



Interactions between observer and stimuli fertility status: Endocrine and perceptual responses to intrasexual vocal fertility cues

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ABSTRACT

Both men and women find female voices more attractive at higher fertility times in the menstrual cycle, suggesting the voice is a cue to fertility and/or hormonal status. Preference for fertile females' voices provides males with an obvious reproduction advantage, however the advantage for female listeners is less clear. One possibility is that attention to the fertility status of potential rivals may enable women to enhance their own reproductive strategies through intrasexual competition. If so, the response to having high fertility voices should include hormonal changes that promote competitive behavior. Furthermore, attention and response to such cues should vary as a function of the observer's own fertility, which influences her ability to compete for mates. The current study monitored variation in cortisol and testosterone levels in response to evaluating the attractiveness of voices of other women. All 33 participants completed this task once during ovulation then again during the luteal phase. The voice stimuli were recorded from naturally cycling women at both high and low fertility, and from women using hormonal birth control. We found that listeners rated high fertility voices as more attractive compared to low fertility, with the effect being stronger when listeners were ovulating. Testosterone was elevated following voice ratings suggesting threat detection or the anticipation of competition, but no stress response was found.

1. Introduction

Though fertility remains relatively concealed in humans as compared to other primate species, subtle physical changes that occur throughout the menstrual cycle may alter the perception of female attractiveness. Both men and women detect differences associated with fertility such as heightened facial (Bobst and Lobmaier, 2012), vocal (Karthikeyan and Locke, 2015; Pipitone and Gallup, 2008; Shoup-Knox and Pipitone, 2015), and body odor attractiveness (Cerdeira-Molina et al., 2013; Miller and Maner, 2010; Singh and Bronstad, 2001). Preference for such cues provides an obvious advantage to men selecting mates of high reproductive capability, however, there are fewer supposed benefits for women to perceive changes in attractiveness as a factor of other women's fertility. It is possible that women may monitor the fertility of others to more effectively adjust their own mating strategies accordingly. Altering mating strategies in response to other females' hormonal profile requires physiological changes, likely involving hormones. Indeed, women exhibit increased testosterone in response to the odors of high fertility women (Maner and McNulty, 2013) as well as increased sympathetic nervous system arousal to the voices (Shoup-Knox and

Pipitone, 2015) of high fertility women. However, no work to date has examined whether these responses vary as a function of the observer's menstrual cycle. It is possible that the motivation to respond to fertility cues in other women, as well as her hormonal response to those cues, differs based on her own fertility and subsequent desire to compete for a mate.

1.1. Intrasexual competition and fertility

Intrasexual selection is the competition among members of the same sex to be chosen as mates (Andersson, 1994). For most species, the majority of research regarding intrasexual competition has examined men (see Puts et al., 2012 for examples). However, research by Buss (1988) found sex differences in the behaviors associated with human intrasexual competition. Males typically display strength, athleticism, or resources more often, while women employ tactics such as wearing makeup and jewelry, altering their appearance, flirting or acting promiscuous. Later, Buss explored women's perceptions of specific intrasexual competition tactics (Schmitt and Buss, 1996). They found that women's most effective strategies included acting flirtatious or

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seductively, displaying exclusivity, sexualizing one's appearance, making sexual propositions, and having sex. This suggests that women may promote themselves by acting sexually available. In the presence of a competitor, however, women employed derogation tactics including: calling a rival sexually unavailable or promiscuous, questioning a rival's fidelity, and derogating a rival's appearance or attractiveness. Evidence suggests that these tactics are cycle-dependent. Women derogated the fidelity of other's when the women pictured were perceived to be more sexually receptive (Pazda et al., 2014). Fisher (2004) found that women rated the attractiveness of other women to be lower than themselves, but only during mid-cycle. Fertile women are also more likely to withhold resources from attractive women (Lucas and Koff, 2013). These findings imply that, when closer to peak fertility, women may be more sensitive to cues of high quality or high fertility mating competition, allowing them to deploy intrasexually competitive strategies. Using hormonal contraception however, which alters normal menstrual cycle hormonal profiles, has been shown to mitigate intrasexual competition levels, specifically among pair-bonded women (Cobey et al., 2013).

In addition to derogating competitors, women simultaneously attempt to increase their own attractiveness at times of high fertility through their choice of clothing and ornamentation (Beall and Tracy, 2013; Durante et al., 2010; Durante et al., 2008; Eisenbruch et al., 2015; Haselton et al., 2007). During ovulation, women wear pink or red, a color shown to increase males' attraction to women (Elliot and Niesta, 2008) and females' mate guarding tactics (Pazda et al., 2014), 2–3 times more often than during other phases (Beall and Tracy, 2013; Eisenbruch et al., 2015; but see Blake et al., 2017 for conflicting evidence). Women also wear and design more revealing and sexier attire while fertile than the same women in their luteal phase (Durante et al., 2008). This strategy does not go unnoticed; photos of fertile women are judged as wearing nicer, more fashionable, and more revealing clothing compared to photos of the same women in their late-luteal phase (Haselton et al., 2007). These cycle-dependent clothing choices can be directly influenced by the presence of an attractive female. When primed with a picture of an attractive woman, high fertility women purchase significantly more sexy clothing, shoes, and accessories (Durante et al., 2010), and display higher attentional bias to ornamental objects (Zhuang and Wang, 2014). These studies are further evidence that many of women's ornamental and behavioral choices are driven by intrasexual competition mechanisms.

In addition to being affected by the mating efforts of their competitors, women have demonstrated shifts in their perception of other women as a function of the target's cycle phase. Puts et al. (2013) found that faces of women with low progesterone (indicating follicular or ovulatory phases of the cycle) were rated by other women as being more flirtatious. Similarly, women rated the voices of other women at high fertility as being more attractive than those of the same women at low fertility (Pipitone and Gallup, 2008; Puts et al., 2013; Shoup-Knox and Pipitone, 2015).

Vocal production is an ideal target for research on fertility cues due to the heavy influence of hormones on the vocal tract. Human vocal folds have receptors for androgens, estrogens, and progesterone (Newman et al., 2000) and cyclical variation in estrogens and progesterone alter female vocal production. Increased progesterone levels can cause production of thicker and more acidic mucus within the vocal folds leading to dryness of the laryngeal muscle and edema of the vocal folds themselves (Abitbol et al., 1999). During pre-ovulatory and late-luteal phases, the interaction of estrogen and progesterone can modify laryngeal mucosa, altering vocal acoustic properties (Abitbol et al., 1999).

The voice and other fertility cues of competitors affect the physiology of women. When listening to the voices of naturally cycling women at high fertility, females' skin conductance response was elevated compared to the response to voices recorded at low fertility (Shoup-Knox and Pipitone, 2015). Heightened skin conductance

response is an indication of sympathetic nervous system arousal that often indicates a response to threat. Testosterone has also been shown to be heightened in women when exposed to the odors of high fertility women compared to the testosterone of women exposed to the odors of low fertility women (Maner and McNulty, 2013). Taken together, these findings imply that women react to fertility cues of other women at the physiological and hormonal level. They also show that the female response is indicative of a reaction to threat and with an alteration of testosterone, a hormone related to increased competitive behavior.

1.2. Endocrine responses to competition

Most research involving endocrine responses to competition has focused on sports or contests (see Salvador and Costa, 2009). Among women, the anticipation of sporting competition produced an increase in testosterone (Bateup et al., 2002; Oliveira et al., 2009; Edwards and Kurlander, 2010) and cortisol (Bateup et al., 2002; Oliveira et al., 2009; though no change was found in Edwards and Kurlander, 2010). However, in addition to Maner and McNulty's (2013) findings of increased testosterone in response to olfactory ovulation cues, there is further evidence that humans may exhibit endocrine responses to sexually competitive rivals, and that these responses may prime downstream competitive behaviors. Basal testosterone levels are positively correlated with feelings of intrasexual competitiveness among women (Hahn et al., 2016) and eliciting sexual jealousy precipitates a rise in testosterone among women (Ritchie and van Anders, 2015).

Among individuals of both sexes, elevated testosterone heightens attention to threat (for review see: Carré and Olmstead, 2015) and increases the likelihood of making risky choices (Stanton et al., 2011). Mehta and Josephs (2006) found that elevated testosterone in response to losing a competition increases the likelihood of continuing to compete across both sexes. The same researchers also found that, across both sexes, higher basal testosterone paired with lower basal cortisol increased the willingness to compete (Mehta and Josephs, 2010). The current study will explore whether women produce a testosterone response during evaluation of other women similar to the response documented in studies of physical competition.

Sexual attraction and intersexual interaction influence both testosterone and cortisol, and this may affect mate-seeking behaviors. Roney et al. (2007) reported increased testosterone and cortisol among men after the mere presence of a young female confederate. Among women, imagining a sexual encounter induces an increase in testosterone, but not cortisol (Goldey and van Anders, 2011). In one of the few testosterone studies that considered cycle phase, researchers found that in response to video footage of an attractive man, both testosterone and cortisol increased in women while at low fertility (López et al., 2009). However, when women were at high fertility, only testosterone increased. Considering the roles for testosterone and cortisol in response to competition, stress, and intrasexual competition, it is reasonable to question whether a competitor's fertility status, or the perception of a competitor's attractiveness, elicits a response in one or both of these hormones. It is possible that increased testosterone and/or cortisol may heighten women's propensity to exhibit aggression, derogation, or other forms of intrasexual competition.

1.3. Current directions

To our knowledge, no studies to date have investigated hormonal changes affecting judgements of same sex stimuli which could lead to intrasexual competitive scenarios when considering both the fertility of the observer and the observed. The current study investigates whether women exhibit endocrine responses indicative of threat detection or stress when evaluating voices of women recorded at high and lower fertility times during the menstrual cycle, and if the response is dependent on the listeners' fertility status. In addition, we explore intrasexual assessments of voice attractiveness as a function of both

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