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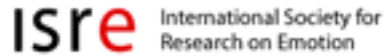The online version of this article can be found at:
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What is This?

Meta-Analysis of Menstrual Cycle Effects on Women's Mate Preferences

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Abstract

In evolutionary psychology predictions, women's mate preferences shift between fertile and nonfertile times of the month to reflect ancestral fitness benefits. Our meta-analytic test involving 58 independent reports (13 unpublished, 45 published) was largely nonsupportive. Specifically, fertile women did not especially desire sex in short-term relationships with men purported to be of high genetic quality (i.e., high testosterone, masculinity, dominance, symmetry). The few significant preference shifts appeared to be research artifacts. The effects declined over time in published work, were limited to studies that used broader, less precise definitions of the fertile phase, and were found only in published research.

Keywords

culture, gender roles, mate preferences, menstrual cycle, meta-analysis

"What does a woman want?" This was Sigmund Freud's "great question that has never been answered," and which, he declared, "I have not yet been able to answer, despite my thirty years of research into the feminine soul" (E. Jones, 1955, p. 468). Psychology has progressed so that we now can systematically document women's preferences, especially with respect to selecting a mate. Experiments have assessed women's preferences for men possessing a variety of different personal attributes.

By understanding women's preferences for male partners, researchers hope to illuminate the basic motives and emotions driving human reproduction. For evolutionary psychologists, these motivating emotions were shaped early in hominin history by sexual selection pressures on women and their ancestors (Buss & Schmitt, 2011; Kenrick, Maner, & Li, 2005). In the present article, we test a specific hypothesis about the influence of ancestral fitness pressures on women's mate preferences. We determine whether women's preferences for a partner shift across the menstrual cycle, given the presumed fitness benefits of mating with different men at each cycle phase (B.C. Jones et al., 2008; Puts, 2010).

To address this issue, we conducted a meta-analysis of experiments on menstrual cycle influences on women's mate preferences. In a typical study in this literature, normally cycling women rated the sexual attractiveness of pictures of men who differed in a particular target attribute, such as extent of facial masculinity (or dominance, testosterone, health, physical symmetry, kindness). Women's preferences during the fertile phase were then compared with preferences during the nonfertile phase. We used this research to evaluate first what attributes women prefer in mates—whether women preferred men with a given trait versus without the trait. Then we tested predictions that women's monthly cycles influenced their preferences for certain male attributes. Finally, to generate a comprehensive explanation of women's preferences and menstrual cycles, we considered how women regulate their reproductive behaviors to conform to gender roles in their society.

Women's Mate Preferences: Evolutionary Psychology Predictions

Contemporary women's emotional reactions to mates are thought to be adaptations to the specific challenges experienced

by ancestral females in the evolutionary past. As these challenges are depicted in parental investment theory (Trivers, 1972), women have a high investment in parenting due to producing relatively few large, metabolically expensive eggs, and gestating and nursing infants. Men's large supply of less costly sperm and freedom from gestation and lactation would yield lower parental investment and a potentially faster reproductive rate. Therefore, women, who bear the greater cost of reproduction, would gain fitness from discriminating choice of mates (Buss & Schmitt, 2011; Kenrick et al., 2005). Women might selectively choose mates who can provide genetic benefits to offspring, material resources and parental care, or limited pathogen exposure. In evolutionary psychology theories, the ancestral benefits of these partner attributes depended on women's menstrual cycle phase and the type of mating relationship, and women's evolved preferences were shaped by this history.

Women in the fertile phase of the cycle are believed to desire partners of high *genetic quality* who potentially convey to offspring heritable features of mating success and survival (Gangestad & Thornhill, 2008). These benefits could be obtained in short-term affairs outside of a primary partner. As Alvergne and Lummaa (2010, p. 171) explain, "preferences for indicators of male genetic quality are hypothesized to be particularly enhanced during oestrus, because not all women are able to pair-bond with high quality males, even though all women could engage in extra-pair copulations" to obtain genetic benefits from these males. Yet high-quality men may not make good pair-bonded partners, because they may not be willing to invest in a long-term relationship (Gangestad & Simpson, 2000; Puts, 2010). In this view, women face a strategic trade-off across partner attributes. When in the fertile phase, women prefer high-quality men for short-term, sexual affairs. When in the nonfertile phase, women are oriented more towards partner investment and prefer longer term mates willing to provide direct, material resources (Little, Jones, Penton-Voak, Burt, & Perrett, 2002). Kindness and generosity are therefore especially attractive traits in a long-term partner. In addition, because of the similarity to pregnancy in hormonal profiles involving progesterone, nonfertile women might prefer to limit pathogen exposure and thus find healthy men especially attractive (B. C. Jones, Perrett, et al., 2005). In these ways, women's emotional desires are predicted to shift across the menstrual cycle with the presumed ancestral fitness benefits of partners' genetic quality, resource generosity, and health.

Men's genetic quality could be reflected in a variety of phenotypic features. As we explain next, these include testosterone levels, masculinity, dominance, and physical symmetry.

Testosterone as an Indicator of Good Genes

According to the *immunocompetence handicap hypothesis* (Folstad & Karter, 1992), testosterone is an immune stressor that increases susceptibility to parasites and other diseases. Yet testosterone also helps to produce masculinized features and behavior that are attractive to women and that enable men to

engage in intrasexual competition for mates and other resources. Given these multiple effects associated with testosterone, only men of good genetic quality are able to support high levels of masculinization and thereby to allocate energy away from their survival efforts into mating efforts. In this view, testosterone is an honest (sic) sign of men's genetic quality.

Despite the popularity of the handicap hypothesis, recent reviews concluded that testosterone is inconsistently related to disease resistance (Harris, 2013; Scott, Clarke, Boothroyd, & Penton-Voak, 2013). As Rantala et al. (2013) note, the handicap hypothesis could suggest either positive or negative relations between testosterone and immunity, given that greater testosterone might impair functioning in men of lower quality but indicate immune strength in men of higher quality. Nonetheless, this hypothesis has been used broadly to predict that fertile women are sexually attracted in short-term affairs to high-testosterone men due to their genetic quality (e.g., Gangestad & Thornhill, 2008; Puts, 2010).

Masculinity and Dominance as Indicators of Good Genes

Masculine features and dominant behavior also are potential signals of men's genetic quality. These features emerge during adolescence, when androgens in combination with other hormones stimulate growth of the jaw, cheekbones, and brow ridges; lengthen the center of the face; promote facial and body hair; coarsen the skin, lower voice pitch; and increase musculature, lean body mass, and height (Lassek & Gaulin, 2009; Rhodes, 2006). Dominant behavior includes assertive, bold, self-confident actions that convey power and leadership.

To the extent that masculinity and dominance reflect high levels of circulating testosterone, then, by the logic of the testosterone immunocompetence hypothesis, these features should signal men's general health proneness (Tybur & Gangestad, 2011). Additionally, these features might signal genetic quality because masculine, dominant men successfully competed with other men and secured resources for mates (Scott et al., 2013). In the present meta-analysis, we tested these good-genes theories by evaluating whether fertile (vs. nonfertile) women desired to have sex with masculine and dominant men in short-term relationships.

Physical Symmetry as an Indicator of Good Genes

Men's genetic quality also might be signaled by the symmetry of their facial features and other bilateral traits, which reflects how precisely an organism develops into adaptive form. Research has focused on symmetry in bilateral facial features as well as fluctuating asymmetry (FA), or asymmetry in the lengths and widths of multiple parts of the body, including the hands, feet, and head (Gangestad & Thornhill, 2008). Highly symmetric men may have inherited resistance to developmental stressors such as parasitic infections and mutations or may have experienced few such stressors in their lives (van Dongen & Gangestad,

2011). Thus, FA is thought to be related to heritable health proneness and genetic quality.

Men's facial symmetry can be observed directly, and women potentially can use this visual information to infer genetic quality. However, women are unlikely to perceive men's FA directly, given that it involves small variations in elbows, ankles, and largely unnoticed parts of the body (Gangestad & Cousins, 2001). To explain how FA could influence mate choice, Gangestad and Cousins (2001) suggested that more symmetric men have more masculine facial features and engage in more dominant, competitive behavioral displays that reflect intrasexual competition. By this reasoning, fertile women prefer low-FA men due to these men's ability to sustain high testosterone levels (i.e., the immunocompetence handicap hypothesis). Specifically, fertile women may be sexually attracted to the appearance of low-FA men as well as their sweat smell, given the androgen-related components of men's sweat (Gangestad & Cousins, 2001). In the present analysis, we tested these ideas by investigating whether fertile (vs. nonfertile) women judged more symmetric men sexy in short-term relationships.

Kindness and Relationship Skills

Women's preferences for partners with relationship skills also might be tied to menstrual cycle phase. As B. C. Jones et al. (2008) argued,

> when women's hormonal profile is similar to that during pregnancy or when the body is preparing for pregnancy (e.g., the luteal phase of the menstrual cycle), women may show stronger preferences for characteristics in a partner or an associate that might be beneficial at this time, such as social and material support or reduced risk of disease. (p.78)

Thus, as a byproduct of selection pressures on pregnancy, women in the nonfertile, luteal phase might prefer to mate with feminine individuals and those who are kind and warm. Additionally, if women have evolved a pattern of mating during nonfertile times of the month in order to retain partner investment, then they might prefer kind, generous partners who are likely to provide such direct benefits (Little et al., 2002). In the meta-analysis, we tested these ideas by evaluating whether nonfertile (vs. fertile) women preferred kinder, warmer men as partners. That is, nonfertile women should find such men attractive (but not necessarily sexy), especially in long-term relationships and perhaps in studies that did not specify relationship length.

Health

Health refers to men's *current condition* as reflected in skin tone and other indicators of illness, and not to general *health proneness*, which is a potential component of genetic quality (Tybur & Gangestad, 2011). Nonfertile women, especially in the luteal phase, might have several reasons to prefer healthy men. As B. C. Jones et al. (2008) noted, this preference might

be the byproduct of disease-avoidance adaptations for pregnancy, when progesterone is high, that might carry over to higher progesterone times in the cycle. In support, pregnant women and women using progesterone-based contraceptives have been found to prefer healthy men (B. C. Jones, Perrett, et al., 2005). In addition, fertile women may be less picky about health because they are willing to risk exposure to pathogens in order to have short-term matings with a high-quality male (Tybur & Gangestad, 2011).

In the present review, we tested whether nonfertile (vs. fertile) women preferred healthier men as partners. If this preference is tied to the hormones of pregnancy, then nonfertile women should prefer healthy men across all rating scales and relationship types. However, if this preference is due to fertile women's willingness to expose themselves to pathogens, then fertile and nonfertile women should differ only in judgments of sexiness for short-term relationships.

Past Reviews of Menstrual Cycle Influences on Mate Preferences

Existing literature reviews of menstrual cycle research have reported tallies of significant findings and relied largely on convenience samples emphasizing the highly cited articles in the published literature. Their conclusions largely support the evolutionary psychology predictions. For example, Alvergne and Lummaa (2010) argued that, "during the past decade, >75% of studies investigating women's cycling mate preferences have demonstrated that … ovulating women prefer more masculine and symmetrical male features … dominance and intrasexual competitiveness, and other possible indicators of genetic quality" (p. 171). Similarly, Gangestad and Thornhill (2008) counted the number of statistically significant findings and concluded that, "female preferences clearly do shift … at mid-cycle, normally-ovulating, non-pill using women particularly prefer a number of masculine male traits" (p. 992). In fact, out of the 18 findings they tallied, 16 were significant. Although these researchers also noted "mixed" evidence from the 10 studies evaluating whether fertile women preferred symmetric faces, fully seven were tallied as supportive. In B. C. Jones et al.'s (2008) tally, seven studies "showed stronger attraction to masculinity around ovulation than at other times" (p. 80). In the same review, a tally of four data sets "showed stronger attraction to apparent health when in the luteal phase than during the late follicular phase of the menstrual cycle" (p. 81). In addition, Gildersleeve et al. (2013) noted the "strong support for cycle shifts in women's sexuality" (p. 518).

Some reviews, however, have offered less sanguine conclusions. Scott et al. (2013) argued that it is not clear that "women preferentially mate with masculine men in short-term/high-fertility contexts, and that this is explicable in terms of heritable immunocompetence" (p. 582). Additionally, a number of carefully conducted studies failed to find menstrual cycle effects on masculinity preferences (e.g., Harris, 2011; Peters, Simmons, & Rhodes, 2009). Nonetheless, DeBruine et al. (2010) argued that

the unsuccessful replications "should be weighed against the much larger number of studies that have shown cyclic variation in women's preferences for male masculinity in many different domains" (p. 768).

Assessing Fertile and Nonfertile Phases of the Menstrual Cycle

Shifts in women's mate preferences across the cycle presumably reflect the mediational role of endocrine systems in emotional reactions. Specifically, "changes in women's preferences are graded shifts probably regulated by changes in the levels of reproductive hormones" (Gangestad & Thornhill, 2008, p. 994). A variety of hormonal, bodily, and neural systems potentially mediate women's preferences across the cycle.

Counting the first day of menses as Day 1, cycles have three broad segments: follicular phase, ovulation, and luteal phase. In a standard 28-day cycle, fertility increases across the follicular phase until ovulation at around Day 14. This fertility peak is marked by surges in (a) follicle stimulating hormone and luteinizing hormone, proteins produced by the anterior pituitary, (b) estradiol, a steroid produced by the ovary, and (c) Inhibin A and B, proteins produced by the ovary (Vitzhum, 2009). With release of the follicle from the ovaries, levels of these hormones fall. Around Day 16 in a standard cycle, the luteal phase begins, along with gradual rises in the levels of progesterone, estrogen, and Inhibin A. Given that women's cycles fluctuate in length, the most fertile days around ovulation are reliably identified from a high ratio of estradiol to progesterone levels or by the surge in luteinizing hormone (Baird, Weinberg, Wilcox, McConnaughey, & Musey, 1991; Wilcox, Dunson, Weinberg, Trussell, & Baird, 2001).

Identifying hormonal cycles. A few studies in our review assayed circulating levels of estrogen, progesterone, and testosterone, and these individual hormones were used to predict mate preferences. Because of the small number of studies using this approach, we simply tallied these findings relating circulating hormonal levels to preference judgments.

By far the majority of studies used women's self-reports of cycle phase to predict mate preferences. For these studies, we calculated exact effect size estimates of the relation between fertile phase and mate preferences. We anticipated that shifts in mate preferences would be most pronounced in studies that identified cycle phase most precisely. The most accurate self-report estimates come from studies that validated women's reports with direct hormone assessments (typically luteinizing hormone) or with subsequent follow-up assessments to certify the day of next menstrual onset. In addition, more precision might be yielded by studies that used a *backward counting* self-report technique, in which women count the days of high fertility backward from their prospective estimate of the next menses, thus taking into account cycle length (DeBruine et al., 2010). In the *forward counting* technique, women count the days of high fertility forward from the onset of last menses. Finally, we anticipated that precision would be greater in studies using more

selective sample exclusion criteria. Studies in our review typically excluded women who were: older and possibly premenopausal, not heterosexual, not normally cycling, and taking birth control pills or other hormonal contraceptives.

Calculating cycle phase from self-reported day. Menstrual cycle day is a continuous measure that researchers typically categorized into fertile and nonfertile phases, assuming a standard cycle of 28 days. The fertile, late follicular phase comprises the "six days when intercourse can result in pregnancy; this 'fertile window' comprises the five days before ovulation and the day of ovulation itself" (Wilcox, Dunson, & Baird, 2000, p. 1260). The nonfertile phase includes the luteal phase, or the days in which progesterone surges following release of the follicle (i.e., days 15–28 in a standard cycle, by forward counting), and also might include the early follicular, menstrual days.

Given the continuous measure of menstrual days, the original researchers constructed their tests of menstrual cycle effects with considerable *degrees of freedom* (Simmons, Nelson, & Simonsohn, 2011; see also Harris, Chabot, & Mickes, 2013). For example, in Frost's (1994) foundational article in this area, women in the first 20 days of their cycle reported a stronger preference for men with darker skin than women in later cycle days, $t(54) = 1.91$, $p < .05$ (one-tailed in the original report).[1] However, in our reanalysis, the results of this study depended on how cycle phase is defined (P. Frost provided the data to us in a personal communication, November 30, 2012). The association between women's skin color preferences and menstrual cycle was not significant when cycle was represented by the conception risk associated with intercourse on any one cycle day (assuming a 28-day cycle; Wilcox et al., 2001), $r(54) = -.02$. A similar nonsignificant result emerged when cycle was dichotomized to compare women's preferences in the 6 most fertile days of the cycle with preferences in other, less fertile cycle days, $t(54) = 0.66$, $p = .512$. The finding became nonsignificant even with a slight variation in Frost's (1994) original analysis that reduced the fertile phase to 19 instead of 20 days, $t(54) = 1.08$, $p = .283$. By configuring his data in the way he did, Frost (1994) produced a statistically significant finding that, despite being widely cited as a fertility effect (e.g., Gangestad & Thornhill, 2008), is not apparent using other decision rules to identify women's fertility status. Given this variation in effects, the present review evaluated whether study results depended on the number of days included in the fertile phase.[2]

The Present Research

The typical study in our review assessed women's menstrual cycle phase and evaluated their preferences for pictures, videos, voices, or scents of men who varied in: (a) testosterone, (b) masculinity, (c) dominance, (d) physical symmetry, (e) kindness, or (f) health. Although past reviews often grouped studies evaluating testosterone, masculinity, and dominance into a single "masculinity" category (e.g., Gangestad & Thornhill, 2008), we used smaller, more uniform study groupings to provide a more sensitive estimate of shifts in mate preferences.

Women's Preferences: Within-Phase Judgments

The data from our review addressed two questions. First, what attributes did women prefer in a mate within each cycle phase? To answer this question, we estimated women's judgments of men with an attribute versus men without that attribute (see Figure 1). These estimates were calculated separately at fertile and nonfertile phases. These within-cycle-phase findings reveal the direction of women's evaluations, specifically whether women were attracted to or repelled by men's attributes when fertile and when not fertile.

Menstrual Cycle Shifts: Between-Phase Judgments

The second question we addressed is, did women in the fertile phase differ in their mating preferences from women in the nonfertile phase? If fertile women have evolved preferences to mate with men with attributes associated with genetic quality in the ancestral past, and if quality is reflected in testosterone levels and related attributes, then fertile women might prefer to mate with men higher in testosterone, masculinity, dominance, and physical symmetry (see Figure 1). We predicted further that "these preference shifts across the cycle are specific to women's judgments of men's sexiness (or desirability as a short-term partner), not their attractiveness as long-term, investing mates" (Tybur & Gangestad, 2011, p. 3382). Thus, fertile more than nonfertile women should find such attributes sexy (but not necessarily attractive) when considering a short-term relationship (but not longer term relationships or when no relationship was specified). In contrast, women in the nonfertile cycle phase might prefer kind, generous, and healthy men due to an evolved orientation to retain partner investment (Little et al., 2002) and due to the similarity in aspects of their hormonal profiles to pregnancy (B. C. Jones et al., 2008).

Finally, we anticipated that studies with more precise estimates of cycle phase would provide the strongest tests of evolutionary psychology theorizing. Thus, preference shifts should be most evident in studies that validated self-reported cycle phase through hormonal assessments and follow-up verification of menses date, as well as in ones that used a narrower, more precise definition of days in the fertile phase.

Method

Sample of Studies and Criteria for Inclusion and Exclusion

The literature search located a total of 45 published and 13 unpublished separate reports that assessed fertile and nonfertile women's preferences for men possessing different levels of the following attributes: testosterone, masculinity, dominance, symmetry, health, and kindness. Most mate preference research has focused on these attributes (see "Study Exclusion Criteria" in online supplement).

In the typical study, women rated pictures or other indicators (voice, scent, personality trait descriptors) of men's attributes. Specifically, testosterone was identified through hormonal assays and conveyed in pictures or scent (e.g., from worn T-shirts). Masculinity was represented by the set of secondary sexual characteristics known to be linked with testosterone, including face shape (e.g., chin length), body shape, voice quality, body gait or facial movement, and body hair, along with participants' direct ratings of the trait, masculine. Dominance was represented through the dominance of men's scent, face shape, voice, and behavior, as well as direct ratings of the traits, dominant, powerful, assertive, and leader. Symmetry was represented through the physical symmetry of men's face and body shape, the voice of men with different levels of symmetry, and the scent of men with different levels of symmetry. Health was represented through the healthiness of men's scent and face, along with direct ratings of the trait, healthy. Kindness was portrayed through the kindness of men's face and behavior, as well as direct ratings of the traits, kind, warm, nice, considerate, and generous.

Search for studies. Computer-based searches, conducted from November 2010 through July 2011,[3] included the following databases: Proquest Digital Dissertations, PubMed Central, Educational Resources Information Center (ERIC), PsycINFO, ScienceDirect, Web of Science, and Google Scholar. These searches linked the following terms: menstrua(l, tion) or fertil(e, ity) or ovulat (ory, ion) or *estr(us) or conce(ption risk, ive) with (a) prefer(ence) or lik(e, ing) or attract(ion, ive, tiveness) or sex(iness); (b) mat(e, ing), partner or genetic benefit(s) or father or parent(ing, al); (c) symmet(ric, ry) or masculin(e, ity) or dominan(ce, t) or health(y, ful); (d) fac(e, ial)/hair or vo(ice, cal) or odor or scent or dimorph(ic, ism).

Descendancy searches also were conducted with Google Scholar on papers that cited foundational articles (e.g., Frost, 1994; Gangestad & Thornhill, 1998; Little et al., 2002; Penton-Voak et al., 1999). Ancestry searchers were conducted with the reference sections of review articles (e.g., Alvergne & Lummaa, 2010; Gangestad & Thornhill, 2008; B. C. Jones et al., 2008).

Following standard procedure in meta-analytic textbooks, we conducted a thorough search for unpublished data (Rothstein & Bushman, 2012). As Rothstein and Hopewell (2009) noted in the *Handbook of Research Synthesis and Meta-Analysis*, "the aim of a high quality literature search in a research synthesis is to generate as comprehensive a list as possible of both published and unpublished studies" (p. 105). Similarly, Johnson and Eagly (in press) recommend that "every effort should be made to obtain unpublished studies. Meta-analyses properly have the goal of describing the universe of studies on a topic or at least an unbiased sample of that universe." Reflecting this goal, unpublished data were used in 69 of the past 95 research syntheses appearing in *Psychological Bulletin* from 1995 to 2005 (Rothstein, 2006). To locate unpublished studies, we posted messages to the Society for Personality and Social Psychology, the Society for the Psychological Study of Social Issues, and the Society of Experimental Social Psychology listservs, as well as the Human Behavior and Evolution Society newsletter. Also, websites of all of the authors of the included articles were searched for reports of related projects. We also searched abstracts of papers presented at the 2006–2011 annual
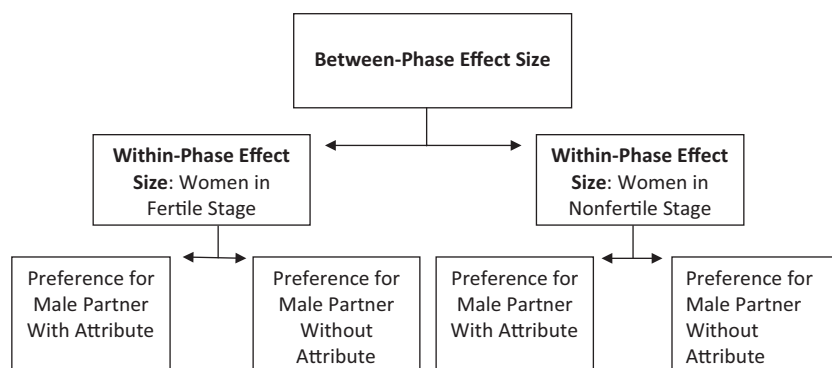
Figure 1. Comparisons used to calculate effect size estimates. Within-phase effect sizes represent women's preferences for men with versus without a particular attribute at each stage of the menstrual cycle. Between-phase effect sizes represent fertile women's preferences for male attributes in comparison with nonfertile women's preferences.

Human Behavior and Evolution Society meetings, the 2007–2011 Northeastern Evolutionary Psychology meetings, and the 2007–2011 Society of Personality and Social Psychology meetings.

The abstract or conference poster of each potential document was evaluated by at least one of the authors, and if the study might fit the inclusion criteria, the full document was obtained. When eligible studies did not provide sufficient information to calculate an effect size, the authors were contacted for the appropriate data, and 32 complied (noted in online Appendix, Tables 1–6). Researchers also provided unpublished raw data from seven additional studies. Five additional documents were not included in the review despite meeting the inclusion criteria: One did not have sufficient fertile and nonfertile participants to estimate a stable effect (Rupp, Librach, et al., 2009) and four did not report the appropriate statistics to calculate an exact effect size, and the study authors failed to provide this information (Cornwell et al., 2004; Gangestad, Garver-Apgar, Simpson, & Cousins, 2007; Gangestad, Simpson, Cousins, Garver-Apgar, & Christensen, 2004; Little, Cohen, Jones, & Belsky, 2007).

Moderator Variables

The included studies, codes, and effect sizes appear in the online data supplement (see online Appendix, Tables 1–6). Two of the authors independently coded 80% of the studies, with the remainder coded by only one author. Agreement was high, with the percentage agreement ranging from 69% to 100%, depending on the item coded. Disagreements were resolved by discussion.

Male stimulus. We evaluated the *relationship context* in which women indicated their preferences (short-term relationship, such as a single date or one-night stand vs. long-term relationship, such as marriage or long-standing commitment vs. no relationship specified); how the *male attribute was conveyed* (facial features vs. body shape vs. voice vs. trait vs. scent vs. physical movement vs. social interaction); how researchers *calibrated the male attribute* (from others' ratings vs. participants'

ratings vs. self-ratings of the stimulus men vs. trait descriptors vs. physical/hormonal markers); and the type of *response rating* (dichotomous choice of most attractive vs. attractiveness rating scale/selection vs. importance rating scale vs. dichotomous choice of most sexually attractive vs. sexual attractiveness rating scale).

Finally, we evaluated *whether the manipulation of the male attribute was demonstrably successful* or not. We judged that women could successfully discriminate men with higher versus lower amounts of an attribute in studies that: (a) presented male trait descriptors (e.g., "masculine," "dominant"), (b) used pretesting to demonstrate variation in the target attribute, (c) used numerous stimulus presentations designed to cover the full range of levels of an attribute (e.g., computer morphing of male faces to range from extremely feminine to extremely masculine), and (d) had actual participants rate the stimulus men in terms of both the target attribute and sexiness/attractiveness, yielding correlations above $r = .20$ between these two indicators. In contrast, studies were classified as not clearly successful if they (a) assessed physical markers (e.g., recent health history, FA) that may or may not have been perceptible to female participants, (b) failed to obtain manipulation checks on the target male attribute (e.g., masculinity), or (c) reported nonsignificant manipulation checks.

Menstrual cycle phase. To evaluate how each study identified the fertile and nonfertile phases from participants' self-reports, we coded whether the reports of menstrual cycle phase were *verified* (by hormonal assays vs. subsequent report of next menstrual onset vs. none), the *fertility estimation method* (forward counting vs. backward counting); the *exclusion criteria for hormonal use* (excluded all hormonal contraception users vs. excluded only birth control pill users); and the *number of fertile days* included in the estimate. We also analyzed the mean age and maximum age of research participants, but these had no consistent effects, and thus we do not report them further.

Additional moderators. We also coded *year of publication* (for published papers only) and *publication status of the report*

(published as a journal article or book chapter vs. unpublished as a dissertation, master's thesis, unpublished data set, or conference presentation). We evaluated a number of additional moderators that yielded no consistent effects and are not reported further, including the *study setting* (laboratory vs. online), the *nationality of participants* (UK vs. US vs. Australia vs. Spain vs. other), the *percentage of participants in a close relationship*, and the *type of participant sample* (college student vs. community vs. mixed).

Computation of Effect Sizes and Data Analysis

Effect sizes were independently calculated by the two senior authors with Comprehensive Meta-Analysis (Version 2.2.05) software. Disagreements were resolved by discussion. Given our focus on menstrual cycle effects, the appropriate metric of variability comes from the participants providing ratings. Thus, for all effects, the sample *N* was calculated from the number of women raters.

Within-phase effect sizes. Some studies provided information to calculate whether women at each cycle stage were attracted to (positively signed effect) or repelled by (negatively signed effect) men with a particular attribute (see Figure 1). When these preferences were reported as mean ratings and standard deviations or appropriate test statistics, we computed *d* effect sizes from the preferences for men with versus without a given attribute: $(M_{\text{Attribute}} - M_{\text{No attribute}})/s_{\text{p}}$, calculated separately for fertile and nonfertile phases. In these analyses, the pooled standard deviation reflected between-participants variability. In other studies, authors reported the findings as correlations between preferences and male attributes within fertile and within nonfertile phases. These correlations were transformed into *d* statistics. Still other studies presented participants with a set of forced-choice trials between men with versus without a particular attribute and thus reported the frequencies or percentages of choice of a male with that attribute. Preferences were then treated as dichotomous, and *d* was estimated from the percentage of trials (compared with chance) in which fertile and nonfertile participants preferred the trait.

Between-phase effect sizes. A greater number of studies reported whether women at fertile versus nonfertile cycle stages preferred a trait more (positively signed effect) or less (negatively signed effect) in potential mates (see Figure 1). For example, some authors reported a single difference score test between the preferences of fertile and nonfertile women. For these studies, we report the computed *d* effect sizes for fertile compared with nonfertile phases: $(M_{\text{Fertile}} - M_{\text{Nonfertile}})/s_{\text{p}}$. Other studies calculated correlations within participants between preferences for (a) a number of men and (b) the extent to which each man possessed a particular attribute, and then predicted these correlations from women's conception risk. For these studies, we used the regression coefficient to generate a *d* score.

Menstrual cycle phase was a within-participants variable in some studies and a between-participants variable in others, and

we standardized study comparisons by using the pooled between-participants' error estimate to calculate effects. To compute these variability estimates from within-participant data, we used the correlation between participants' ratings in the two phases provided by the study or the default value of *r* = .5.

Analytic models. All effect sizes were converted to *g* with the correction for small sample bias (Borenstein, Hedges, Higgins, & Rothstein, 2009). We used Comprehensive Meta-Analysis (Version 2.2.05) to test mixed-effect models on differences across subgroups because these specific groupings (e.g., short-term relationships, long-term relationships) were fixed across studies (Borenstein et al., 2009). We present subgroup analyses and meta-regressions to examine whether moderators accounted for variability among effect sizes. Because the between-phase estimates allowed us to include the greatest amount of data, we conducted most of the moderator analyses on these effects.

Within subgroups, the models were random effects to reflect that the levels of male attributes and other study characteristics were randomly selected from a broader population, with appropriate inverse variance weights (Borenstein et al., 2009). That is, the studies' effect sizes within groupings were not assumed to be consistent with a single underlying mean value. In these models, the variances in the study weighting terms consist of the sum of the within-study variance and the between-studies variance (see Borenstein et al., 2009, p. 72).

Meta-regressions were calculated as random-effects models using the method of moments, with appropriate inverse variance weights (Borenstein et al., 2009). These calculations involved individual predictors for each continuous moderator (e.g., date of publication).

Publication bias. To evaluate for potential publication bias, a mixed-effects subgroup analysis tested for differences between published and unpublished effect sizes. We also analyzed the distribution of effect sizes to ensure that our intensive retrieval strategy ameliorated any potential biases in publication or inclusion of studies (see Borenstein et al., 2009). We first examined the effect sizes plotted by the standard error and calculated Egger's test of the funnel plot's asymmetry to evaluate the relationship between sample size and effect size, which may be indicative of bias. To determine how much the observed results were influenced by bias, we implemented Duval and Tweedie's (2000) trim-and-fill procedure, which estimates the number of studies that should be removed to create a more symmetric funnel plot. This procedure assesses the impact of removing these studies on the mean effect size, then fills these studies back in and imputes a mirror image for each such study to correct the variance. Following Sutton (2009), we used fixed-effects models for the trim-and-fill, given that random effect estimators are more influenced by publication bias.

Analytic strategy. Unless otherwise noted, we conducted moderator tests by aggregating across all variables in a study except the target moderator of interest. In this way, each moderator grouping included independent effect size estimates.

Results: Women's Preferences for Male Attributes

The 58 separate study reports yielded 51 independent within-phase effect sizes (when estimated for fertile and nonfertile cycle phases, 102 effects total) that reveal whether women at each cycle phase preferred men with a particular attribute (positively signed effect) or men without that attribute (negatively signed effect).

Within-phase effects for masculinity, testosterone, dominance, symmetry, health, and kindness are listed in Table 1. Tests for moderators were reserved primarily for the larger data set comparing preferences between phases, although we report the effects of relationship length on within-phase effects in Table A in the online Appendix.

As can be seen in Table 1, both fertile and nonfertile women significantly preferred partners with more masculine, dominant, symmetric, and healthy features. In addition, women nonsignificantly preferred kind men, although they did not show any preference for high-testosterone men. Furthermore, the nonsignificant comparisons between fertile and nonfertile phases suggest that women's preferences were relatively constant across the menstrual cycle.

Discussion of Within-Phase Effects

The within-phase effect sizes revealed that women in both fertile and nonfertile phases preferred masculine, dominant, symmetric, kind (although this effect was not significant), and healthy men. Preferences for high-testosterone men are especially interesting because they provide a relatively direct test of good-genes hypotheses, given that high testosterone levels may signal genetic benefits of health proneness or success at intersexual contests (Gangestad & Thornhill, 2008; Scott et al., 2013). Contrary to the idea that high-testosterone men would appear sexy for short-term affairs, the single study that assessed their sexiness yielded a nonsignificant trend countering predictions. That is, fertile women judged lower testosterone men slightly sexier (Rantala, Eriksson, Vainikka, & Kortet, 2006). This finding echoes a number of other failures to find a relation between men's testosterone and attractiveness to women—studies not included in our review because they did not assess menstrual cycle phase (e.g., Neave, Laing, Fink, & Manning, 2003; Penton-Voak & Chen, 2004; Peters, Simmons, & Rhodes, 2008; Swaddle & Reierson, 2002).

In the present review, we tested preference shifts across the menstrual cycle primarily with the larger number of between-phase comparisons, but it is worth noting the lack of variation in women's preferences within phase. That is, women in nonfertile as well as fertile phases preferred to mate with men higher in masculinity, dominance, and symmetry. Furthermore, women's preferences for these attributes held across short-term as well as long-term relationships (see online Appendix, Table A). Evolutionary psychology theories anticipating cycle effects are especially challenged by the evidence that high- and low-fertility women placed comparable value on these attributes in short-term affairs.

Our review also provided insight into the inconsistency in past findings concerning women's overall preference for men with more masculine, symmetric, and healthy facial shapes (Scott et al., 2013; Welling et al., 2007). In analyses reported in the online supplement (see "Method of Portraying Facial Stimuli"), women's preferences for men with these features depended on the specific techniques used to create these attributes. As found in Rhodes's (2006) earlier meta-analysis, masculine, symmetric, and healthy faces were less attractive in studies that used highly stylized morphing techniques to vary these attributes than in studies using more naturalistic methods. In general, our findings highlight one source of inconsistency in the literature on face preferences—the realism of the techniques used to create male attributes.

In the next two sections of the article, we address preference shifts across the cycle. First, we present direct hormone assessments and then the meta-analysis on between-phase shifts.

Results: Direct Assessments of Reproductive Hormones

A handful of studies in our review assessed naturally occurring variations in women's estradiol, progesterone, and testosterone levels across the monthly cycle and related these to preferences for men who varied in testosterone or masculinity. We anticipated that women would be sexually attracted to higher testosterone and masculine men when their hormonal profiles were similar to fertile phases of the month in that their estrogen levels were elevated, progesterone levels were decreased, and perhaps testosterone levels were elevated (Welling et al., 2007). Nonetheless, fluctuations in these single hormones are ambiguous markers of women's fertility status. Estrogen surges, for example, do not necessary mark fertility, given that these happen twice during the cycle, with the most marked increase around ovulation and a smaller one during the (nonfertile) luteal phase. Because of the small number of studies that directly assessed endocrine levels, we provide just a tabled summary of the results.

Tabulated Results

The studies in our review largely failed to detect significant relations between hormonal fluctuations and mate preferences (see Table 2). The exception is estradiol mediation of women's preferences for men with higher testosterone. Specifically, Roney and Simmons (2008) reported that women with higher circulating estradiol—at either high- or low-fertility phases—preferred men with higher testosterone. However, a subsequent study by this research group (Roney, Simmons, & Gray, 2011) failed to replicate this effect using the identical between-participants design (J. R. Roney, personal communication, March 22, 2012). Nonetheless, this follow-up study did report significant effects on a within-participants basis. Specifically, women's estradiol was assessed twice across the month, and women preferred higher testosterone men in the assessments with higher estradiol levels. In summary, women higher in estradiol inconsistently preferred higher testosterone men.

Table 1. Within-phase effect sizes: Preferences for male attributes

Male attribute	Fertile			Nonfertile			k	Q_b
	Effect size (g)	T	95% CI	Effect size (g)	T	95% CI		
Testosterone	−0.04	0.00	[−0.20, 0.12]	−0.01	0.00	[−0.15, 0.13]	4	0.07
Masculinity	0.46	0.27	[0.29, 0.63]	0.46	0.13	[0.30, 0.63]	15	0.02
Dominance	0.64	0.37	[0.24, 1.04]	0.66	0.16	[0.35, 0.96]	6	0.01
Symmetry	0.50	0.28	[0.26, 0.73]	0.30	0.31	[0.06, 0.50]	12	1.43
Kindness	0.38	0.00	[−0.13, 0.89]	0.39	0.00	[−0.05, 0.84]	3	0.002
Health	0.45	0.30	[0.17, 0.73]	0.52	0.37	[0.22, 0.83]	10	0.11

Note. g = within-phase effect size indicating whether women at each cycle phase prefer men with a trait (positively signed effect) versus without a trait (negatively signed effects). T = estimated between-studies standard deviation of the effect size (g); k = total number of samples; Q_b = variability due to fertility (df = 1).

Table 2. Studies that directly assessed hormonal mediators of women's mate preferences

Women's hormones	Study	Bivariate correlation between women's attribute preferences and hormone levels	Male attribute
Estrogen (salivary)	Roney & Simmons (2008)	r (69) = .35*	Facial testosterone
Δ Estrogen (salivary) across cycle	Roney et al. (2011)	r (34) = .40*[a]	Δ Preference for facial testosterone across cycle
Estrogen (urinary)	Feinberg et al. (2006)	*ns*	Vocal masculinity
Estrogen (blood)	Rupp, James, et al. (2009)	r (11) = .20	Facial masculinity
Δ Estrogen (salivary) across cycle	Roney et al. (2011)	r (34) = −.27	Δ Preference for facial masculinity across cycle
Estrogen (salivary)	Welling et al. (2007)	*ns*	Facial masculinity
Testosterone (salivary)	Roney & Simmons (2008)	r (69) = .06	Facial testosterone
Δ Testosterone (salivary) across cycle	Roney et al. (2011)	r (34) = −.05	Δ Preference for facial testosterone across cycle
Δ Testosterone (salivary) across cycle	Roney et al. (2011)	r (34) = .28	Δ Preference for facial masculinity across cycle
Testosterone (blood)	Rupp, James, et al. (2009)	*ns*	Facial masculinity
Testosterone (salivary)	Welling et al. (2007)	r (69) = .25* male faces; r(69) = .26* female faces	Facial masculinity
Progesterone (salivary)	Roney & Simmons (2008)	r (69) = .06	Facial testosterone
Progesterone (urinary)	Feinberg et al. (2006)	*ns*	Vocal masculinity
Progesterone (blood)	Rupp, James, et al. (2009)	r (11) = .18	Facial masculinity
Progesterone (salivary)	Welling et al. (2007)	*ns*	Facial masculinity

Note. [a]When we estimated the association at each assessment period (comparable to Roney & Simmons, 2008), women's estrogen levels were not significantly related to their preferences for higher testosterone men, r = .18, *ns* (*n*s = 61 and 35, for Time 1 and Time 2 assessments, respectively).
*p < .05.

Women's circulating levels of estradiol or progesterone did not significantly predict their preferences for masculine features or voices (Feinberg et al., 2006; Rupp, James, et al., 2009; Welling et al., 2007), and Roney et al. (2011) even reported a nonsignificant tendency in the reverse direction, with increases in estrogen across the cycle associated with reduced preferences for facial masculinity. Regarding circulating testosterone levels, women with higher levels preferred more masculine men in one study (Welling et al., 2007), but not others (i.e., Roney & Simmons, 2008; Roney et al., 2011; Rupp, James, et al., 2009).

Discussion of Direct Hormonal Assessments

In summary, women's hormonal fluctuations across the month were inconsistently related to mate preferences. However, interpretation is uncertain because these relations have been tested in only a few studies,[4] the sample sizes are generally small, and the levels of single hormones do not map directly onto fertile and nonfertile phases. It is interesting that the findings suggest very different patterns of preferences for testosterone and masculinity. In the one study in which high-estrogen women preferred men with higher testosterone, they did not prefer more masculine

men (Roney & Simmons, 2008). In the one study in which high-testosterone women preferred masculine men, they did not prefer men higher in testosterone (Welling et al., 2007). Also relevant, Roney et al. (2011) reported a negative association between women's changes in preferences for testosterone and masculinity across the cycle, $r(33) = -.35$, $p = .042$. In general, this disconnect between preferences for masculinity and testosterone challenges good-genes theories in which women prefer masculine men due to their high testosterone levels. To provide a more comprehensive test of preference shifts across the cycle, we turn to the larger research literature on self-reported estimates of menstrual phase.

Results: Between-Phase Effects

A total of 96 effect sizes estimated whether women at fertile versus nonfertile cycle phases preferred an attribute more (positively signed effect) or less (negatively signed effect) in potential mates (see Table 3). We conducted moderator analyses to test the evolutionary psychology predictions that masculine, symmetric, dominant, and high-testosterone men appear sexy for short-term affairs in which women can obtain indirect genetic benefits, but these men are not attractive long-term partners because of the presumed trade-off between such men's mating and parenting qualities.

Overall Effect Estimates

Testosterone. Fertile women did not show stronger preferences for high testosterone partners than nonfertile women (see Table 3). All ratings were made in an unspecified relationship context. The studies overall showed a marginal amount of variability, $Q(4) = 8.83$, $p = .065$, with the meaningful percentage of between-studies variability, $I^2 = 54.71\%$. Contrary to expectations, fertile women did not find high-testosterone men especially sexy (see "Type of Dependent Measure" in online supplement).

Masculinity. Fertile women did not show stronger preferences for masculine attributes than nonfertile women (see Table 3). Contrary to expectations, fertile women did not particularly prefer masculine men for short-term affairs (Table 4). In this analysis, studies overall showed a significant amount of variability, $Q(48) = 86.12$, $p < .001$, with the meaningful percentage of between-studies variability, $I^2 = 44.26\%$. Contrary to expectations, fertile women preferred masculine men most strongly on general attractiveness rating scales (see "Type of Dependent Measure" in online supplement).

Dominance. Fertile women did not show stronger preferences for dominant partners than nonfertile women (see Table 3). Contrary to expectations, fertile women did not particularly prefer dominant men for short-term affairs (see Table 4). In this analysis, the studies overall did not reveal a significant amount of variability, $Q(18) = 16.99$, $p = .524$. Contrary to predictions, fertile women did not prefer dominant

men more strongly when evaluating men's sexiness (see "Type of Dependent Measure" in online supplement).

Symmetry. Fertile women showed a significantly stronger preference for symmetrical men than did nonfertile women (see Table 3). Contrary to expectations, fertile women significantly preferred symmetrical men only in studies that did not specify a relationship context (see Table 4), although the comparison across types of relationships was not significant, $Q_b(2) = 2.00$, $p = .368$. In this analysis, the studies overall showed a significant amount of variability, $Q(17) = 42.35$, $p < .001$, with the meaningful percentage of between-studies variability, $I^2 = 59.85\%$. Contrary to expectations, fertile women did not prefer symmetric men more strongly when evaluating men's sexiness (see "Type of Dependent Measure," online supplement).

Kindness. Fertile and nonfertile women did not differ in their preferences for kindness in partners (see Table 3). Also, relationship context did not moderate these effects (see Table 4). In this analysis, the studies did not reveal a significant amount of variability, $Q(17) = 17.65$, $p = .411$. Furthermore, we did not have any predictions about the effects of dependent measure, and no effects emerged.

Health. Nonfertile women showed significantly stronger preferences for healthier men than did fertile women (Table 3). Contrary to expectations, nonfertile women more strongly preferred healthy partners than fertile ones only in studies that did not specify a relationship context (see Table 4), although the comparison across types of relationships was only marginally significant, $Q_b(2) = 4.96$, $p = .084$. In this analysis, the studies did not show a significant amount of variability, $Q(14) = 12.41$, $p = .574$. Again, we had no predictions about type of measure, and no consistent effects emerged.

Precision of Estimating Cycle Phase

In general, the analyses on precision of estimating cycle phases did not find stronger fertility effects in studies that measured menstrual cycles more precisely (see "Precision of Estimating Fertility," online supplement).

Verification of cycle day. Most surprising is the lack of systematic effects in studies that verified menstrual cycle phase. As shown in Table B in the online Appendix, studies that verified cycle phase with hormonal assessments or subsequent contact to validate day of menses onset did not find stronger evidence of preference shifts than studies relying just on women's self-reports of cycle day. That is, with the exception of one testosterone study, menstrual cycle shifts were not found in studies that verified cycle phase.

Number of fertile days. The most consistent results in the analyses on method of estimating cycle phase were the larger effects in studies that estimated the fertile window less precisely by including larger numbers of days. As shown in Figure 2,

Table 3. Between-phase effect sizes: Preferences of fertile versus nonfertile women

Male attribute	k	Effect size (g)	T	SE	95% CI
Testosterone	5	0.11	0.25	0.16	[−0.20, 0.42]
Masculinity	38	0.08	0.17	0.04	[−0.01, 0.16]
Dominance	13	0.05	0.00	0.003	[−0.06, 0.16]
Symmetry	15	0.22	0.23	0.09	[0.05, 0.39]
Kindness	12	0.07	0.00	0.06	[−0.04, 0.18]
Health	13	−0.19	0.00	0.05	[−0.29, −0.09]

Note. k = number of samples; g = between-phase effect size indicating whether women in the fertile phase prefer a male attribute more (positively signed effect) or less (negatively signed effect) than women in the nonfertile phase. T = estimated between-studies standard deviation of the effect sizes for each attribute; 95% CI = measure of accuracy of the estimated effect size for each attribute (95% of mean effect sizes would fall inside this interval).

Table 4. Between-phase effect sizes across short term, long term, and no relationship contexts

Male attribute	Q_b	k	Effect size (g)	T	95% CI
Masculinity[a]	0.66				
Short term		15	0.09	0.20	[−0.07, 0.24]
Long term		11	0.03	0.00	[−0.08, 0.13]
No context		23	0.09	0.21	[−0.03, 0.20]
Dominance[b]	0.55				
Short term		6	0.02	0.00	[−0.14, 0.18]
Long term		7	−0.01	0.09	[−0.16, 0.14]
No context		6	0.10	0.23	[−0.14, 0.34]
Symmetry[c]	2.00				
Short term		5	0.11	0.26	[−0.18, 0.40]
Long term		3	0.06	0.00	[−0.13, 0.25]
No context		10	0.32	0.33	[0.09, 0.55]
Kindness[d]	0.49				
Short term		6	0.11	0.09	[−0.07, 0.28]
Long term		7	0.06	0.08	[−0.08, 0.20]
No context		5	−0.004	0.00	[−0.27, 0.26]
Health[e]	4.96*				
Short term		3	−0.33	0.00	[−0.67, 0.02]
Long term		5	0.00	0.00	[−0.20, 0.20]
No context		7	−0.24	0.00	[−0.34, −0.13]

Note. Q_b = variability across effect sizes due to relationship context (df = 2); k = number of samples at each level of relationship context; g = effect size indicating whether women in the fertile phase show a stronger preference (positively signed effects) or weaker preference (negatively signed) for a male attribute than women in the nonfertile phase. T = estimated between-studies standard deviation of effect sizes; 95% CI = measure of accuracy of the estimated effect size at each level of relationship context (95% of mean effect sizes would fall inside this interval).
[a]Eleven masculinity studies reported effect sizes in both short-term and long-term contexts.
[b]Six dominance studies reported effects in both short-term and long-term contexts.
[c]Three symmetry studies reported effects in both short-term and long-term contexts.
[d]Two health studies reported effects in both short-term and long-term contexts.
*p = .084.

this pattern emerged for three attributes: masculinity (fertile days ranged from 3 to 15 days, five studies did not provide information), $B = 0.04$ ($SE = 0.02$), $z = 2.10$, $k = 33$, $p = .036$;

symmetry (fertile days ranged from 2 to 12 days, one study did not provide information), $B = 0.05$ ($SE = 0.02$), $z = 2.46$, $k = 14$, $p = .014$; and health (fertile days ranged from 2 to 8 days, two studies did not provide information), $B = −0.09$ ($SE = 0.05$), $k = 11$, $z = −1.97$, $p = .049$.

We also conducted more targeted analyses to determine whether stronger effects emerged in studies that verified cycle day and in addition identified the fertile phase most accurately as the 6 days of maximum fertility around ovulation (Wilcox et al., 2000). Again, this subset of studies failed to yield the predicted cycle shifts.

Year Effects on Published Research

Regression analyses were conducted to evaluate whether year of study publication moderated fertility effect sizes for each attribute. Only masculinity and symmetry preferences varied with publication year (see Figure 3), and we do not discuss the effects for other attributes. Studies published earlier were more likely to detect that fertile women, more than nonfertile ones, preferred masculine men (publication year ranged from 1999 to 2011), $B = −0.05$ ($SE = 0.01$), $z = −4.18$, $k = 28$, $p < .001$, and symmetric men (publication year ranged from 1998 to 2009), $B = −0.09$ ($SE = 0.03$), $z = −2.62$, $k = 12$, $p = .009$. As can be seen in Figure 3, more recent studies yielded an estimated effect size of around 0. Thus, cycle effects on preferences for masculinity and symmetry are apparent only in the earliest published studies.

Publication Bias

We directly tested the effects of publication status on between-phase effect sizes through categorical models, and in addition we conducted a variety of tests of retrieval and publication bias based on the funnel plot distributions of effect sizes plotted against the standard errors of the estimates (Borenstein et al., 2009). No publication bias emerged for testosterone (five published effects) or kindness (three published effects, nine unpublished), and these are not discussed further.

Masculinity. Published studies reported that fertile more than nonfertile women preferred masculine men, $g = 0.11$ ($k = 28$, $T = 0.18$; 95% CI = 0.01, 0.21), but not unpublished studies, $g = −0.03$ ($k = 10$, $T = 0.00$; 95% CI = −0.16, 0.09), and the publication effect was marginally significant, $Q_b(1) = 3.04$, $p = .081$. However, tests of the distribution across all (published and unpublished) data did not reveal significant evidence of bias.

Dominance. Published studies reported that fertile more than nonfertile women preferred dominant men, $g = 0.29$ ($k = 4$, $T = 0.00$; 95% CI = 0.004, 0.58), but not unpublished studies, $g = 0.01$ ($k = 9$, $T = 0.00$; 95% CI = −0.11, 0.13), and this comparison was marginally significant, $Q_b(1) = 3.10$, $p = .078$. However, tests of the distribution across all (published and unpublished) data did not reveal significant evidence of bias.

Symmetry. In published studies, fertile more than nonfertile women preferred symmetric men, $g = 0.27$ ($k = 12$, $T = 0.29$;
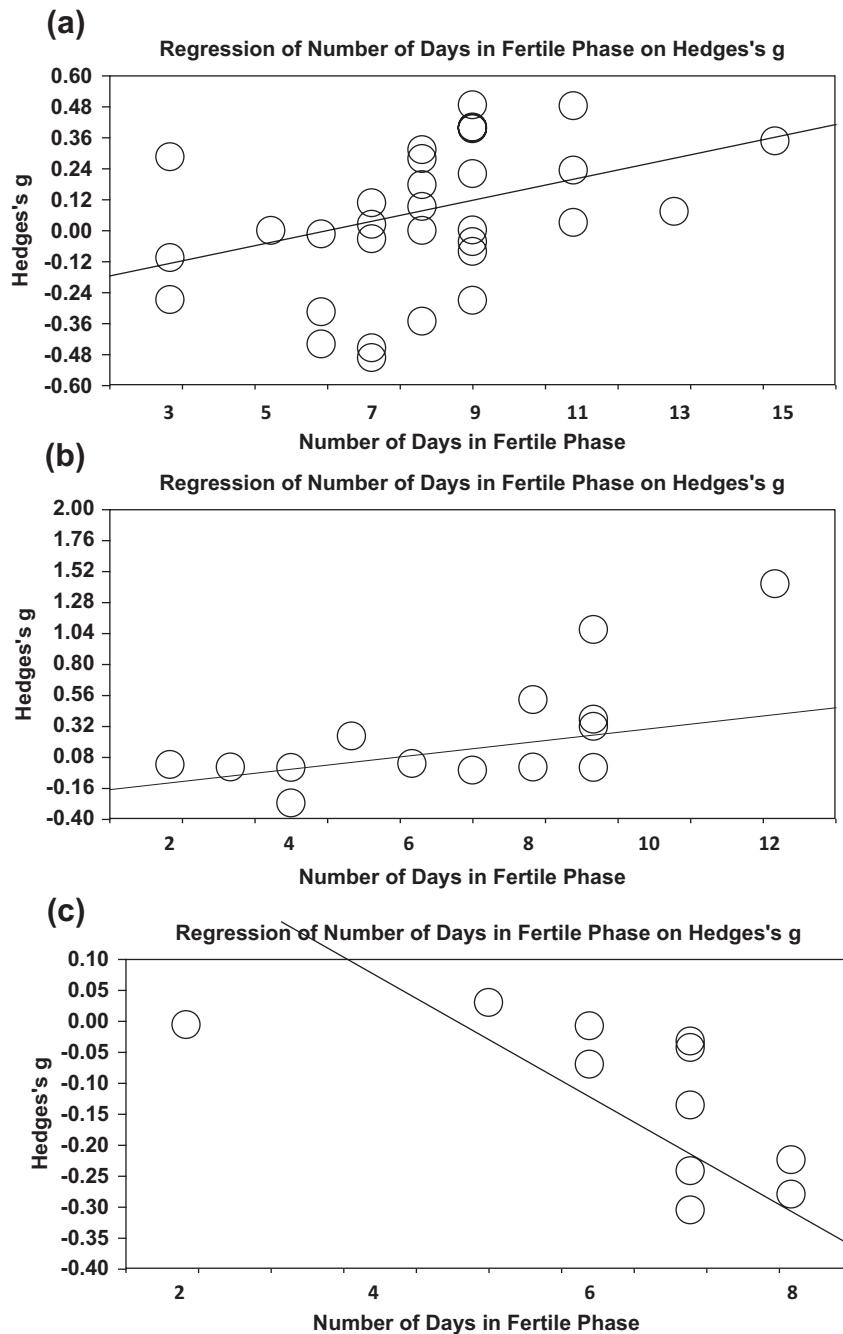
(a)

(b)

(c)

Figure 2.   Results of meta-regressions in which studies with more days in the fertile phase were more likely to find that fertile women preferred masculine men (2a, $k = 33$) and symmetric men (2b, $k = 14$), and that nonfertile women preferred healthy men (2c, $k = 11$). Each circle represents a single study effect size comparing preferences of women in fertile versus nonfertile phases. Positive effects represent fertile women's stronger preferences for masculine, symmetric, and healthy men and negative effects represent nonfertile women's stronger preferences for such men.

95% CI = 0.07, 0.47), but not in unpublished studies, $g = 0.07$ ($k = 3$, $T = 0.00$; 95% CI = -0.27, 0.41), although the publication effect was not significant, $Q_b(1) = 1.04$, $p = .306$. Across the full set of unpublished and published data, Egger's test of the asymmetry of the plot of effect sizes against standard errors was significant, $t(13) = 2.28$, $p = .024$. Thus, in studies with smaller standard errors, the funnel plot deviated from symmetry in the predicted direction of greater preference for symmetry
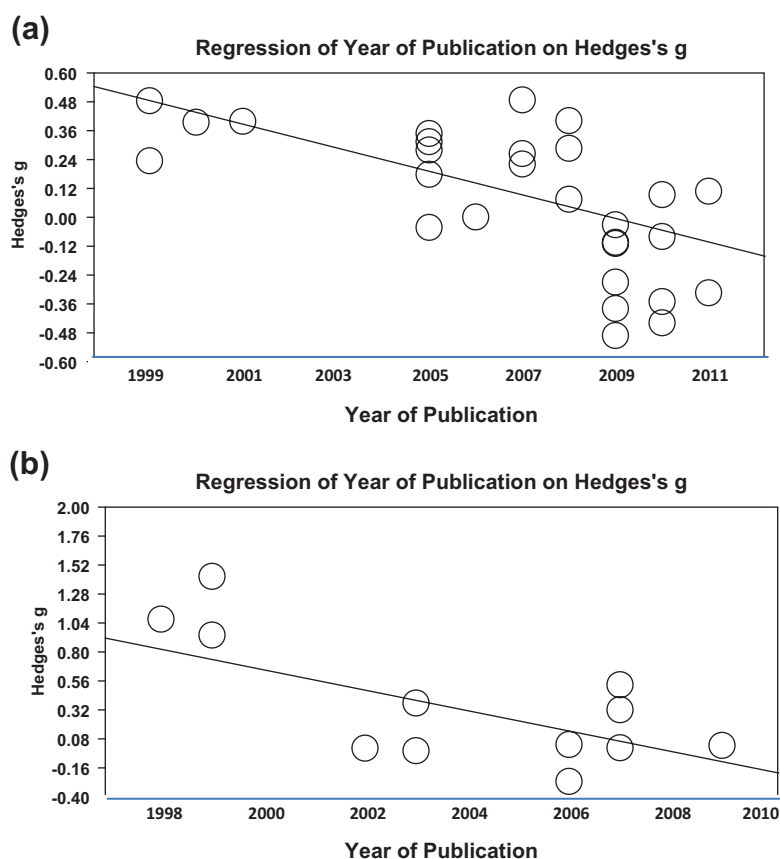
(a)

(b)

Figure 3. Results of meta-regressions in which studies with earlier publication dates reported stronger evidence that fertile women preferred more masculine men (3a, $k = 28$) and more symmetric men (3b, $k = 12$). Each circle represents a single study effect size comparing preferences of women in fertile versus nonfertile phases. Positive effects represent fertile women's stronger preferences for masculine and symmetric men and negative effects represent nonfertile women's stronger preferences for such men.

among fertile women. In addition, using the standard error of the estimate to order the data, cumulative meta-analyses revealed that, with the addition of studies with less precise estimates, findings shifted to indicate that women preferred more symmetrical men. That is, the symmetry effect became significant only with the addition of Thornhill and Gangestad (1999), Rikowski and Grammer (1999), and Thornhill et al. (2003). Furthermore, Duval and Tweedie's trim-and-fill procedure indicated that three studies should be trimmed to make the plot more symmetric, reducing the estimated effect size to nonsignificance, $d = 0.10$ (95% CI = -0.10, 0.30). Even by the highly conservative, *tandem* procedure (Ferguson & Brannick, 2012) based on a combination of Egger's regression, trim-and-fill, and Orwin's fail-safe N estimate (in which only eight missing studies were required to bring the effect to $g = .10$), publication bias influenced women's preference for symmetry.

Health. Published studies reported that nonfertile more than fertile women preferred healthy men, $g = -0.23$ ($k = 9$, $T = 0.00$; 95% CI = -0.32, -0.13), but not unpublished studies, $g = 0.01$

($k = 4$, $T = 0.00$; 95% CI = -0.25, 0.27), and this comparison was marginally significant, $Q_b(1) = 2.77$, $p = .096$. When both published and unpublished research was evaluated, Egger's test of the asymmetry of the plot of effect sizes against standard errors was marginally significant, $t(11) = 1.83$, $p = .095$. Thus, in studies with smaller standard errors, the funnel plot deviated (marginally) from symmetry in the expected direction of greater preference for health among nonfertile women. However, no other tests revealed bias.

Discussion of Between-Phase Effects

The between-phase results provided little support for the evolutionary psychology hypothesis that fertile women have evolved preferences for men of high genetic quality. Based on this logic, women in the fertile phase should have been motivated to obtain indirect, genetic benefits from sexual affairs with high-testosterone, masculine, dominant, and symmetric men. Because men of high quality may not invest in pair-bonded relationships, however, they may be less attractive to women in

the nonfertile phase, especially as longer term partners. Contrary to these predictions, fertile women did not show heighted sexual attraction to men higher in testosterone, masculinity, dominance, or symmetry for short-term relationships. The failure to find cycle shifts in preferences for high-testosterone men is striking, given that this attribute is central to many theories of genetic quality (Gangestad & Thornhill, 2008). These null results contribute to the growing evidence challenging the testosterone immunocompetence handicap hypothesis (Harris, 2013; Scott et al., 2013).

Before interpreting the findings, it is worth noting that we evaluated whether the findings were stronger in studies with better quality methods in our review. However, the cycle shift findings were not stronger in studies that successfully varied male attributes so as to be clearly detectable (see "Success of Experimental Variations" in online supplement) or in studies that validated women's cycle phase.

From the results across all studies reported in Table 3, fertile and nonfertile women differed significantly in their preferences for two attributes in a partner, symmetry and health. As shown in Table 4, however, the patterning of these preferences across different types of relationships did not conform to evolutionary psychology predictions. We explain this pattern first for symmetry and then for health.

Preferences for Symmetric Men

Challenging the idea that women are sexually attracted to symmetric men for short-term affairs in which they can obtain genetic benefits, fertile women preferred symmetric men only in the 10 studies that did not specify a relationship, and not in the five studies that specified a short-term relationship or in the three that specified a long-term relationship. Furthermore, among the no-specific relationship studies, a cycle shift emerged only the subset of four studies that evaluated scent preferences for men based on fluctuating asymmetry (Gangestad & Thornhill, 1998; Rikowski & Grammer, 1999; Thornhill & Gangestad, 1999; Thornhill et al., 2003). Because the symmetry findings overall did not conform to evolutionary psychology predictions, we consider in the following lines the variety of factors that might have produced these results.

Preferences for Healthy Men

Health preferences also were not consistent with the specific patterns predicted in evolutionary psychology. A preference among nonfertile women to avoid disease (similar to pregnancy, B. C. Jones et al., 2008) should have been apparent across relationships. A willingness among fertile women to risk exposure to pathogens in order to mate with a high-quality male (Tybur & Gangestad, 2011) should have been apparent in short-term relationships. Instead, nonfertile women especially preferred healthy men in the seven studies that did not specify a relationship context, but not in the eight studies that specified short-term or long-term relationships. Furthermore, only a subset of four of the no-specific relationship studies yielded evidence of a

cycle shift, and these all evaluated health from pictures of men's faces (i.e., B. C. Jones, Little, et al., 2005; B. C. Jones, Perrett, et al., 2005, Studies 1 and 2; Vaughn, Bradley, Byrd-Craven, & Kennison, 2010). Given that health preference findings overall did not conform to evolutionary psychology predictions, we consider next various factors that could have produced these results.

Significant Shifts in Mate Preferences Only in Studies with Wide Fertile Windows

Cycle shifts in women's preferences for symmetry and health, along with masculinity, were more pronounced in studies that included more days in the fertile window (depicted in Figure 2). We can only speculate why studies with larger fertile windows produced larger preference shifts. It is not likely that these studies more accurately captured the fertile phase. The gold standards for detecting cycle phase are hormonal assays or follow-up assessments of menstrual onset, but studies using these verification techniques did not reveal significant cycle shifts in preferences.

Following Wilcox et al.'s (2001) publication of validated cycle-risk estimates, researchers cannot easily justify including more than 6 days in the fertile phase in a standard 28-day cycle. As they argue, "outside this 6-day interval, the estimated probability of pregnancy is < 0.01" (pp. 211–212). The symmetry and health preference shifts evident in studies that did not specify a relationship were obtained primarily using broad fertile windows. The subset of four studies reporting that fertile women preferred the scent of men low in fluctuating asymmetry defined the fertile phase as 9 to 12 days in length (Gangestad & Thornhill, 1998; Rikowski & Grammer, 1999; Thornhill et al., 2003) or used Jöchle's (1973) continuous assessment of conception risk that predated modern estimates (Thornhill & Gangestad, 1999). Similarly, the subset of four studies reporting that nonfertile women preferred healthy men defined the fertile phase as 7 or 8 days in length (B. C. Jones, Little, et al., 2005; B. C. Jones, Perrett, et al., 2005, Studies 1 and 2; Vaughn et al., 2010).

Longer fertile phase estimates might capture neuroendocrine fluctuations across the month that are linked to women's olfactory or visual sensitivities and affective reactions (see Farage, Osborn, & MacLean, 2008; Sakaki & Mather, 2012). This explanation builds on models of neural and hormonal mechanisms that do not focus on specific mating adaptations but instead recognize broad endocrine-mediated sensitivities (see Frost, 1994). However, the inconsistent menstrual cycle effects in the present review leave us skeptical of such shifts, and a meta-analysis of the neuroendocrine literature is needed before speculating about broader hormonal effects.

A more plausible explanation for the larger cycle shifts in studies with wider fertile windows involves confirmatory hypothesis-testing procedures enabled by the continuous predictor of menstrual cycle days. The original researchers configured women's self-reports of cycle day in various ways to test their hypotheses (see Harris et al., 2013). They may have specified the study design prior to conducting the analyses as the

6 days of highest conception risk (Wilcox et al., 2001). Alternatively, they may have begun with this narrow designation, and in the case of finding nonsignificant results, successively broadened the fertile phase definition in exploratory analyses designed to maximize the distinction between fertile and nonfertile women's preferences in a given sample. Researchers who followed this confirmatory strategy would have inflated Type 1 error and produced spurious evidence of cycle shifts (Wagenmakers, Wetzels, Borsboom, van der Maas, & Kievit, 2012). This procedure would have produced the present pattern for symmetry, health, and masculinity in which studies using 6 or fewer days in the fertile phase obtained few significant findings, whereas those using broader definitions generated more significant effects.

Significant Shifts in Mate Preferences May Be Artifacts Linked to Publication Date and Publication Bias

The few preference shifts in the present review also might be explained as research artifacts tied to reporting or publication practices. In particular, the significant findings for symmetry are plausibly linked to factors associated with publication date and to publication bias.

With respect to year of publication, earlier studies reported that fertile women preferred more symmetric as well as more masculine men (depicted in Figure 3). In more recent publications, these effect sizes approached zero. In fact, the subset of four studies reporting significant preference shifts for symmetry include some of the earliest articles in our review, with publication dates between 1998 and 2003 (Gangestad & Thornhill, 1998; Rikowski & Grammer, 1999; Thornhill & Gangestad, 1999; Thornhill et al., 2003). Thus, menstrual cycle effects on mate preferences may be similar to other disappearing effects in the scientific literature (Lehrer, 2010). Effects decline over time when initial estimates are false positives that subsequently fail to replicate (Simmons et al., 2011).

The evidence of publication bias, especially for studies of symmetry and health, provide additional reason to believe that the few significant effects are research artifacts. We tested for publication influences first by comparing published and unpublished studies. Only in published studies did fertile women prefer masculine, dominant, symmetric, and healthy men. Each of these conclusions was based on relatively small numbers of studies, with relatively low power to detect effects. Thus, we also report here the effects of publication status aggregated across all of the attributes thought to be indicative of good genes—masculinity, dominance, and symmetry. In this analysis, the cycle shift was significant in published studies, $g = 0.16$ ($k = 42$, $T = 0.17$; 95% CI = 0.08, 0.24), but not unpublished studies, $g = 0.01$ ($k = 16$, $T = 0.00$; 95% CI = −0.13, 0.14), and this comparison approximated significance, $Q_b(1) = 3.71$, $p = .054$.

Additional tests for publication bias were based on funnel plots of effect size against standard errors (Borenstein et al., 2009). These analyses revealed that the overall estimates were significantly biased for symmetry, and when the distribution of effects was reconfigured taking into account the data presumed missing, fertile women's preference for symmetry was no longer significant. Health preferences also revealed some evidence of publication bias, although the effects were not consistent across bias analyses.

Our finding that unpublished studies reported smaller, nonsignificant effects has precedence in the literature. In research registry evaluations that recorded initial research protocols and then followed the planned research over time, studies with larger, statistically significant findings were more likely to be published and with shorter lag times (Cann, Valentine, Cooper, & Rantz, 2003; Dwan, Gamble, Williamson, & Kirkham, 2013). Investigators might halt or alter studies at preliminary stages when findings fail to approach significance, or they might selectively focus on significant results in published reports.

Publication bias is a recurring problem across scientific literatures, with a recent review finding evidence for such bias in about 25% of meta-analyses in psychology (Ferguson & Brannick, 2012). Publication bias appears to be a particular concern in research on fluctuating asymmetry, possibly biasing results of past meta-analyses so that symmetry appeared to be linked to reproductive outcomes (e.g., Palmer, 1999; see also van Dongen & Gangestad, 2011). The present findings of cycle shifts in preferences for symmetric men also could be an artifact of publication practices.

Publication status is of course a proxy variable that itself reflects the variety of causally relevant factors actually responsible for producing or impeding scientific reports of an effect, including data analysis and reporting decisions of the study authors, decisions of journal editors, and retrieval biases in literature searches (Wood & Eagly, 2009). In our review, quality of study methodology did not seem to contribute to the difference between published and unpublished studies. Specifically, published studies did not have higher quality methods involving more precise menstrual cycle estimates or clearer manipulations of male attributes (see Tables C and D, online Appendix).

In summary, the few significant findings for symmetry and for health may reflect a number of artifactual processes including overly inclusive definitions of the fertile phase in the original analyses, the waning of effects over time in the published literature, and the limitation of effects to published work. The possibly artifactual nature of the symmetry and health effects, along with the failure to find differences between fertile and nonfertile women's preferences for other attributes, challenge evolutionary psychology theories of mating.

Explaining What Women Want in a Man

Along with the limited evidence for differences across the menstrual cycle, our review revealed that women in both fertile and nonfertile phases preferred to mate with more masculine, dominant, physically symmetric, and healthy men. How can we explain these preferences for a romantic partner? Given the findings of the present review, we believe that the answer is unlikely to be found in theories that tie such preferences to monthly hormonal fluctuations.

The present review failed to support evolutionary psychology predictions about menstrual cycle influences on multiple attributes that might signal genetic quality (testosterone, masculinity, dominance, symmetry) as well as on attributes of heath and kindness. Furthermore, the lack of empirical support was evident in the few studies that directly assessed women's hormonal fluctuations as well as in the larger sample that used self-reports of cycle day. Of course, these failures to reject the empirical null hypothesis do not invalidate the underlying theory that motivated the reviewed research. Following logical reasoning, the absence of evidence in our review is not evidence of absence. However, evolutionary psychology theories postulating innate preferences for partners that shift across the month are rendered less plausible by this broad base of empirical failures across multiple attributes and research methods.

Theoretical grounds provide additional reason to doubt evolutionary psychology accounts of women's preferences across the cycle. Evolutionary psychologists draw from old sociobiological models that focus on biological influences on behavior separate from cultural influences. In contrast, more modern evolutionary approaches recognize that social learning and innovation are central human adaptations that are enabled by biological processes (Boyd, Richerson, & Henrich, 2011; Mesoudi, 2009). Modern accounts emphasize humans' evolved capacities to innovate and communicate with others and thereby to produce a cumulative culture in which beliefs and practices are shared and subsequently modified. These capacities likely arose from selection pressures in the novel, nonrecurring environments of the late Pleistocene Era. Given rapidly changing environments, humans adapted, not primarily to particular environmental features, but to variation itself, which favored cognitive and motivational capacities to thrive in novel contexts (Richerson & Boyd, 2005).

From this evolutionary history, humans possess hormones and related neural structures shaped in part through ancient selection pressures common to other animals. However, the evolution of the human brain did not stop with these ancient sensory, perceptual, and motivational systems. Human brains continued to evolve to develop general purpose, higher cognitive functions associated with the neocortex that promote group living and allow flexible responding to others' expectations and to personal identities (Heatherton, 2011; Panksepp & Panksepp, 2000). Human's executive functions and other general-purpose cognitive mechanisms, in coordination with more ancient neurohomonal systems, enable women and men to regulate their behavior and cooperate in a division of labor. All human societies practice a division of labor in which women perform some tasks and men perform others. The division of labor, in turn, shapes psychological sex differences and similarities through biological and social processes (Eagly & Wood, 2013; Wood & Eagly, 2012).

As we explain in what follows, women's preferences for particular mates, along with the patterning of women's menstrual cycles, have evolved to be sensitive to the division of labor in a society. Thus, theories of women's reproduction need to recognize these influences.

Societal Influences on Women's Reproductive Activities

Women's mate preferences vary with the division of labor. The roles of women and men in society influence the costs and benefits attached to mate attributes. This influence is evident in the ways that women's preferences for masculinity and dominance vary across cultures with masculine social roles. Women desire greater masculinity in lower gross national product (GNP) economies, in which men's work may involve manual labor jobs and male brawn, than in higher GNP economies, which rely more on knowledge workers (DeBruine, Jones, Little, Crawford, & Welling, 2011). Furthermore, women desire men with greater ambition and better financial prospects in societies with lesser gender equality, in which men are more likely to fill traditional roles of good provider (Eagly & Wood, 1999; Zentner & Mitura, 2012). The present review included mostly U.S. and European women, and their preference for masculine and dominant men was still somewhat intact, presumably reflecting that these societies have not yet reached sexual equality in earnings, and that men continue to perform some brawn jobs.

Women's preference for symmetric men in the present review is consistent with an increasing emphasis on partners' good looks in recent years in postindustrial societies. Within the past half century, women increasingly participated in the paid workforce and men decreasingly were sole family providers (see review in Wood & Eagly, 2012). Preferences for mates changed accordingly, with women desiring better looking men but being less concerned with good financial prospects, ambition, and industriousness (Boxer, Noonan, & Whelan, 2013; Buss, Shackelford, Kirkpatrick, & Larsen, 2001).

Finally, women value health in a partner because it is relevant to men's performance of a variety of physical and reproductive roles. In this way, women largely value attributes that they believe can promote their ability to survive and prosper in the society in which they live (Wood & Eagly, 2007, 2010).

Menstrual cycles vary with the division of labor. The division of labor, especially women's productive roles, also influences the frequency and patterning of menstrual cycles. The influence of roles is apparent in comparisons between *natural fertility* societies, in which women do not practice birth control, and industrialized societies that have undergone the demographic transition.

In natural fertility societies such as modern foraging groups and simple horticultural societies, women bear children and lactate throughout their reproductive years. For example, fertile women in foraging societies have their first child at an average of 19.5 years of age, give birth every 3.7 years, and nurse each child for 2.9 years (Eaton et al., 1994; Sellen, 2007). These extensive reproductive activities were compatible with their other productive roles in foraging societies, especially gathering plant foods and small animals (Wood & Eagly, 2002). This extensive nursing and frequent childbearing established a hormonal pattern of only limited menstrual cycling, with women in foraging societies experiencing only about 160 ovulations and associated cycles in a lifetime (Eaton et al., 1994).

In industrialized societies, women increasingly gained formal education, entered paid employment, and participated in political offices—roles not compatible with intensive nursing and childbearing (see review in Wood & Eagly, 2012). European women now average 1.59 live births (Eurostat, 2012), and U.S. women average 2.08 births (U.S. Census Bureau, 2012, Table 80). Lactation is limited, and women in industrialized societies resume ovulation and monthly cycling as early as 1 or 2 months' postpartum (Eaton et al., 1994). As a result, fertile women experience an estimated 450 ovulations and associated hormonal cycles in a lifetime.

Because modern foragers, more than industrialized women, presumably live in ways closest to the environment of evolutionary adaptedness, it might seem plausible that humans evolved to have menstrual patterns typical of noncontracepting women. Malcolm Gladwell (2000) made this point, arguing that the pattern of "many pregnancies and long menstrual-free stretches caused by intensive breastfeeding was virtually universal up until the 'demographic transition' of a hundred years ago…. what we think of as normal—frequent menses—is in evolutionary terms abnormal" (p. 56). Regardless of what might have been normative in ancestral history, with the advent of cultural roles and complex group living, women showed the capacity to tailor their reproductive activities to a variety of social roles.

The research we included in our meta-analysis tested causal relations between menstrual cycles and mate preferences and thereby largely overlooked the broader impact of social roles on both of these processes. Given the strong impact of women's productive roles in society on reproduction, a complete model of human reproduction needs to acknowledge women's impressive capacity to regulate both their mate preferences and their menstrual cycles in order to contribute in diverse ways to productive labor. In this view, endocrine processes may not drive particular mate choices, but instead they contribute to broader neurohormonal mechanisms of self-regulation and control. We suspect that, by testing evolutionary psychology ideas of the causal role of menstrual cycles in driving preferences, researchers overlooked some of the strongest evidence of the role of menstrual cycles in human reproduction—the way that cycles, along with mate preferences, are flexibly responsive to the division of labor.

Summary

The present review failed to support evolutionary psychology predictions about women's evolved preferences for male attributes across the menstrual cycle. Women in the fertile phase were expected to be sexually attracted in short-term affairs to men possessing good genetic qualities, given that such matings yielded fitness benefits in the ancestral past. However, women did not show the predicted pattern of preferences for high-testosterone, masculine, dominant, or physically symmetric men. In addition, women in the nonfertile phase were expected to be attracted to healthy men, given that nonfertile women are similar in certain hormonal profiles to pregnant women, and that disease avoidance during pregnancy enhanced fitness. Again, however, the specific pattern of preferences for health did not conform to these predictions.

The few instances in which women's preferences shifted across the cycle appeared to be largely artifacts of research practices. That is, only studies that did not specify a relationship length found that fertile women preferred the scent of men low in fluctuating asymmetry and nonfertile women preferred the facial features of healthy men. Suggesting that these findings might be artifacts, preferences for symmetry and health were apparent primarily in published and not unpublished work, and the symmetry effects declined to null in more recent published studies. Furthermore, preferences for symmetry and health shifted primarily in studies that used a broad, imprecise definition of the fertile phase, perhaps because these definitions capitalized on chance findings in the research.

Finally, we note that the limited evidence of menstrual cycle influences on mate preferences cannot easily be attributed to weaknesses in the methodology of the reviewed studies. That is, the predicted effects were not stronger in studies that validated menstrual cycle day or that manipulated male attributes in ways clearly detectable by female participants.

Our failure to find consistent effects of women's hormonal cycling on their mate preferences does not, of course, rule out such influences. Women's hormonal cycles might still under certain, currently unidentified circumstances, direct specific mate preferences or other reproductive activities. Yet our review suggests that these effects are subtle, if at all present. We concluded the article with a review of the evidence that women regulate both menstrual cycles and mate preferences to suit their productive roles in society. We suggested that, by overlooking these effects of culture on reproductive behavior and by relying on outmoded theories that emphasize biology to the exclusion of culture, evolutionary psychologists may be missing some of the most important, characteristically human, evolutionary processes.

Notes

1   This study was not included in our meta-analysis, given that darker skin color plausibly signified outgroup status rather than masculinity to the French Canadian participants.
2   We thank Kelly Gildersleeve for initially suggesting that we code for length of the fertile phase.
3   We included two additional reports received after this deadline (i.e., Eastwick & Finkel, 2012; Finkel, Slotter, & Luchies, n.d.).
4   This tabulation does not include studies that failed to obtain direct hormonal assays and instead estimated women's hormonal levels from self-reported menstrual day (e.g., Puts, 2006). These studies of cycle days were included in the meta-analytic computation of between-phase effects.

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