ELSEVIER

Evolution and Human Behavior 24 (2003) 406–417

Evolution and Human Behavior

Domain-specific variation in disgust sensitivity across the menstrual cycle

Daniel M.T. Fessler*, C. David Navarrete

Center for Behavior, Evolution, and Culture, UCLA, Los Angeles, CA, USA
Department of Anthropology, UCLA, 341 Haines Hall, Box 951553, Los Angeles, CA 90095-1553, USA

Received 2 June 2003; received in revised form 19 July 2003

Abstract

Disgust operates in many domains of behavior. On the presumption that facets of this emotion evince adaptive design, we conducted a cross-sectional study of 307 women, investigating changes in disgust sensitivity across the menstrual cycle. Two hypotheses were tested, namely (i) sexual disgust is an adaptation that serves to reduce participation in biologically suboptimal sexual behaviors, and (ii) many facets of disgust sensitivity compensate for cyclic changes in immunological robusticity via patterned alterations in behavioral prophylaxis against pathogens. Hypothesis (i) was supported, as disgust sensitivity in the sexual domain, and only in the sexual domain, was positively correlated with presumed conception risk as assessed on the basis of self-reported position in the menstrual cycle. Hypothesis (ii) was not supported, as no facet of disgust sensitivity changed as a function of the presumed level of immunosuppression assessed on the basis of self-reported position in the menstrual cycle. Results are discussed in light of published ethnographic evidence indicating that, in disparate cultures, disgust is elicited by aberrant sexual behaviors, and sex is equated with eating. Together with published findings on an animal model of sexual conditioning, this corpus suggests that sexual disgust may be a panmammalian adaptation.

Keywords: Disgust sensitivity; Menstrual cycle; Sexual disgust; Reproductive immunosuppression

* Corresponding author. Tel.: +1-310-794-9252; fax: +1-310-206-7833.
E-mail address: dfessler@anthro.ucla.edu (D.M.T. Fessler).

1090-5138/03/$ – see front matter © 2003 Elsevier Inc. All rights reserved.
doi:10.1016/S1090-5138(03)00054-0

1. Introduction

Disgust is a multifaceted emotion spanning a variety of behavioral domains. While most investigators concur that this emotion originally evolved to protect the body from oral incorporation of pathogen- and toxin-bearing substances, there is disagreement as to whether adaptationist approaches explain the operation of disgust outside of the domain of dietary selectivity (compare Cosmides & Tooby, 2000; Curtis & Biran, 2001; Haidt, McCauley, & Rozin, 1994, Haidt, Rozin, McCauley, & Imada, 1997; Rozin, Haidt, & McCauley, 2000; Wronska, 1990). In this paper we employ an adaptationist perspective in exploring the operation of disgust across the menstrual cycle.

2. Menstrual cycle periodicity in the costs of disgust-relevant actions

2.1. Sexual selectivity and disgust

A variety of findings indicate that disgust is antithetical to sexual desire. Disgust is negatively correlated with subjective sexual arousal in response to erotic films (Koukounas & McCabe, 1997) and guided imagery (Vonderheide & Mosher, 1988). Descriptions of protagonists' disgust reactions decrease subjects' arousal to a variety of erotic stories (Malamuth & Check, 1980). Disgust sensitivity is negatively correlated with desire to engage in a variety of sexual behaviors (Rempel & Baumgartner, 2003), and disgust figures prominently in clinical sexual aversion disorder (Carnes, 1998). Cross-culturally, ethnographic examples reveal antipathy between sexual arousal and disgust among the Mangaians of Polynesia (Marshall, 1971, pp. 118, 121, 152), and the Bengkulu of Sumatra (first author's field notes).

Aberrant sexual behaviors such as bestiality, age-disparate unions, and sex with close kin elicit disgust in Western populations (Angyal, 1941; Barker & Davey, n.d. cited in Troop, Treasure, & Serpell, 2002; Haidt et al., 1994; 1997; Wronska, 1990). Incest and other deviant sexual behaviors are similarly considered disgusting cross-culturally (first author's fieldnotes [Bengkulu, Indonesia]; Bubandt, 1998 [Bali, Indonesia]; Roscoe, 1994, p. 51 [Yangoro Boiken, Melanesia]; J. Haidt, personal communication [urban Japan]; Gorer, 1938, pp. 152, 163 [Lepcha, Himalaya]; Shore, 1976, p. 280 [Samoa, Polynesia]; Labby, 1976, p. 171 [Yap, Micronesia]; Haidt, Koller, & Dias, 1993 [urban Brazil]; Gregor, 1985, p. 58 [Mehinaku, Amazonia]; Fortes, 1949. pp. 38, 251 [Tallensi, Subsaharan Africa]; Beidelman, 1971a, p. 183 [Kaguru, Subsaharan Africa]; Evans-Pritchard, 1951, p. 37 [Nuer, Subsaharan Africa]). Given that many aberrant sexual behaviors are fitness reducing, we propose that sexual disgust is an adaptation that functions to inhibit participation in biologically suboptimal sexual unions (see also Cosmides & Tooby, 2000).

Fitness costs of biologically suboptimal sexual behavior are a function of the likelihood of conception, since (a) inbreeding depression and other poor genes effects impact offspring conceived through such unions, and (b) fertility is time limited, hence time spent in

suboptimal behaviors cannot be dedicated to reproductive activities that would make greater contributions to fitness. If sexual disgust is an adaptation designed to reduce the likelihood that suboptimal sexual behaviors will occur, then sexual disgust sensitivity (the ease with which disgust is elicited by aberrant sexual behaviors) should vary across the menstrual cycle as a function of conception risk. Because fertility affects the costs and benefits of actions solely in the sexual domain, and does not affect the costs and benefits of avoidance behaviors in other domains in which disgust occurs, the predicted positive correlation with conception risk should appear exclusively in the area of sexual disgust sensitivity, and should not be evident with regard to other facets of disgust sensitivity.

2.2. Reproductive immunosuppression and disgust

In addition to variation in sexual disgust sensitivity as a function of conception risk, other aspects of disgust sensitivity may vary as a function of a second, independent feature of the menstrual cycle. Gestation requires the partial suppression of the maternal immune system to tolerate the fetal allograft. Elevated progesterone levels in pregnancy shift the balance in a number of chemical messengers that regulate immune responses, enhancing maternal tolerance of foreign antigens. Pregnancy, particularly the first trimester, is therefore characterized by decreased ability to combat pathogens and parasites, placing both mother and fetus at risk (reviewed in Fessler, 2002). Moreover, if rejection of the conceptus is to be precluded, maternal tolerance must begin prior to implantation and subsequent development. The elevation of progesterone levels, and the accompanying immunosuppression, therefore begins during the luteal phase of the menstrual cycle (reviewed in Fessler, 2001).

Disease prophylaxis via the regulation of ingestion is a principal ultimate function of disgust. If reproductive immunosuppression influences the costs of dietary choices (a question yet to be answered), then disgust sensitivity in the food domain should correlate positively with immunosuppression. If other aspects of disgust also perform a prophylactic function (Curtis & Biran, 2001; Wronska, 1990), then the same patterned variation should be evident in nonfood domains as well.

2.3. Predictions

The adaptationist perspective on disgust presented above generates two predictions:

1. The extent to which aberrant sexual behavior elicits disgust will be positively correlated with conception risk. No other aspect of disgust sensitivity will vary in a systematic fashion as a function of conception risk.
2. Disgust sensitivity, both as a general attribute and across many domains, will be positively correlated with reproductive immunosuppression.

To test these predictions, we conducted a study of the relationship between position in the menstrual cycle and disgust sensitivity in a variety of domains.

3. Methods

We used a cross-sectional design in which both conception risk and immunosuppression were estimated on the basis of self-reported position in the menstrual cycle. This design introduces substantial noise into the data, as the correlation between cycle position and both conception risk and progesterone levels is incomplete and, moreover, self-report is not always accurate. To partially compensate for the expected noise, we strove for a large sample size with a greater diversity of participants than is typical of university settings. Because a previous application of the measure that we chose to employ found a negative effect of age (Quigley, Sherman, & Sherman, 1997), we sought a range of participant ages so as to be able to test for an age effect as a check on the validity of our administration of the instrument.

To obtain the desired sample, we created an Internet-based questionnaire consisting of two parts (the complete instrument is posted at http://www.sscnet.ucla.edu/anthro/faculty/fessler/disgustsurvey). Part I contained numerous health-related questions, and requested the dates on which the most recent menstrual period (i.e., menses) and the preceding menstrual period began. Because a graphic representation of a calendar makes it easy to count the interval between two dates, more challenging pull-down date menus were employed so as to increase the likelihood that participants would select dates based on their actual histories rather than on the basis of preconceptions regarding cycle length. The difficulty of fabricating dates based on preconceptions also discouraged frivolous respondents from participating, and made it easier to identify those who did so. Part II was a slightly modified form of the Disgust scale (D-scale) (Haidt et al., 1994).

4. Participants

Participants were recruited through postings to psychology- and anthropology-related web sites and listservs (list available on request). Participation was anonymous, and no compensation was offered. One thousand two hundred fifty-nine people replied, but the data for 952 were excluded from the analyses for the following reasons: failure to answer any section of the survey; age younger than 18 or older than 45; chronic health problems; cycle length variation of more than 2 weeks during the past 6 months; use of hormonal contraceptives[1]; pregnancy; and length of previous or present cycle less than 22 days or greater than 35 days. This resulted in a final sample of 307 women, ranging in age from 18 to 45 years ($M = 26.1$, S.D. = 7.4), and having a mean menstrual cycle length of 29.4 days (S.D. = 3.1).

[1] Although we had hoped to treat participants taking hormonal contraceptives as a control group, of the 189 women who fell into this category, a majority reported using phasic contraceptives in which the hormonal dose varies within the monthly pill cycle. Such within-cycle variation, the patterns of which differ between contraceptive brands, precludes testing null predictions on a heterogeneous sample of contraceptive users. We therefore abandoned the goal of examining contraceptive users and discarded responses from these individuals.

5. Analysis

Scores on the D-scale were computed for both overall disgust sensitivity and disgust sensitivity on each of eight constituent subscales (food, animals, body products, sex, body envelope violations, death, hygiene, and magical thinking). Descriptive statistics for all dependent measures of disgust relevant to our analyses are displayed in Table 1. D-scale and subscale scores were compared with three continuous variables: presumed conception risk based on day of cycle, presumed level of immunosuppression based on day of cycle, and age.

To examine the effects of likelihood of conception on disgust sensitivity, we used an expedient, if crude, method similar to that employed in a number of other cross-sectional menstrual cycle studies (cf. Chavanne & Gallup, 1998; Gangestad & Thornhill, 1998; Penton-Voak & Perrett, 2000), assigning each participant a conception risk based on the number of days since onset of most recent menstruation (the so-called forward-counting method). However, whereas previous studies employed questionable conception risk figures provided by Jöchle (1973), we used Wilcox, Dunson, Weinberg, Trussell, and Baird's (2001) more reliable table of probability of conception for each day of the menstrual cycle conditional on reaching that day. Because these figures cover 40 days, it is not necessary to regularize the cycle, sort the sample beyond excluding individuals with excessively short or long cycle lengths, or determine the exact length of the current cycle; the latter feature makes forward counting the appropriate method for the Wilcox et al. (2001) figures.

To examine the possible effects of reproductive immunosuppression on disgust sensitivity we used another expedient, if crude, method also employed by others (cf. Thornhill &

Table 1
Descriptive statistics for D-scale and subscales

Subscales	Mean	S.D.	Range
Food	2.98	.96	1–5
Animals	3.59	.97	1–5
Body products	3.50	.98	1–5
Sex	3.47	.87	1–5
Body envelope violations	3.32	1.09	1–5
Death	2.52	1.18	1–5
Hygiene	2.55	.93	1–5
Magical thinking	2.70	1.00	1–5
D-scale (Sex subscale included)			
Mean disgust across subscales	3.08	.62	1.5–4.6
Global disgust (Total)	24.62	4.94	12.0–36.5
D-scale (Sex subscale excluded)			
Mean disgust across subscales	3.02	.64	1.3–4.7
Global disgust (Total)	21.15	4.51	9.0–33.0

Gangestad, 1999) to calculate position in the menstrual cycle: the length of the previous cycle was computed as the difference between the two dates provided, and this was then used as an estimate of the projected duration of the present cycle (the so-called backward-counting method). Employing published daily reference values for salivary progesterone levels (Finn et al., 1988), we then assigned each participant a probable immunosuppression level based on the number of predicted days before the onset of next menstruation.

To examine the effects of position in the menstrual cycle on disgust sensitivity to aberrant sexual behavior, we conducted a multiple regression analysis. The dependent variable was subjects' score on the sex subscale of the D-Scale (1–9). Anticipating an effect of age, we controlled for age in assessing the independent effects of presumed conception risk and presumed immunosuppression on sex disgust. The analysis revealed a significant effect for presumed conception risk as a predictor of sex disgust in the predicted direction, $B = 3.14$, $F(1,307) = 2.01$, $P < .05$, $\beta = .11$. An effect for age was found as well, $B = -.02$, $F(1,307) = 6.05$, $P < .01$, $\beta = -.15$. Presumed immunosuppression level did not significantly affect sex disgust score, $F < 1$.

To explore the effect of presumed conception risk, presumed immunosuppression level, and age as predictors of disgust sensitivity as measured by each of the other seven subscales, we conducted another multivariate regression analysis. The multiple dependent variables were the scores on the subscales of food, animals, body products, body envelope violations, death, hygiene, and magical thinking. On a test that the coefficient for presumed immunosuppression level was 0 in all dependent variables, the analysis revealed no significant effect, $F(7,303) = 1.01$, $P > .05$. An identical test for presumed conception risk revealed no effect as well, $F < 1$. However, there was an effect for age, $F(7,303) = 5.82$, $P < .0001$. Inspection of the regression tables for this analysis revealed significant negative effects of age on the food, body products, and death subscales. Finally, we conducted a regression in which we examined the effects of presumed conception risk, presumed immunosuppression level, and age on subjects' global disgust score (the average of all subscales including sex disgust). The analysis revealed no significant effects for presumed conception risk, $F < 1$, or presumed immunosuppression level, $F = 0$, but a significant effect for age, $B = -.01$, $F(1,303) = 3.99$, $P < .05$, $\beta = -.12$.

6. Discussion

As evidenced by our high discard rate, the level of detail requested in Part I and the difficulty of guessing using the pull-down date menus created a reasonable filter against the inclusion of frivolous participants. Our finding that disgust sensitivity declines with age is consistent with published results (Quigley et al., 1997), indicating that the D-scale likely functioned as intended. In contrast to the prediction derived from the reproductive immunosuppression hypothesis, disgust sensitivity in contamination-relevant domains is not correlated with presumed level of immunosuppression as estimated on the basis of self-reported position in the menstrual cycle. However, consistent with the prediction of the sexual

selectivity hypothesis, disgust sensitivity in the sex domain, and only in the sex domain, is positively correlated with presumed conception risk as estimated on the basis of self-reported position in the menstrual cycle.

It is difficult to interpret our finding that immunosuppression levels estimated on the basis of cycle day do not influence disgust sensitivity given that, at present, little is known about the degree to which luteal phase immunosuppression changes the costs of actions that may entail disease exposure. In contrast to the ambiguity surrounding this null result, our demonstration of a domain-specific positive correlation between presumed conception risk and sexual disgust sensitivity provides direct support for an adaptationist account of sexual disgust, as, for a number of reasons, this correlation cannot be explained as an accidental consequence of some other, more general change. First, many investigators report increases in sexual activity, sexual desire, and sexual satisfaction during the periovulatory period (see Regan & Berscheid, 1999, for review; see also Clayton, Clavet, McGarvey, Warnock, & Weiss, 1999; Gangestad, Thornhill, & Garver, 2002; Graham, Jannsen, & Sanders, 2000). It is thus likely that there is an increasingly positive orientation toward things sexual as a function of conception risk, a pattern in stark contrast to the simultaneous increase in sexual disgust sensitivity. Second, there is some evidence that women (a) are more positively inclined toward new social experiences around ovulation (Doty & Silverthorne, 1975), and (b) increase their levels of physical activity and ranging behavior (reviewed in Fessler, 2003). Both patterns are consistent with an increase in openness to new experiences as a function of conception risk. The personality trait of sensation seeking is negatively correlated with overall disgust sensitivity (Haidt et al., 1994), hence on atheoretical grounds one might expect that, if aspects of disgust sensitivity were to change across the menstrual cycle, they would decline as a function of conception risk, rather than increase. Similar conclusions derive from the observation that there appears to be a general elevation of mood at ovulation (Altmann, Knowles, & Bull, 1941; Graham et al., 2000; Henderson & Whissell, 1997; McCance, Luff, & Widdowson, 1937).

In contrast to the inability of side-effect explanations to account for the observed pattern, an adaptationist approach predicts that, since the fitness costs of suboptimal sexual behavior are largely a function of conception risk, sexual disgust sensitivity, and sexual disgust sensitivity alone, should be positively correlated with conception risk. Our findings in support of this prediction are consistent with others' reports that during the ovulatory period women are more avoidant of activities that put them at risk of sexual assault (Chavanne & Gallup, 1998) and evince greater handgrip strength in response to imagined sexual assault (Petralia & Gallup, 2002), patterns that presumably reflect a design to avoid suboptimal unions during the period when conception is probable. We conclude that the functioning of disgust in the sexual domain exhibits signs of adaptive design.

7. Limitations

For a number of reasons, the conclusions presented above should be considered preliminary. First, the D-scale incompletely predicts performance on behavioral measures

of disgust sensitivity (Rozin, Haidt, McCauley, Dunlop, & Ashmore, 1999). Second, estimated position in the menstrual cycle is a crude index of conception risk, as even healthy women may experience many anovulatory cycles (Haiman et al., 2002). Lastly, the method used to estimate level of immunosuppression provides only a very rough estimate, as, in addition to the problem of anovulatory cycles, both cycle length and sequential progesterone profiles vary between and within individuals, and progesterone levels are affected by a wide variety of lifestyle factors (Chiazee, Brayer, Parker, & Duffy, 1968; Finn et al., 1988; Lenton, Landgren, Sexton, & Harper, 1984). Remedies to these limitations exist in the form of (a) psychophysiological measures of disgust reactivity (Kring & Gordon, 1998), (b) assays of hormonal indices of ovulation, and (c) assays of salivary progesterone. A more rigorous investigation of the relationship between disgust sensitivity and the menstrual cycle is thus both called for and feasible.

8. Future directions: tracing the phylogenetic roots of sexual disgust

The study reported above provides initial evidence that sexual disgust is a fitness-enhancing feature of the evolved emotion at issue. Because the most compelling evolutionary account includes both ultimate and phylogenetic explanations (Tinbergen, 1963), we turn to a consideration of the evolution of sexual disgust.

The domains of eating and sex are conceptually linked in many cultures (cf. Carrin-Bouez, 1998, p. 44 [Santal, South Asia]; Yalman, 1971, p. 95 [Sri Lanka]; first author's field notes [Bengkulu, Indonesia]; Brindley, 1995, p. 19 [Trobriands, Melanesia]; Meigs, 1984, pp. 36–39 [Hua, Melanesia]; Tuzin, 1978 [Arapesh, Melanesia]; McKnight, 1973 [Wik-Mungkan, Australia]; Thompson, 1996, p. 125 [Fiji, Polynesia]; Emanatian, 1996 [Chagga, Subsaharan Africa]; Shostak, 1981, p. 355 [!Kung, Subsaharan Africa]; Beidelman, 1971b [Kaguru, Subsaharan Africa]; Calame-Griaule, 1986, p. 373 [Dogon, Subsaharan Africa]; Bohannan, 1958, pp. 85, 269 [Tiv, Subsaharan Africa]; Maxwell, 1983, p. 32 [Bemba, Subsaharan Africa]; Reichel-Dolmatoff, 1990, p. 11 [Kogi, highland Columbia]; Gregor, 1985, pp. 69–91 [Mehinaku, Amazonia]; Arhem, 1998, p. 203 [Makuna, Amazonia]; Jonaitis, 1986, p. 136 [Tlingit, Pacific Northwest]). Although this association may in part reflect similarities in experiential aspects of these two appetitive forms of behavior, there is also substantial overlap between the psychophysiological mechanisms governing action in the two domains (reviewed in Fessler, 2003). This overlap is evident in an animal model.

Disgust, the emotion that eliminates appetitive desire for targeted food items (Rozin et al., 2000), is linked to nausea and vomiting (Rozin et al., 2000; Wronska, 1990). Nausea and vomiting are central to the acquisition of conditioned taste aversions (reviewed in Bernstein, 1999). The evolved mechanisms responsible for taste aversion learning appear to also operate in the mating domain. If male rats are allowed to copulate with estrus females and then injected with lithium chloride, causing nausea, they acquire an aversion to copulation (Peters, 1983; Peters, Blythe, Koch, & Kueker, 1989; but see also Lawrence & Kiefer, 1987). They are averse only to copulation, and not to social interaction in general (Koch & Peters, 1987).

This conditioning does not result in a suppression of testosterone (Koch & Peters, 1992), suggesting that it is the manifestations of sexual desire, rather than its wellsprings, that are affected. Importantly, pairing copulations with electric shocks does not affect male copulatory behavior (Peters et al., 1989)—just as in the food domain (Green, Bouzas, & Rachlin, 1972), nausea is privileged as an inhibitor of rat sexual behavior. Although we cannot access the emotional states of animals with precision, the intimacy of the association between nausea and disgust in humans suggests that, as in humans, a disgust-like emotion serves to regulate both dietary and sexual behavior in the rat.

In addition to their appetitive nature, the highly fitness-relevant tasks of feeding and mating share the need to discriminate between possible targets on the basis of cost/benefit ratios. We suggest that the task demands of feeding and mating are sufficiently similar that it is parsimonious to use a single cost-marking mechanism in both domains. Natural selection thus apparently coopted a mechanism that originally guarded the body against pathogens and toxins, employing it to preclude fitness-reducing sexual behavior as well. Inbreeding depression is a significant source of selective pressure in many species, hence a disgustlike emotion can be expected to play a role in mating behavior in many mammals. While identifying such an emotion in animals is challenging, relevant features of the display repertoire of some species have been documented (cf. Berridge, 1991), making a comparative enterprise potentially feasible.

Acknowledgments

For their helpful feedback, we thank Elizabeth Pillsworth and the other members of the UCLA XBA Lab, as well as Margo Wilson and Martin Daly. We are grateful to Ramon Macias for assistance with Web design, and to Harry Finley, John Krantz, Scott Plous, Michael Mills, and Douglas Degelman for help publicizing the study.

References

Altmann, M., Knowles, E., & Bull, H. D. (1941). A psychosomatic study of the sex cycle in women. *Psychosomatic Medicine*, *3*, 199–225.

Angyal, A. (1941). Disgust and related aversions. *Journal of Abnormal and Social Psychology*, *36*, 393–412.

Arhem, K. (1998). *Makuna social organization: a study in descent, alliance, and the formation of corporate groups in the north-western Amazon*. New Haven, CT: Human Relations Area Files.

Barker, K., & Davey, G. C. L. (n.d.) *Categories of disgust: A factor analysis study.* Unpublished manuscript.

Beidelman, T. O. (1971a). *The Kaguru, a matrilineal people of East Africa*. New York: Holt, Rinehart and Winston.

Beidelman, T. O. (1971b). Some Kaguru notions about incest and other sexual prohibitions. In R. Needham (Ed.), *Rethinking kinship and marriage* (pp. 181–201). London: Tavistock.

Bernstein, I. L. (1999). Taste aversion learning: a contemporary perspective. *Nutrition*, *15*, 229–234.

Berridge, K. C. (1991). Modulation of taste affect by hunger, caloric satiety, and sensory-specific satiety in the rat. *Appetite*, *16*, 103–120.

Bohannan, P. (1958). *Three source notebooks in Tiv ethnography.* New Haven, CT: HRAF.

Brindley, M. (1995). *The symbolic role of women in Trobriand gardening*. New Haven, CT: HRAF.

Bubandt, N. (1998). The odour of things: smell and the cultural elaboration of disgust in Eastern Indonesia. *Ethnos*, *63*, 48–80.

Calame-Griaule, G. (1986). *Words and the Dogon world*. Philadelphia: Institute for the Study of Human Issues.

Carnes, P. J. (1998). The case for sexual anorexia: an interim report on 144 patients with sexual disorders. *Sexual Addiction & Compulsivity*, *5*, 293–309.

Carrin-Bouez, M. (1998). *Inner frontiers: Santal responses to acculturation*. New Haven, CT: Human Relations Area File.

Chavanne, T. J., & Gallup, G. G. Jr. (1998). Variations in risk taking behavior among female college students as a function of the menstrual cycle. *Evolution and Human Behavior*, *19*, 27–32.

Chiazee, L. Jr., Brayer, F. T., Macisco, J. J., Parker, M. P., & Duffy, B. J. (1968). The length and variability of the human menstrual cycle. *JAMA: Journal of the American Medical Association*, *203*, 377–380.

Clayton, A. H., Clavet, G. J., McGarvey, E. L., Warnock, J. K., & Weiss, K. (1999). Assessment of sexual functioning during the menstrual cycle. *Journal of Sex & Marital Therapy*, *25*, 281–291.

Cosmides, L., & Tooby, J. (2000). Evolutionary psychology and the emotions. In M. Lewis, & J. M. Haviland-Jones (Eds.), *Handbook of emotions* (pp. 91–115). New York: Guilford Press.

Curtis, V., & Biran, A. (2001). Dirt, disgust, and disease: is hygiene in our genes? *Perspectives in Biology and Medicine*, *44*, 17–31.

Doty, R. L., & Silverthorne, C. (1975). Influence of menstrual cycle on volunteering behaviour. *Nature*, *254*, 139–140.

Emanatian, M. (1996). Everyday metaphors of lust and sex in Chagga. *Ethos*, *24*, 195–236.

Evans-Pritchard, E. E. (1951). *Kinship and marriage among the Nuer*. Oxford, UK: Clarendon Press.

Fessler, D. M. T. (2001). Luteal phase immunosuppression and meat eating. *Rivista di Biologia (Biology Forum)*, *94*, 407–430.

Fessler, D. M. T. (2002). Reproductive immunosuppression and diet: an evolutionary perspective on pregnancy sickness and meat consumption. *Current Anthropology*, *43*, 19–39.

Fessler, D. M. T. (2003). No time to eat: an adaptationist account of periovulatory behavioral changes. *Quarterly Review of Biology*, *78*, 3–21.

Finn, M. M., Gosling, J. P., Tallon, D. F., Madden, A. T., Meehan, F. P., & Fottrell, P. F. (1988). Normal salivary progesterone levels throughout the ovarian cycle as determined by a direct enzyme immunoassay. *Fertility and Sterility*, *50*, 882–887.

Fortes, M. (1949). *The web of kinship among the Tallensi; the second part of an analysis of the social structure of a Trans-Volta tribe*. New York: Oxford University Press.

Gangestad, S. W., & Thornhill, R. (1998). Menstrual cycle variation in women's preferences for the scent of symmetrical men. *Proceedings of the Royal Society of London. Series B, Biological sciences*, *265*, 927–933.

Gangestad, S. W., Thornhill, R., & Garver, C. E. (2002). Changes in women's sexual interests and their partners' mate-retention tactics across the menstrual cycle: evidence for shifting conflicts of interest. *Proceedings of the Royal Society of London. Series B, Biological sciences*, *269*, 975–982.

Gorer, G. (1938). *Himalayan village. An account of the Lepchas of Sikkim*. London: M. Joseph.

Graham, C. A., Janssen, E., & Sanders, S. A. (2000). Effects of fragrance on female sexual arousal and mood across the menstrual cycle. *Psychophysiology*, *37*, 76–84.

Green, L., Bouzas, A., & Rachlin, H. (1972). Test of an electric-shock analog to illness-induced aversion. *Behavioral Biology*, *7*, 513–518.

Gregor, T. (1985). *Anxious pleasures: the sexual lives of an Amazonian people*. Chicago: University of Chicago Press.

Haidt, J., Koller, S. H., & Dias, M. G. (1993). Affect, culture, and morality, or is it wrong to eat your dog? *Journal of Personality and Social Psychology*, *65*, 613–628.

Haidt, J., McCauley, C., & Rozin, P. (1994). Individual differences in sensitivity to disgust: a scale sampling seven domains of disgust elicitors. *Personality and Individual Differences*, *16*, 701–713.

Haidt, J., Rozin, P., McCauley, C., & Imada, S. (1997). Body, psyche, and culture: the relationship between disgust and morality. *Psychology and Developing Societies*, *9*, 107–131.

Haiman, C. A., Pike, M. C., Bernstein, L., Jaque, S. V., Stanczyk, F. Z., Afghani, A., Peters, R. K., Wan, P., & Shames, L. (2002). Ethnic differences in ovulatory function in nulliparous women. *British Journal of Cancer*, *86*, 367–371.

Henderson, B. J., & Whissell, C. (1997). Changes in women's emotions as a function of emotion valence, self-determined category of premenstrual distress, and day in the menstrual cycle. *Psychological Reports*, *80*, 1272–1274.

Jöchle, W. (1973). Coitus induced ovulation. *Contraception*, *7*, 523–564.

Jonaitis, A. (1986). *Art of the northern Tlingit*. Seattle, WA: University of Washington Press.

Koch, P. C., & Peters, R. H. (1987). Suppression of adult copulatory behaviors following LiCl-induced aversive contingencies in juvenile male rats. *Developmental Psychobiology*, *20*, 603–611.

Koch, P. C., & Peters, R. H. (1992). Plasma testosterone concentration in adult male rats following acquisition of copulation-illness associations. *Physiology & Behavior*, *51*, 873–876.

Koukounas, E., & McCabe, M. (1997). Sexual and emotional variables influencing sexual response to erotica. *Behaviour Research & Therapy*, *35*, 221–230.

Kring, A. M., & Gordon, A. H. (1998). Sex differences in emotion: expression, experience, and physiology. *Journal of Personality and Social Psychology*, *74*, 686–703.

Labby, D. (1976). Incest as cannibalism: the Yapese analysis. *Journal of the Polynesian Society*, *85*, 171–179.

Lawrence, G. J., & Kiefer, S. W. (1987). Cessation of male rat copulatory behavior using illness as punishment: facilitation with a novel odor. *Behavioral Neuroscience*, *101*, 289–291.

Lenton, E. A., Landgren, B. M., Sexton, L., & Harper, R. (1984). Normal variation in the length of the follicular phase of the menstrual cycle: effect of chronological age. *British Journal of Obstetrics and Gynaecology*, *91*, 681–684.

Malamuth, N. M., & Check, J. V. (1980). Sexual arousal to rape and consenting depictions: the importance of the woman's arousal. *Journal of Abnormal Psychology*, *89*, 763–766.

Marshall, D. S. (1971). Sexual behavior on Mangaia. In D. S. Marshall, & R. C. Suggs (Eds.), *Human sexual behavior: variations in the ethnographic spectrum* (pp. 103–162). New York: Basic Books.

Maxwell, K. B. (1983). *Bemba myth and ritual: the impact of literacy on an oral culture*. New York: P. Lang.

McCance, R. A., Luff, M. C., & Widdowson, E. E. (1937). Physical and emotional periodicity in women. *Journal of Hygiene*, *37*, 571–611.

McKnight, D. (1973). Sexual symbolism of food among the Wik-Mungkan. *Man*, *8*, 194–209.

Meigs, A. S. (1984). *Food, sex, and pollution: a New Guinea religion*. New Brunswick, NJ: Rutgers University Press.

Penton-Voak, I. S., & Perrett, D. I. (2000). Female preference for male faces changes cyclically: further evidence. *Evolution and Human Behavior*, *21*, 39–48.

Peters, R. H. (1983). Learned aversions to copulatory behaviors in male rats. *Behavioral Neuroscience*, *97*, 140–145.

Peters, R. H., Blythe, B. L., Koch, P. C., & Kueker, C. A. (1989). Copulation-illness associations in male rats: lithium chloride dose and delay manipulations. *Behavioral Neuroscience*, *103*, 117–123.

Petralia, S. M., & Gallup, G. G. Jr. (2002). Effects of a sexual assault scenario on handgrip strength across the menstrual cycle. *Evolution and Human Behavior*, *23*, 3–10.

Quigley, J. F., Sherman, M. F., & Sherman, N. C. (1997). Personality disorder symptoms, gender, and age as predictors of adolescent disgust sensitivity. *Personality and Individual Differences*, *22*, 661–667.

Regan, P. C., & Berscheid, E. (1999). *Lust: what we know about sexual desire*. Thousand Oaks, CA: Sage Publications.

Reichel-Dolmatoff, G. (1990). *The sacred mountain of Colombia's Kogi Indians*. New York: E.J. Brill.

Rempel, J. K., & Baumgartner, B. (2003). The relationship between attitudes towards menstruation and sexual attitudes, desires, and behavior in women. *Archives of Sexual Behavior*, *32*, 155–163.

Roscoe, P. B. (1994). Amity and aggression: a symbolic theory of incest. *Man*, *29*, 49–76.

Rozin, P., Haidt, J., McCauley, C., Dunlop, L., & Ashmore, M. (1999). Individual differences in disgust sensitivity: comparisons and evaluations of paper-and-pencil versus behavioral measures. *Journal of Research in Personality*, *33*, 330–351.

Rozin, P., Haidt, J., & McCauley, C. R. (2000). Disgust. In M. Lewis, & J. Haviland (Eds.), *Handbook of emotions* (pp. 637–653). New York: Guilford Press.

Shore, B. (1976). Incest prohibitions and the logic of power in Samoa. *Journal of the Polynesian Society*, *85*, 275–296.

Shostak, M. (1981). *Nisa, the life and words of a !Kung woman*. Cambridge, MA: Harvard University Press.

Thompson, L. (1996). *Fijian frontier*. New Haven, CT: Human Relations Area Files.

Thornhill, R., & Gangestad, S. W. (1999). The scent of symmetry: a human sex pheromone that signals fitness? *Evolution and Human Behavior*, *20*, 175–201.

Tinbergen, N. (1963). On aims and methods of ethology. *Zeitschrift für Tierpsychologie*, *20*, 410–433.

Troop, N. A., Treasure, J. L., & Serpell, L. (2002). A further exploration of disgust in eating disorders. *European Eating Disorders Review*, *10*, 218–226.

Tuzin, D. F. (1978). Sex and meat-eating in Ilahita: a symbolic study. *Canberra Anthropology*, *1*, 82–93.

Vonderheide, S. G., & Mosher, D. L. (1988). Should I put in my diaphragm? Sex-guilt and turn-offs. *Journal of Psychology & Human Sexuality*, *1*, 97–111.

Wilcox, A. J., Dunson, D. B., Weinberg, C. R., Trussell, J., & Baird, D. D. (2001). Likelihood of conception with a single act of intercourse: providing benchmark rates for assessment of post-coital contraceptives. *Contraception*, *63*, 211–215.

Wronska, J. (1990). Disgust in relation to emotionality, extraversion, psychoticism and imagery abilities. In P. J. D. Drenth, J. A. Sergeant, & R. J. Takens (Eds.), *European perspectives in psychology* (pp. 125–138). Chichester, UK: Wiley.

Yalman, N. (1971). *Under the bo tree: studies in caste, kinship, and marriage in the interior of Ceylon*. Berkeley, CA: University of California Press.