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Original Article

Evolutionary Medicine: Semen Sampling and Seminal Plasma Hypersensitivity

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Abstract: Evidence suggests that each male may have a unique semen signature, and there are reasons to consider the possibility that semen sampling (i.e., being inseminated by different prospective mates during courtship) may be part of an evolved female mate assessment strategy. Here we theorize that seminal plasma hypersensitivity represents the extreme negative end of this continuum and functions as a deterrent to mating with genetically incompatible suitors.

Keywords: seminal plasma hypersensitivity, semen sampling, mate choice

Evolutionary Medicine

The emerging field of evolutionary medicine often focuses on instances in which modern technological changes have put people out of phase, or even at odds, with adaptations shaped by natural selection (Gallup, Reynolds, Bak, and Aboul-Seoud, 2014). For instance, the rising incidence of obesity is associated with a number of serious medical problems, but body fat used to be highly adaptive. Fat is an adaptation to variation in the availability of food. Periods of feast and famine were a recurrent feature throughout human evolutionary history, and the capacity to store calories in the form of fat when food was abundant represented a means of surviving periods in which food was scarce. As a consequence of modern agriculture, however, some people now confront what amounts to a continuous feast, which promotes what used to be the adaptive response of overeating that is out of phase with the conditions some people confront today.

The photoperiod represents another mismatch example. Seasonal variation in the amount of daylight relative to darkness in any 24-hour period is a feature of living displaced to the north or south of the equator. With the invention of artificial sources of illumination, we have unwittingly created the equivalent of a continuous summer, whereby
people are often exposed to 16 or more hours of light on a daily basis independent of season. Moreover, working under conditions of a reversed photoperiod only became possible with the invention of artificial sources of illumination, and this has led to a number of health-related risks, including breast cancer in women (Davis, Mirick, and Stevens, 2001).

Bottle-feeding is an instance in which we have created the technology that allows mothers to opt out of breastfeeding, which heretofore was an indispensable part of reproduction for members of the mammalian order. Consistent with an approach based on evolutionary medicine, there is evidence that bottle-feeding simulates child loss and increases the risk of postpartum depression (Gallup, Pipitone, Carrone, and Leadholm, 2010). Bottle-feeding also undermines evolved birth-spacing mechanisms, leads to premature re-impregnation under conditions of a compromised intrauterine environment, and may increase the risk of autism in the next child (Gallup and Hobbs, 2011).

**Mate Choice Mechanisms**

Because evolution is based on reproductive competition and the perpetuation of genes, another important adaptive problem involves mate choice. One way to ensure that genes are transmitted successfully to the next generation is to pair them with a member of the opposite sex with whom one is genetically compatible and who is reproductively viable, in good health, and has good genes. A variety of features, such as facial attractiveness, have been identified that can be used as cues to the health and fertility of prospective mates (see review by Gallup and Frederick, 2010). As a consequence of natural selection, many of these features have come to exert a profound impact on interpersonal attraction and perceived sex appeal. Work on digit ratios has also been used to illustrate the phenotype-linked fertility hypothesis (Manning, 2002).

Research by Hughes, Harrison, and Gallup (2007) suggests that kissing is part of a species-specific human courtship display that functions as a mate-screening mechanism. One of the more interesting findings in the Hughes et al. study was that the majority of both men and women have found themselves attracted to someone, only to discover after kissing that person for the first time that they are no longer interested. At the moment of the first kiss, there is a rich exchange of postural, tactile, olfactory, and gustatory cues, which may activate evolved mechanisms that process information about the other person’s health, fertility, and genetic compatibility. In instances in which there is not a good match, these mechanisms may function to terminate the relationship.

**Semen Sampling**

We hypothesize that similar mate choice mechanisms may operate at the level of semen chemistry. Courtship in ancestral and contemporary environments often involves a series of sexual encounters that include insemination by different potential mates; as such, semen sampling could provide cues to a suitor’s relative fertility and genetic compatibility.

Semen is much more than a vehicle for the administration of sperm. Only about 5% of the volume of an ejaculate consists of sperm. The remaining 95% is represented by
Evolutionary medicine

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Evolutionary medicine

Evolutionary medicine

Evolutionary Psychology

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seminal plasma, a complex concoction of hormones, neurotransmitters, endorphins, immunosuppressants, and alkaline substances which function to neutralize vaginal acidity and render the female’s reproductive tract a more user-friendly environment for sperm (Burch and Gallup, 2006). In addition to these shared chemical features, each male may have a unique semen signature as evidenced by findings that impregnation by unfamiliar semen (such as a change in paternity from one child to the next) is a significant risk factor for preeclampsia and spontaneous abortion (see Davis and Gallup, 2006; Gallup, Burch, and Petricone, 2012).

Psychological Consequences of Semen Exposure

Does insemination have psychological consequences? If semen sampling operates in parallel with kissing as one of an ensemble of evolved mate selection/screening mechanisms, it might be expected that semen exposure would have psychological and affective consequences. Within 1 or 2 hours following insemination it is possible to detect elevated blood serum levels of seminal chemicals (see Burch and Gallup, 2006), showing that some of the components of seminal plasma pass through vaginal epithelial tissue into a woman’s blood stream, where they could produce effects elsewhere in the body. Among the chemicals found in semen are those that could have psychological consequences, including estrogen, oxytocin, serotonin, norepinephrine, and endorphins.

A study conducted a number of years ago examined women’s scores on the Beck Depression Inventory (a well-established clinical measure of depression) as a function of whether women were having sex on a regular basis (Gallup, Burch, and Platek, 2002). Sexually active women were partitioned into those who were having unprotected sex and those using condoms. Women having unprotected sex and being inseminated on a regular basis were significantly less depressed than women that used condoms. In contrast, women who were having sex with condoms did not differ in their depression scores from those who abstained from sex. Thus, depression scores vary as a function of the presence or absence of semen exposure, not the presence or absence of sex. Controlling for the use of hormonal contraceptives, being in a committed romantic relationship, and the length of the relationship, made no difference in terms of depression scores across these different groups. Following publication of this study, unsolicited email testimony from women who had previously switched from condoms to unprotected sex, as well as those whose partners had undergone vasectomies, indicated individual differences in the magnitude of the apparent mood-altering effects of semen exposure (personal communication). Thus, in parallel with kissing experiences, after being inseminated some women report feelings of enhanced attraction toward their partner, whereas others report negative consequences such as feelings of regret.

Seminal Plasma Hypersensitivity

The literature on semen chemistry typically focuses on proximate causes and fertility treatment techniques, rather than on ultimate or evolutionary issues. In what follows, we argue that a medical condition known as seminal plasma hypersensitivity
(SPH) may anchor the negative end of this semen sampling continuum and may have evolved to minimize the reoccurrence of female sexual involvement with unsuitable mates.

Seminal plasma hypersensitivity has been described as an allergic reaction to semen, whereby genital and even topical exposure to seminal fluid can lead to swelling and irritation, sometimes with burning and painful side effects (Sublett and Bernstein, 2011). SPH appears to be a reaction to semen rather than sperm, as affected patients do not show this response to washed sperm (Weidinger, Ring, and Köhn, 2005). One estimate puts the current occurrence of SPH in the United States at 40,000 women (Sublett and Bernstein, 2011), with many unreported cases. The prevention of such symptoms through the use of condoms has been taken as the gold standard for diagnosing SPH. Although there have been no reported fatalities, in rare instances putative allergenic reactions to semen can be severe, with some patients showing signs of apparent anaphylactic shock (Lee et al., 2008). The etiology of SPH is not clearly defined in the literature, but some researchers have argued that these reactions are IgE-mediated responses against glycoprotein antigens in seminal plasma (Weidinger et al., 2005). These glycoproteins are present in all males and are produced primarily in the prostate. However, if such proteins were the cause, one would expect a generalized allergy in patients to all seminal plasma but that is not usually the case. Thus, the proximate factors responsible for the hypersensitivity effect have yet to be identified.

Unlike typical allergic reactions, SPH rarely has a heritable/familial component (Weidinger et al., 2005). For many patients, SPH is specific to the semen of a particular male, rather than a generalized reaction to semen from any man (Shah and Panjabi, 2004). Moreover, the use of graded seminal challenges involving exposing patients to titrated amounts of their partner’s seminal fluid, modeled after the desensitization trials used by allergists to treat various allergies, has produced mixed results (Resnick et al., 2004).

We propose that these discrepancies from an allergic model may be a consequence of a failure to distinguish between two different types of SPH. Patients who show a generalized, nonspecific reaction to the semen of any male provide a closer fit to the allergic model. There are other patients, however, who have been inseminated by a number of different partners but only report having been adversely affected by semen from one particular male (Shah and Panjabi, 2004). We theorize that reactions in this latter category may be a consequence of evolved mechanisms that function to discourage mating with a man whose genetic makeup does not represent a good fit for the particular woman. If our hypothesis is correct, SPH is not an inherent feature of the man’s semen. Rather, a man whose semen triggers SPH in one woman because of a poor match will not necessarily induce SPH in other women with whom he is better matched. Even in instances in which desensitization works, such treatment may be counterproductive, according to our model, because of the risk of pregnancy complications and other congenital or developmental problems in children conceived by women who experience seminal plasma hypersensitivity.

Although an inability to conceive has been interpreted an important cue for the diagnosis of SPH (Shah and Panjabi, 2004), the inability to conceive could be a consequence of the fact that the painful and irritating side effects of semen exposure serve as a deterrent to unprotected sex for women affected by this condition. Such an outcome
would be consistent with our hypothesis that SPH may function to minimize the frequency of sex and, therefore, the chances of conception among individuals who are genetically incompatible. However, in spite of the aversive side effects, Shah and Panjabi (2004) identified a number of patients with SPH who, in an effort to get pregnant, persevered in having unprotected sex either without success or with maladaptive consequences. For instance, one such couple experienced three first-trimester spontaneous abortions, and another had a child who died 22 days after birth (Shah, Panjabi, and Singh, 2003). Also consistent with our hypothesis based on genetic incompatibility is the case of a 32-year-old woman with three healthy children from a prior marriage who experienced SPH with her second husband (but not her first) and, in spite of evidence of ovulation, was unable to conceive (Frankland and Parish, 1974). There are other instances of women suffering from SPH who have conceived and given birth to children ostensibly sired by the partner whose semen was the source of their symptoms (Ferre-Ybarz, Basagaña, Coroleu, Bartolomé, and Cistero-Bahima, 2006), but unfortunately there have been no long-term follow-up studies conducted on these children. According to our hypothesis, follow-up studies might reveal problems or deficiencies in such children. If that turned out to be the case, it would be prudent to test for SPH as a means of screening potential semen donors for women undergoing artificial insemination.

To return to the literature on evolutionary medicine, the use of contemporary barrier methods of contraception (e.g., condoms), along with treatments for “allergic” reactions to semen through desensitization trials, may mask or minimize SPH and undermine the adaptive benefits this seemingly peculiar phenomenon may otherwise confer.

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