants who were exposed to maternal scents transitioned more quickly from feeding tubes to oral feeding and were discharged from the hospital an average of 4 days sooner than babies exposed to no odor (Yildiz, Arikan, Gözüm, Taştekın, & Budancamanak, 2011). Other studies indicate that infants exposed to maternal scents, compared with control scents, during a briefly painful event displayed reduced pain reactions, lower heart rates, and lower cortisol responses—indicating that infants find the mere scent of their mother comforting (Akcan & Polat, 2016; Badiee, Asghari, & Mohammadizadeh, 2013).

Just like infants, adults also find the smell of a loved one comforting (McBurney, Shoup, & Streeter, 2006). Hofer, Collins, Whillans, and Chen (2018) placed female participants in a stressful situation (involving a mock job interview and a mental math task) during which they sniffed a shirt previously worn by their romantic partner, a shirt previously worn by a stranger, or an unworn shirt. Compared with women who smelled strangers' or unworn shirts, women who smelled their partner's body odor reported experiencing less stress both before and after the stressor (Fig. 1).

If indeed the smell of one's romantic partner has a stress-buffering effect, then there may be downstream consequences for other psychological phenomena. In a recent set of experiments, Hofer and Chen (2020) examined implications for sleep. Across multiple nights, participants—all of whom were in romantic relationships—slept alone with a T-shirt on their pillow. On some nights, that shirt had been previously worn by their romantic partner; on other nights, it was a control shirt. Sleep efficiency was assessed using a wrist-worn actigraphy watch. Although results for male sleepers were equivocal, results for female sleepers were clear: Women's sleep efficiency was higher on the nights that they slept with a shirt that retained the smell of their romantic partner (Fig. 2). This result occurred regardless of whether participants were able to identify which nights they slept with their partner's scent.

The stress-buffering and sleep-inducing effects of a romantic partner's odor are likely to be contingent on the expectation that one's partner provides a source of safety or support. If so, then these effects may vary depending on the extent to which romantic relationships are perceived to be safe and supportive. Granqvist

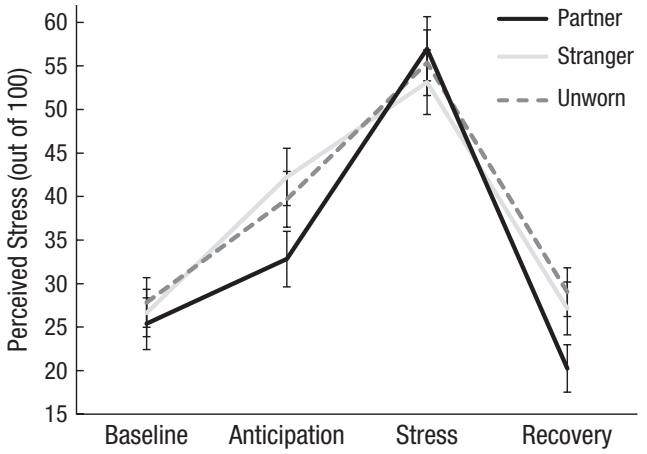

Fig. 1. Women's perceived stress in response to a stressful situation as a function of the type of shirt sniffed (one previously worn by a romantic partner, one previously worn by a stranger, and one that was unworn). The body odors of 96 men—all of whom were in romantic relationships with women—were collected by having them wear a clean T-shirt for 24 hr. The men's female romantic partners smelled a shirt before learning about an upcoming stressful situation (baseline) as well as immediately before, during, and after a stressful situation (anticipation, stress, and recovery phases, respectively). Depending on experimental condition, the shirt had been previously worn by—and retained the scent of—the participant's romantic partner or a stranger; in a third condition, the shirt had never been worn. During the anticipation phase, women who smelled their romantic partner's body odor felt less stressed than women who smelled a stranger's odor. In addition, during the recovery phase, women who smelled their romantic partner's body odor felt less stressed than women who smelled a stranger's shirt or an unworn shirt. Error bars represent ±1 *SEM*. This figure is based on results reported by Hofer, Collins, Whillans, and Chen (2018).

et al. (2019) recently reported results that provided some preliminary support for this hypothesis. Participants experienced electric shocks as less uncomfortable while smelling their partner's scent compared with their own scent (conceptually replicating the subjective stress-buffering effect reported by Hofer et al., 2018). Additionally, participants who reported higher levels of attachment security had a lower autonomic stress response when exposed to their partner's scent, whereas those who reported lower attachment security had an elevated stress response. An important direction for future research will be to identify additional factors that might influence whether the smell of one's romantic partner has a calming effect (or might even have the opposite effect, as in the case of an abusive relationship).

Future Directions

These bodies of research reveal that people extract a great deal of useful inferential information from others' odors (often without even being aware of it). Future research could productively explore ways in which different lines of inquiry might be integrated. For instance, research on olfactory communication of emotions has typically focused on odor-based inferences about the emotions of strangers. Very little is known about odor-based inferences regarding the emotions of friends, lovers, and family members. Research on the smell of sickness has also focused on the smells of strangers. Might people be differentially sensitive to infection-connoting odor cues, depending on their relationship to the infected individual? Parents, for example, might be especially sensitive to olfactory cues of sickness in their children, and these cues might plausibly elicit approach-oriented responses rather than the avoidance responses elicited by the smell of a sick stranger.

Another interesting future direction will be to compare how body odors contribute to inferences relative to other sensory cues. Research on emotions indicates that another person's fear smell may be as informative as audio and visual cues (de Groot, Semin, & Smeets, 2014), and research on the smell of sickness has begun to examine whether body odor uniquely influences appraisals of illness even when encountered alongside visual cues that are also diagnostic of infection (Sarolidou et al., 2020). These lines of work represent important steps toward understanding of the ways in which body odor might uniquely influence interpersonal appraisals within the multimodal perceptual complexity of social life.

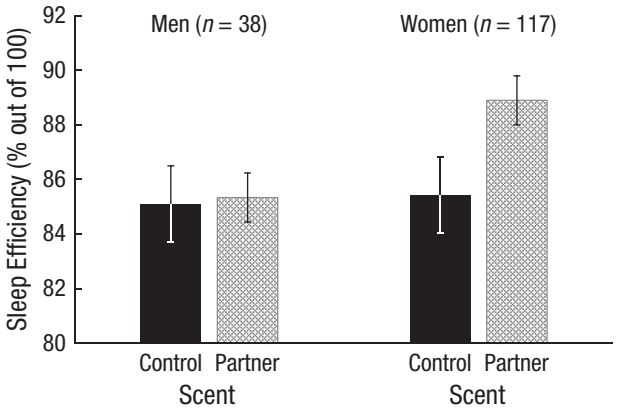

Fig. 2. Sleep efficiency of male and female participants who slept with a shirt bearing their partner's scent (partner scent) and a shirt that had either been previously worn by a stranger or had never been worn (control scent). Across four separate nights, 155 people in romantic relationships slept with a shirt as a pillow cover. For two nights, this pillow cover was a shirt that had been previously worn by—and retained the scent of—their romantic partner; for the other two nights, this pillow cover was a control shirt that had either been previously worn by a stranger or had never been worn. Participants wore an actigraphy monitoring device that measured sleep efficiency (time spent asleep divided by total time spent attempting to sleep). Results indicate that women slept more efficiently on nights when they smelled their romantic partner's body odor. Error bars represent ±1 *SEM*. This figure is based on results reported by Hofer and Chen (2020).

Although it has become clear that humans can perceive specific body odors that convey specific kinds of functionally useful information to perceivers, the exact chemical nature of many of these odors remains a mystery. In a few pioneering studies, researchers have attempted to identify the molecular structure of body odors, including odors associated with specific emotions, sicknesses, and individual identities (Penn et al., 2007; Smeets et al., 2020; Trivedi et al., 2019). Results are awaiting replication and, as a next step, manipulation of the identified compounds. Methodological advances may aid in this endeavor by allowing scientists to assess the air surrounding people in real time. For instance, one study measured airborne chemical compounds in a movie theater and detected increased levels of specific compounds as the audience responded to suspenseful movie scenes (Williams et al., 2016). This method creates the opportunity to isolate and identify which compounds are emitted in response to certain events—such as the experience of fear. The identification of the specific chemical structures that communicate specific states, traits, and individual "odor prints" will be an important step forward scientifically and may also have useful practical applications (e.g., diagnoses of diseases with specific odor profiles).

It will also be useful to pursue research on exactly how people acquire the knowledge they use to make odor-based inferences. One useful theoretical framework highlights the role of associative learning mechanisms as a means through which people come to associate specific body odors with specific traits and states (de Groot et al., 2017). A related question of perennial interest is this: To what extent might there be an innate component underlying specific responses to specific odors? There are, of course, innate bases for the learning mechanisms through which learned associations are acquired, and—as with analogous responses to other kinds of perceptual stimuli (e.g., conditioned taste aversions, fearful responses to the sight of snakes)—it is likely that there are innate predispositions to efficiently learn specific associations with specific body-odor profiles. However, there is limited evidence for any purely innate response to a specific human odor. One possible candidate for a purely innate response is a newborn's positive reaction to the scent of human breast milk: Even exclusively bottle-fed infants prefer the scent of a lactating woman's breast to the scent of their own familiar formula; for a comprehensive review of relevant evidence, see Schaal, Saxton, Loos, Soussignan, and Durand (2020). However, although this phenomenon is consistent with an innate attraction to the odor of breast milk, it may also be explained as a learned response acquired through prenatal exposure to chemicals in the fetal environment (Schaal et al., 2020). Stevenson (2010) emphasized "the importance and ubiquity of learning in supporting all aspects of olfactory function" (p. 15). Research in the last decade has supported this point. Obtaining a nuanced understanding of specific learning mechanisms, and the specific ways that they apply to specific phenomena, remains a challenge for future research.

To answer all these questions will involve a substantial collective research effort, requiring attention from researchers with diverse areas of expertise who, ideally, will collect data from diverse segments of the human population (Roberts, Havlíček, & Schaal, 2020). This kind of research is rarely cheap or easy, which can pose a practical barrier to researchers with limited resources (and, even when resources are available, may be a disincentive within a scientific community that prizes large sample sizes). An additional obstacle for new researchers will be to navigate the various methodological decisions that need to be made (often without well-defined best practices), such as selecting control variables and deciding between diverse scent-collection and scent-presentation techniques. Increased international collaboration may provide a route to meet and overcome these challenges and to produce exciting new insights into the many psychological consequences that arise when people smell other people's smells.

Recommended Reading

de Groot, J. H., Semin, G. R., & Smeets, M. A. (2017). (See References). A comprehensive review of the communicative function of human body odors.

Hofer, M. K., & Chen, F. S. (2020). (See References). A representative empirical article on the sleep-enhancing effects of a romantic partner's body odor.

Lundström, J. N., & Olsson, M. J. (2010). (See References). A clear overview of how the human brain processes body odors.

Schaal, B., Saxton, T. K., Loos, H., Soussignan, R., & Durand, K. (See References). (2020). A comprehensive review of the impact and importance of the olfactory sense across early development.

Stevenson, R. J. (2010). (See References). An accessible overview of the various functions of the human sense of smell, including comparisons with olfactory functions in other mammals.

Transparency

Action Editor: Robert L. Goldstone
Editor: Robert L. Goldstone
Declaration of Conflicting Interests
The author(s) declared that there were no conflicts of interest with respect to the authorship or the publication of this article.
Funding
This research was funded by an American Psychological Foundation Visionary Grant to M. K. Hofer and F. S. Chen. M. K. Hofer is supported by a University of British

Columbia Four-Year Doctoral Fellowship. F. S. Chen is supported by a Canadian Institutes of Health Research New Investigator Award and a Michael Smith Foundation for Health Research Scholar award. M. Schaller is supported by Social Sciences and Humanities Research Council of Canada Insight Development Grant 430-2018-00218.

ORCID iDs

Marlise K. Hofer https://orcid.org/0000-0002-3758-1756
Mark Schaller https://orcid.org/0000-0003-1243-4650

Acknowledgments

Parts of this article overlap with material that appears in M. K. Hofer's doctoral dissertation (Hofer, 2020).

References

Akcan, E., & Polat, S. (2016). Comparative effect of the smells of amniotic fluid, breast milk, and lavender on newborns' pain during heel lance. *Breastfeeding Medicine*, *11*, 309–314. doi:10.1089/bfm.2015.0174

Badiee, Z., Asghari, M., & Mohammadizadeh, M. (2013). The calming effect of maternal breast milk odor on premature infants. *Pediatrics & Neonatology*, *54*, 322–325. doi:10.1016/j.pedneo.2013.04.004

de Groot, J. H., Semin, G. R., & Smeets, M. A. (2014). I can see, hear, and smell your fear: Comparing olfactory and audiovisual media in fear communication. *Journal of Experimental Psychology: General*, *143*, 825–834. doi:10.1037/a003373

de Groot, J. H., Semin, G. R., & Smeets, M. A. (2017). On the communicative function of body odors: A theoretical integration and review. *Perspectives on Psychological Science*, *12*, 306–324. doi:10.1177/1745691616676599

de Groot, J. H., & Smeets, M. A. (2017). Human fear chemosignaling: Evidence from a meta-analysis. *Chemical Senses*, *42*, 663–673. doi:10.1093/chemse/bjx049

Gangestad, S. W., Thornhill, R., & Garver-Apgar, C. E. (2005). Adaptations to ovulation: Implications for sexual and social behavior. *Current Directions in Psychological Science*, *14*, 312–316. doi:10.1111/j.0963-7214.2005.00388.x

Gildersleeve, K., Haselton, M. G., & Fales, M. R. (2014). Do women's mate preferences change across the ovulatory cycle? A meta-analytic review. *Psychological Bulletin*, *140*, 1205–1259. doi:10.1037/a0035438

Granqvist, P., Vestbrant, K., Döllinger, L., Liuzza, M. T., Olsson, M. J., Blomkvist, A., & Lundström, J. N. (2019). The scent of security: Odor of romantic partner alters subjective discomfort and autonomic stress responses in an adult attachment-dependent manner. *Physiology & Behavior*, *198*, 144–150. doi:10.1016/j.physbeh.2018.08.024

Haselton, M. G., & Gildersleeve, K. (2016). Human ovulation cues. *Current Opinion in Psychology*, *7*, 120–125. doi:10.1016/j.copsyc.2015.08.020

Hofer, M. K. (2020). *The smelly truth: Evidence that exposure to the scent of a romantic partner reduces stress reactivity and improves sleep efficiency* (Doctoral dissertation). University of British Columbia, Canada. Retrieved from https://doi.org/10.14288/1.0392677

Hofer, M. K., & Chen, F. S. (2020). The scent of a good night's sleep: Olfactory cues of a romantic partner increase sleep efficiency. *Psychological Science*, *4*, 449–459. doi:10.1177/0956797620905615

Hofer, M. K., Collins, H. K., Whillans, A. V., & Chen, F. S. (2018). Olfactory cues from romantic partners and strangers influence women's responses to stress. *Journal of Personality and Social Psychology*, *114*, 1–9. doi:10.1037/pspa0000110

Hoffmann, H. (2019). The aroma of arousal: Effects of menstrual cycle phase and women's sexual arousal state on men's responsiveness to women's body odor. *Biological Psychology*, *142*, 54–61. doi:10.1016/j.biopsycho.2019.01.012

Kadohisa, M. (2013). Effects of odor on emotion, with implications. *Frontiers in Systems Neuroscience*, *7*, Article 66. doi:10.3389/fnsys.2013.00066

Kavaliers, M., & Choleris, E. (2017). Social cognition and the neurobiology of rodent mate choice. *Integrative and Comparative Biology*, *57*, 846–856. doi:10.1093/icb/icx042

Lundström, J. N., & Olsson, M. J. (2010). Functional neuronal processing of human body odors. In G. Litwack (Ed.), *Vitamins & Hormones* (Vol. 83, pp. 1–23). San Diego, CA: Academic Press. doi:10.1016/S0083-6729(10)83001-8

Mahmut, M. K., & Stevenson, R. J. (2019). Do single men smell and look different to partnered men? *Frontiers in Psychology*, *10*, Article 261. doi:10.3389/fpsyg.2019.00261

McBurney, D. H., Shoup, M. L., & Streeter, S. A. (2006). Olfactory comfort: Smelling a partner's clothing during periods of separation. *Journal of Applied Social Psychology*, *36*, 2325–2335. doi:10.1111/j.0021-9029.2006.00105.x

McGann, J. P. (2017). Poor human olfaction is a 19th-century myth. *Science*, *356*(6338), Article 7263. doi:10.1126/science.aam7263

Natsch, A., & Emter, R. (2020). The specific biochemistry of human axilla odour formation viewed in an evolutionary context. *Philosophical Transactions of the Royal Society B*, *375*, Article 20190269. doi:10.1098/rstb.2019.0269

Neuberg, S. L., & Schaller, M. (2015). Evolutionary social cognition. In M. Mikulincer, P. R. Shaver, E. Borgida, & J. A. Bargh (Eds.), *APA handbook of personality and social psychology* (Vol. 1, pp. 3–45). Washington, DC: American Psychological Association. doi:10.1037/14341-001

Olsson, M. J., Lundström, J. N., Kimball, B. A., Gordon, A. R., Karshikoff, B., Hosseini, N., . . . Lekander, M. (2014). The scent of disease: Human body odor contains an early chemosensory cue of sickness. *Psychological Science*, *25*, 817–823. doi:10.1177/0956797613515681

Pause, B. M. (2012). Processing of body odor signals by the human brain. *Chemosensory Perception*, *5*, 55–63. doi:10.1007/s12078-011-9108-2

Penn, D. J., Oberzaucher, E., Grammer, K., Fischer, G., Soini, H. A., Wiesler, D., . . . Brereton, R. G. (2007). Individual and gender fingerprints in human body odour. *Journal of the Royal Society Interface*, *4*, 331–340. doi:10.1098/rsif.2006.0182

Quintana, P., Nolet, K., Baus, O., & Bouchard, S. (2019). The effect of exposure to fear-related body odorants on anxiety and interpersonal trust toward a virtual character. *Chemical Senses*, *44*, 683–692. doi:10.1093/chemse/bjz063

Roberts, S. C., Havlíček, J., & Schaal, B. (2020). Human olfactory communication: Current challenges and future prospects. *Philosophical Transactions of the Royal Society B*, *375*, Article 20190258. doi:10.1098/rstb.2019.0258

Sarolidou, G., Axelsson, J., Kimball, B. A., Sundelin, T., Regenbogen, C., Lundström, J. N., . . . Olsson, M. J. (2020). People expressing olfactory and visual cues of disease are less liked. *Philosophical Transactions of the Royal Society B*, *375*, Article 20190272. doi:10.1098/rstb.2019.0272

Schaal, B., Saxton, T. K., Loos, H., Soussignan, R., & Durand, K. (2020). Olfaction scaffolds the developing human from neonate to adolescent and beyond. *Philosophical Transactions of the Royal Society B*, *375*, Article 20190261. doi:10.1098/rstb.2019.0261

Schäfer, L., Sorokowska, A., Sauter, J., Schmidt, A. H., & Croy, I. (2020). Body odours as a chemosignal in the mother–child relationship: New insights based on an human leucocyte antigen-genotyped family cohort. *Philosophical Transactions of the Royal Society B*, *375*, Article 20190266. doi:10.1098/rstb.2019.0266

Shirasu, M., & Touhara, K. (2011). The scent of disease: Volatile organic compounds of the human body related to disease and disorder. *The Journal of Biochemistry*, *150*, 257–266. doi:10.1093/jb/mvr090

Smeets, M. A. M., Rosing, E. A. E., Jacobs, D. M., van Velzen, E., Koek, J. H., Blonk, C., . . . Semin, G. R. (2020). Chemical fingerprints of emotional body odor. *Metabolites*, *10*, Article 84. doi:10.3390/metabo10030084

Stevenson, R. J. (2010). An initial evaluation of the functions of human olfaction. *Chemical Senses*, *35*, 3–20. doi:10.1093/chemse/bjp083

Trivedi, D. K., Sinclair, E., Xu, Y., Sarkar, D., Walton-Doyle, C., Liscio, C., . . . Barran, P. (2019). Discovery of volatile biomarkers of Parkinson's disease from sebum. *ACS Central Science*, *5*, 599–606. doi:10.1021/acscentsci.8b00879

Williams, J., Stönner, C., Wicker, J., Krauter, N., Derstroff, B., Bourtsoukidis, E., . . . Kramer, S. (2016). Cinema audiences reproducibly vary the chemical composition of air during films, by broadcasting scene specific emissions on breath. *Scientific Reports*, *6*, Article 25464. doi:10.1038/srep25464

Wisman, A., & Shrira, I. (2020). Sexual chemosignals: Evidence that men process olfactory signals of women's sexual arousal. *Archives of Sexual Behavior*, *49*, 1505–1516. doi:10.1007/s10508-019-01588-8

Yildiz, A., Arikan, D., Gözüm, S., Taştekın, A., & Budancamanak, İ. (2011). The effect of the odor of breast milk on the time needed for transition from gavage to total oral feeding in preterm infants. *Journal of Nursing Scholarship*, *43*, 265–273. doi:10.1111/j.1547-5069.2011.01410.x