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Martha McClintock is a biopsychologist who specializes in social behavior and the regulation of fertility. It is through her pioneering work that menstrual synchrony amongst social groups of females was discovered to be a result of human pheromonal interactions. During McClintock's undergraduate work at Wellesley College, she observed that menstrual synchrony was a common phenomenon between her dorm mates and herself (1). Through greater experimentation, she associated this trend was due to pheromonal output of women during social interactions. This work became her senior thesis at Wellesley and was published in Nature in 1971 (2). The discovery of ovarian pheromones has lead to a wider debate on the role these odorless compounds play in human physiology and behavior. From studies on other mammalian species, non-ovarian pheromones have been shown to influence mating preferences, dominance relationships, and stress levels when introduced to a new environment as depending on the emotional state of the previous occupants (3). Pheromone signaling between human females could, in fact, have implications for fertility, conception, and puberty (4). McClintock's pioneering work in this field has lead to much advancement in the understanding of female interaction.

Background

Two neuroendocrine compounds control the menstrual cycle: luteinizing hormone (LH) and follicle-stimulating hormone (FSH) (5). These two hormones are secreted into the blood stream from the specialized endocrine region of the brain, the anterior pituitary. Syntheses of LH and FSH are started by the release of a different hormone, GnRH, from the hypothalamus. GnRH travels down to the anterior pituitary to stimulate hormone production in the endocrine cells. The cyclic variations of the relative concentrations of LH and FSH in the bloodstream cause the different stages of the menstrual cycle. In the follicular phase of the cycle, FSH has an increased role whereas the luteal phase is dependent on the presence of LH.

Pheromones can be broadly defined as odorless chemical compounds that regulate specific neuroendocrine functions in same-species members without the recipient being consciously aware of the odor (3). The existence of human pheromones was only speculated until McClintock proved the cause of menstrual synchrony in a follow-up experiment in 1998 (4).

The Experiment

In McClintock's initial 1971 study, she explored the then-anecdotal phenomenon that young women within a college dorm often experience synchronization of their menstrual cycles (2). Her study had a subject pool of 135 females from 17 to 22 years of age, all of whom were classmates of McClintock at Wellesley. Three times throughout the academic year, she asked this pool when their last and second to last menstrual cycles had begun. A survey was given to the subject pool asking for names of their closest friends and their roommates. Date of menstrual onset was then compared amongst these social groups, which were defined by the mutual identification of a subject's close friends and living group. The results clearly displayed synchrony had occurred: a significant decrease in the difference between onset dates of the menstrual cycle was observed between roommates, among close friends, and between both groups combined (2). McClintock addressed at least one confounding variable in this study: whether conscious knowledge of friends' menstrual cycles had an effect in shifting their own. The subjects were surveyed on whether an individual was aware of the onset of the menstrual cycles of her friends. McClintock found that only 48% of the participants were even vaguely aware of others' menstrual cycles (2). She concluded therefore that time spent together, devoid of conscious knowledge of physiological changes, was the primary factor affecting synchrony.

In her 1998 follow-up study, McClintock confirmed her suspicion that human pheromones were responsible for this change in neuroendocrine control of a female's menstrual cycle (4). In this experiment, axillary compounds from female donors were applied to the subject's upper lip every day for four consecutive menstrual cycles. It was known from a study on rat ovarian synchrony that two pheromones were responsible for opposing effects in modulating the onset of rat cycles. Similarly, when human subjects received axillary compounds that were collected during the donor's follicular phase, their cycles were shortened whereas compounds that were collected during the ovulatory phase caused the subject's cycle to lengthen (4). McClintock argued that due to the complex mechanism of two opposing effects both leading to synchrony, it was highly unlikely that the disruption of ovulation was caused by a simple chemical, but rather must have been pheromonal interaction with the neuroendocrine system. The study goes on to identify which of the three phases of ovulation was affected by the pheromone activity. McClintock determined the onset of each phase through urinalysis and traced back all differential patterns of the subject's cycle to their follicular phase (4). The follicular phase is ended as an influx luteal hormone (LH) begins to trigger the luteal phase, so pheromonal activity probably has functionality in delaying the onset of the surge of LH (4). This experiment left McClintock wondering whether pheromonal effects are primarily experienced in young, healthy women, as were the college-aged women in both of the studies mentioned, or whether these effects would be just as robust in a larger class of women.

Further Implications

Pheromonal synchrony of ovulation within female social groups can coordinate cooperative care and increased parental involvement by aligning birth cycles (6). It is also possible that pheromones act to reflect the state of the physical environment, as social signals rely heavily on the state of the environment in which the group is acting. Thus, female physiological activity may be highly dependent on the nature of their environment (6). It has been been suggested that the pheromone leading to estrous suppression in rat populations is similar in structure to the puberty-delaying pheromone. Puberty is a time in which high-energy investment is required of the female, and pheromones that reflect the physical environment could help determine if said environment is viable for such energy expenditure (6). In a further extrapolation, pheromones excreted by lactating mothers could suppress the fertility of their daughters so that they are available for help in child rearing of their sibling (4).

Today, McClintock is active in her lab at the University of Chicago, where she furthers her studies on the interaction between behavior and reproductive endocrinology (1). She experiments both with animals and in parallel human-clinical settings. McClintock is an accomplished researcher and is the recipient of many awards including the American Psychological Association's Distinguished Scientific Award for an Early Career Contribution to Psychology (1). Through her revolutionary discoveries, McClintock is able to further the link between hormonal and pheromonal control of the neural endocrine system. She has identified the role of female social groups in coordinating ideal fertility patterns for a community. Her contributions to the field of neuroscience have truly had a profound impact on the way we view the role of social interactions on our physiology.

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