Original Article

Mate choice preferences in an intergroup context: evidence for a sexual coercion threat-management system among women

Melissa M. McDonald [a,*], M. Brent Donnellan [b], Joseph Cesario [c], Carlos David Navarrete [c]

[a] Oakland University, Department of Psychology, 204 Pryale Hall, Rochester, MI 48309, USA
[b] Texas A&M, Department of Psychology, 4235 TAMU, College Station, TX, 77843, USA
[c] Michigan State University, Department of Psychology, 316 Physics Rd, East Lansing, MI 48824, USA

ABSTRACT

Given the importance of reproductive choice in female mating strategies, women may be equipped with a threat-management system that functions to protect reproductive choice by avoiding individuals and situations that have historically posed an increased threat of sexual coercion. Previous research suggests that bias against outgroup men may be one consequence of such a system, resulting from an evolutionary history of intergroup conflict in which women were often at increased risk of sexual assault from outgroup men. We provide a critical extension to this literature by demonstrating that the output of this system is not limited to attitudinal biases, but extends to behavioral decisions regarding dating, particularly among women for whom threats to reproductive choice are most costly and perceived to be most likely. Participants received an unsolicited dating request made by an ingroup or outgroup member, with group boundaries manipulated in a minimal-group paradigm. Consistent with predictions, women self-appraised as vulnerable to sexual coercion were less likely to agree to date requests from outgroup members, but not ingroup members, during the fertile period of the menstrual cycle. Our findings are consistent with the notion that women possess a psychological system that functions to protect reproductive choice by avoiding individuals that historically posed an increased threat of sexual coercion, and that this system may be calibrated to be most strongly activated among women who both appraise themselves as vulnerable and for whom threats to reproductive choice are most costly.

© 2015 Elsevier Inc. All rights reserved.

1. Introduction

A threat-management perspective (Neuberg, Kenrick, & Schaller, 2011) suggests that humans are equipped with psychological systems for coping with adaptive challenges to biological fitness. Such systems are thought to be characterized by a suite of mechanisms adaptively tuned to perceptual cues in the environment that increase or decrease the risk of harm to the individual, as well as to individual characteristics that make an individual more or less vulnerable to such threats. Based on previous theory and research (e.g. McDonald, Asher, Kerr, & Navarrete, 2011; Navarrete, Fessler, Fleischman, & Geyer, 2009; Navarrete, McDonald, Molina, & Sidanius, 2010), we propose that women may be equipped with a threat-management system that functions to protect reproductive choice by avoiding individuals that may have historically posed an increased threat of sexual coercion, particularly when threats to reproductive choice are most costly and probable.

Drawing on this theoretical framework, we investigate whether women who appraise themselves as more vulnerable to sexual coercion exhibit a greater tendency to deny date requests from outgroup men when they are at increased risk of conception.

1.1. Reproductive choice in female mating strategies

A key biological difference between males and females is the level of parental investment required of each in order to produce viable offspring, such that the obligatory investment of females is much greater than that of males (Bateman, 1948; Trivers, 1972). This incentivizes female mating strategies that prioritize the selection of high quality mates. As such, maintaining control over reproductive choice is a critical factor for increasing reproductive success among females. Attempts by males to subvert reproductive choice are potentially quite costly to females because they (1) inhibit a female's ability to exert control over her mate's genetic quality, (2) preclude selection for traits that indicate a paternal willingness to invest resources in offspring, (3) increase the risk of abandonment by an existing male partner who leaves to avoid the potential costs of cuckoldry, and (4) may increase the probability of injury or exposure to disease (e.g. Navarrete & Fessler, 2006; Thornhill & Palmer, 2000; Ullman & Knight, 1991). If sexually coercive mating tactics were a persistent threat to female reproductive success

* Corresponding author. Oakland University, 204 Pryale Hall, Rochester, MI 48309. Tel.: +1 248 370 4195.
E-mail addresses: mmmcdonald@oakland.edu (M.M. McDonald), mbdonnellan@tamu.edu (M.B. Donnellan), cesario@msu.edu (J. Cesario), cdn@msu.edu (C.D. Navarrete).

throughout evolutionary history, then selection may have favored a psychological system for protecting reproductive choice that includes mechanisms for avoiding individuals and situations that pose a threat of sexual coercion.

1.2. Mechanisms of a sexual coercion threat management system

A system that produces avoidant behavior cannot operate without costs (e.g. time, attention, energy, and foregone opportunities). To minimize costs and maximize benefits, such a system is likely to be calibrated so that avoidant behaviors are most likely to occur when threats pose the greatest cost. In terms of protecting reproductive choice, sexual coercion is most costly to women when it could result in conception. The risk of conception for women varies across the menstrual cycle, peaking on the day of ovulation and the immediately preceding days (Wilcox, Weinberg, & Baird, 1995; Wilcox, Dunson, Weinberg, Trussell, & Baird, 2001). Given this fact, we posit that avoidant behavior that functions to minimize the risk of sexual coercion may track conception risk across the menstrual cycle.

A psychological system for protecting reproductive choice should be attuned not only to time periods when sexual coercion is most costly (i.e. peak conception risk), but also when the likelihood of sexual coercion increases. Throughout human history, intergroup conflict has provided greater affordances for sexual violence to be perpetrated against women, especially by men of the invading group (Lalumière, Harris, Quinsey, & Rice, 2005). Such affordances include the absence of consenting heterosexual mating options, antagonistic attitudes toward the victims' group, and a reduced likelihood of punishment or retaliation (Smuts, 1996). Indeed, the weight of evidence suggests that, throughout evolutionary history, intergroup conflict has increased a woman's risk of becoming the victim of sexual violence (Brownmiller, 1975; Buss, 1998; Chagnon, 1988; Chang, 1997; Epp, 1997; Lawson, 1989; Mezey, 1994; Niarchos, 1995; Roland, 1997; Rosenman, 2000; Sanday, 1981; Seifert, 1996).

Given the risk of sexual coercion associated with intergroup conflict, and the persistence of conflict throughout evolutionary history (Keeley, 1996; Pinker, 2011), the association between sexual coercion and outgroup men may have been quite strong for women. Although ingroup men were also likely to have used sexually coercive mating tactics, many of women's interactions with ingroup men would have included beneficial support in the form of food, shelter, and protection from predators and intergroup attack. Additionally, ingroup men are likely subject to greater monitoring from the ingroup with the potential to be sanctioned for coercive behavior. As a result, outgroup men may have been perceived as a more probable threat of sexual assault than ingroup men, particularly when controlling for the amount of time spent, and the nature of interactions, with members of each group (Navarrete & Tybur, 2013; Navarrete et al., 2010). For these reasons, women may have evolved specific psychological mechanisms for protecting reproductive choice within intergroup contexts.

In addition to external circumstances that elevate the threat to women's reproductive choice, individual differences in women's perceived vulnerability may also play a role in calibrating a threat-management system for avoiding sexual coercion. Women who appraise themselves as vulnerable to sexual coercion may feel less capable of defending themselves or may feel they are at greater risk of encountering coercive threats. As a result, perceiving oneself as particularly vulnerable to sexual coercion, in combination with an elevated risk of conception, may increase a woman's vigilance against being targeted by men that are perceived as posing a threat of sexual coercion.

Consistent with the theorizing above, a number of recent studies have found support for the proposition that women may possess psychological mechanisms that function to protect reproductive choice via the avoidance of sexually coercive threats (e.g., Bröder & Hohmann,

2003; Chavanne & Gallup, 1998; Fessler, Holbrook, & Fleischman, 2014; Garver-Apgar, Gangestad, & Simpson, 2007; Guéguen, 2012; McDonald et al., 2011; Navarrete et al., 2009, 2010; Petralia & Gallup, 2002) or which function to reduce the costs associated with sexual coercion (Chivers, Seto, Lalumière, Laan, & Grimbos, 2010). Relevant to the current research, in a series of studies Navarrete et al. (2010; Studies 3 and 4) showed that racial bias against outgroup *men* is elevated among women who appraise themselves as being vulnerable to sexual coercion, even when controlling for domain-general fearfulness. Along similar lines, attitudinal bias against outgroup men was greater among women who appraised themselves as vulnerable to sexual coercion, and this was particularly pronounced among women at peak conception risk in their menstrual cycle (Navarrete et al., 2009). These results are consistent with the notion that women's intergroup bias may be the output of a psychological system that functions to protect reproductive choice.

1.3. The current research

Previous research suggests that women evaluate outgroup men more negatively when their risk of conception is elevated, particularly among women who express greater vulnerability to sexual coercion. However, research has yet to link these attitudinal responses to actual behavior. To address this issue, we examined men and women's behavioral responses to dating requests made by individuals identified as ingroup or outgroup members.

1.3.1. Key prediction
Given the goal of protecting reproductive choice and the potential threat to this goal that outgroup men may have posed throughout evolutionary history, we predicted that women would be less willing to accept date requests from outgroup members when conception risk and appraisals of vulnerability to sexual coercion are high. We posit that this combination of elevated conception risk and vulnerability to sexual coercion is critically important, given that there may be competing psychological systems at play when evaluating outgroup men. The system we describe here functions to protect reproductive choice by increasing negative judgments of outgroup men as a function of conception risk. However, a separate system may also be operative that serves to capitalize on the potential benefits of exogenous mating with males possessing genetic profiles optimally distinct from one's own. Such a strategy may reduce the likelihood that offspring will inherit congenital disorders, or be vulnerable to disease and parasites (e.g. Roberts & Little, 2008; Wedekind, Seebeck, Bettens, & Paepke, 1995). Research informed by this view demonstrates that women's sexual response to their partners decreases as the proportion of shared alleles associated with the immune system increases (Garver-Apgar, Gangestad, Thornhill, Miller, & Olp, 2006).

Which of these competing systems is activated may depend on numerous inputs orthogonal to disease concerns, including the level of one's self-appraised vulnerability to sexual coercion, whether the context suggests the presence of intergroup conflict, and whether the outgroup is perceived as physically formidable. Given the historical association between outgroup men and sexual coercion in intergroup contexts, our key prediction is that women will be less likely to accept date requests from outgroup members, when (a) threats to reproductive choice are most costly due to increased likelihood of conception, and (b) when women appraise themselves as being particularly vulnerable to sexual coercion.

1.3.2. Exploratory hypotheses
We did not make specific predictions about how conception risk and vulnerability to sexual coercion would influence women's willingness to accept date requests from *ingroup* members. However, previous research on mate choice implies that high fertility may be associated with an increased willingness to respond positively to date requests

from attractive ingroup members (e.g. Gangestad, Garver-Apgar, Simpson, & Cousins, 2007), though this has not been experimentally tested in a behavioral setting. In contrast, greater self-appraised vulnerability to sexual coercion may be negatively associated with willingness to accept date requests from ingroup as well as outgroup members as part of a broader sexual coercion threat-management system.

We also examined men's responses to date requests from ingroup and outgroup women. Our theoretical perspective suggests that men have historically posed a recurrent threat of sexual coercion to women from other groups. This does not necessarily mean that men will exhibit a *preference* for outgroup women, but it is a possibility, particularly considering the genetic diversity advantage of mating across group lines. Although research has documented that men exhibit a weaker ingroup dating preference relative to women (e.g. Fisman, Iyengar, Kamenica, & Simonson, 2006), research has not examined such preferences experimentally within an intergroup dating framework.

1.3.3. Intergroup context

Previous research examining intergroup bias as means of protecting reproductive choice has primarily been conducted within a racial groups context. For example, Navarrete et al. (2009, 2010) examined White women's bias against Black men. Here, we sought to expand to a more general intergroup context for two reasons. First, relying on social groups as stimuli for which research participants may harbor culturally-loaded, pre-existing racial stereotypes makes it difficult to draw strong conclusions about the underlying mechanism producing bias. For example, White women may decline date requests from Black men because such individuals fit a category stereotyped as criminal and hostile (Devine & Elliot, 1995), rather than simply because of their categorization as an outgroup member. Second, evolutionary approaches to intergroup relations suggest that humans evolved to process information about social groups as coalitional categories, rather than racial groups specifically (Kurzban, Tooby, & Cosmides, 2001; Pietraszewski, Cosmides, & Tooby, 2014). This reasoning is based on data suggesting that the geographic distribution of racial groups was dispersed widely enough that, for most of human evolutionary history, an individual would have been very unlikely to ever encounter a member of a different racial group (Stringer & McKie, 1997; Van den Berghe, 1978).

Rather than living in groups stratified by race, humans' hunter gatherer ancestors lived in bands in which it was necessary to track shifting coalitional memberships both within the band and between bands in conflict. Features that covary with a group's tendency to engage in coordinated action, such as a similar style of dress or shared dialect, often serve as cues to coalitional membership (Kurzban et al., 2001; Pietraszewski et al., 2014). Indeed, research using the so-called *minimal group paradigm* demonstrates that subtle cues to group membership that do not rely on cultural stereotypes, even when rather arbitrary, are sufficient to produce a preference for one's ingroup over the outgroup (Tajfel, Billig, Bundy, & Flament, 1971). From this perspective, race is not encoded as a special category, but is instead used as a marker of coalitional membership. Thus, if women evolved a threat management system that discriminates against men from coalitional outgroups, the system should be operative whether the feature that cues coalitional membership is race, dialect, dress, or some other shared feature. Therefore, to prevent contamination from culturally acquired stereotypes and to permit inferences about a more fundamental coalitional psychology of intergroup bias that relies on group categories in its strictest sense, we elected to use *minimal groups* as the intergroup context in the current research.

2. Method

Following recommendations from Simmons, Nelson, and Simonsohn (2012), "we report how we determined our sample size, all data

exclusions (if any), all manipulations, and all measures in the study" (p. 1). This study was part of a larger research project which tested additional hypotheses, which are not presented here. Details on the other hypotheses, measures, and results can be found in the online supplementary material. The data needed to reproduce the analyses reported below is available at: https://osf.io/dfz3y/files/

2.1. Participants

We aimed to collect a sample of 350–400 participants, with women comprising two-thirds of the sample in order to increase the power to detect the predicted third-order interaction, with the expectation that many observations from female participants would be dropped due to unusable conception risk data. Our sample included 371 university students enrolled in the psychology participant pool at a Midwestern University. Data collection was stopped at the end of the Spring 2013 semester. Twenty-one participants were excluded from analysis due to experimenter error (n = 12), same-sex sexual/ romantic preferences (n = 6), being much older than the traditional college student (30 years of age or older; n = 2), and non-English fluency (n = 1). Decisions to exclude participants on these criteria were made prior to primary data analysis. Of the remaining 350 participants (M_{age} = 19.27, SD_{age} = 1.66), 263 were female (75.1%). The racial/ ethnic background of participants (selecting all that applied) was: 279 White, 36 Black, 21 Asian, 9 Hispanic, and 15 multiracial or other. Nearly a third of the final sample, 32.6% (n = 114), reported being in a romantic relationship.

2.2. Procedure

Participants signed up for a study described as an investigation of how individuals "get to know each other in online environments" which required completing an online survey prior to their scheduled lab session. This online survey included the measure of women's self-appraised vulnerability to sexual coercion, as well as other measures not related to the current research. At their scheduled lab session, participants were assigned to either a red, yellow, or blue group on the basis of a color perception task (see the online supplementary material for details). Participants wore a t-shirt matching their group color assignment to maintain the saliency of group membership throughout the experiment.

Participants were then instructed that they would be interacting online with three other participants (who were actually trained research confederates) via Skype chat for five minutes each. Video communication was disabled but participants could see images of their purported chat partners, and participants presumed that their chat partners could also see a picture of them (submitted by the participant before the lab session). Images were digitally manipulated to include a colored border as an indicator of group membership. For analyses, partners with a border color matching participants' assigned group were defined as belonging to the ingroup, whereas those with a non-matching border color were defined as belonging to the outgroup. However, no attempt was made to draw attention to the group membership of the chat partners during the experiment.

To increase the credibility of the cover story, participant's first two interactions drew from a set of pre-determined question prompts (e.g. What do you like to do for fun?) and always occurred with ingroup members (one male and one female, counterbalanced). Each interaction was followed with a brief survey assessing the participant's perception of the chat partner.

In the third and critical interaction, participants were paired with a confederate portrayed in an electronic image as an attractive member of the opposite sex. The image was randomly assigned to have a matching border color (ingroup condition) or a non-matching border color (outgroup condition). The confederate introduced him or herself as Michael (for female participants) or Ashley (for male participants)

and asked the following introductory questions, (1) "How are you?" (2) "What year are you?" (3) "What is your major?" Then the confederate followed a script inspired by the classic research paradigm of Clark & Hatfield (1989): "Your picture looks really familiar, I think I've seen you around campus before. I think you're really attractive. Do you want to hang out with me sometime this week?" Following the participant's response to the date request, the confederate backed off from the request and then continued with the conversation prompts until five minutes elapsed. The participant then completed the final follow-up measures. Female participants also answered questions about their menstrual cycle to ascertain their level of conception risk. Following this, all participants completed a manipulation check, items probing for suspicion, and a detailed debriefing process.

2.3. Materials

2.3.1. Chat partner photographs

A large sample of images of young-adults was obtained online from royalty-free stock photo websites. Via pretesting, one attractive male image and one similarly attractive female image were selected for the third online interaction. Each served as the image for both the ingroup and outgroup condition. Images for the first and second interaction partners were selected to have a lower average attractiveness rating than the third interaction partner. Details on the selection of photographs can be found in the online supplementary material.

2.4. Predictors of intergroup dating preferences

2.4.1. Conception risk

Female participants were asked to report the date of the beginning of their last two menstrual periods, using calendars to help make their estimate. Current cycle day was determined using the forward counting method (Wideman, Montgomery, Levine, Beynnon, & Shultz, 2013). Participants who were pregnant or unsure if they were pregnant (n = 2), currently 5 or more days late for their menstrual period (n = 39), using hormonal contraceptives or declined to respond to this question (n = 94), or reported non-standard cycle lengths (less than 20 days or greater than 40 days; n = 62) were excluded from analyses that included conception risk as a predictor. In the final sample of women used for the conception risk analyses, average cycle length was 29.47 days long ($SD = 4.27$).

Conception risk ($M = .03$, $SD = .03$) was estimated using the pregnancy probability values provided by Wilcox et al. (2001) that map menstrual cycle day onto actuarial data divided into three categories of cycle regularity. Additional details about assigning conception risk values are provided in the supplementary material.

2.4.2. Vulnerability to sexual coercion

Self-appraised *vulnerability to sexual coercion* (VSC) was measured using the 30-item Fear of Rape questionnaire (Senn & Dzinas, 1996) with responses ranging from 1 (strongly disagree) to 7 (strongly agree). The items assess behavioral vigilance against threats (e.g., "Before I go to bed at night I double check to make sure the doors are securely locked") and explicit fear of sexual assault (e.g., "I am afraid of being sexually assaulted"). A composite of the items ($M = 4.14$, $SD = .83$; $\alpha = .92$) was used for all analyses.

2.5. Assessment of intergroup dating preferences

2.5.1. Participant responses and willingness

Chat conversations between each participant and the third interaction partner were edited to remove cues of participant sex. Each conversation was then coded by two research assistants for whether the participant said yes (1) or no (0) to the dating request, as well as how willing the participant was to respond positively to the request (1 = Not at all willing to 5 = Very willing). Coders agreed

on 91.9% of cases for the yes/no response (Kappa = .83, $p < .001$), and ratings for the willingness variable were strongly correlated between coders ($r = .88$; Kappa = .53, $p < .001$). Discrepancies between coders were resolved by a third independent coder. The willingness variable was created because many participant responses did not fall clearly into a "yes" or "no" category. As an example, one participant's response: "…haha maybe, I have a ton of tests and what not to study for." In our view, willingness provides a better representation of the true distribution of the data, and is therefore used as the outcome variable in the key analyses that follow. However, results using the dichotomous yes/no outcome produced the same pattern of results, and are presented in the online supplemental material.[1]

2.6. Manipulation and suspicion check

Following the last set of ratings for the third interaction, participants were asked to indicate to which color group their chat partners belonged. The group membership of most chat partners was accurately recalled (84.3%). Participants were also asked to indicate how suspicious they were (1 = Not at all Suspicious, 5 = Very Suspicious) that their chat partners were not real ($M = 3.49$, $SD = 1.44$). There was a small effect by which more suspicious participants were less likely to agree to the request ($r = -.12$, $p = .020$). Analyses were conducted with and without suspicion scores entered as a covariate, but its inclusion did not change the pattern of results. For ease of interpretation, the reported statistics below do not include the suspicion covariate in the model.

3. Results

3.1. Relationship status and responses to the date request

A number of participants in the sample indicated that they were currently involved in a romantic relationship (35.0% of women and 25.3% of men). Despite this, 35 of the 92 women in a relationship[2] (38.0%), and 19 of the 22 men in a relationship (86.4%), accepted the date request. Given this variation, non-single participants were included in all analyses, but because they were less willing than single participants to respond positively to the date request, particularly women (Single women $M = 3.25$, $SD = 1.59$ versus women in a relationship $M = 2.27$, $SD = 1.47$; t-test with unequal variances, $t(199.50) = 4.98$, $p < .001$; $d = .61$. Single men $M = 4.48$, $SD = 0.90$ versus men in a relationship $M = 4.18$, $SD = 1.18$; $t(85) = 1.22$, $p = .225$; $d = .31$), relationship status was included as a covariate in the multiple regression analyses that follow; it did not interact with the other predictors.

3.2. Sex differences in date request responses

Overall, 61.1% of participants agreed to the date request, but this differed significantly between men (90.8%) and women (51.3%), $\chi^2 (1) = 42.88$, $p < .001$. This pattern was also reflected in the

---

[1] Although the same pattern of results was found using the dichotomous outcome variable, two key effects dropped to marginal significance: (1) the two-way interaction between conception risk and vulnerability to sexual coercion in the outgroup condition: ($b = -51.52$, $SE = 27.56$, $Z = -1.87$, 95% CI = [−105.54, 2.50], $p = .062$) and the simple slope for this interaction among women reporting high levels of vulnerability to sexual coercion ($b = -42.43$, $SE = 22.84$, $Z = -1.86$, 95% CI = [−87.20, 2.34], $p = .063$).

[2] This finding is consistent with previous empirical work in which pair-bonded women near to ovulation (particularly those partnered to individuals with low mate-value) report having greater interest in attending social gatherings where they might meet men (Haselton & Gangestad, 2006), greater extra-pair flirtation (Haselton & Gangestad, 2006), extra-pair attraction (Larson, Pillsworth, & Haselton, 2012), and were more critical of their current partners (Larson, Haselton, Gildersleeve, & Pillsworth, 2013).

Table 1
Descriptive statistics for female participants split by group condition.

	1.	2.	3.	Outgroup Mean (SD)
1. Willingness	-	-.04	-.14	2.95 (1.60)
2. Conception Risk	.03	-	.09	0.03 (0.03)
3. Vulnerability to Sexual Coercion	.13	.01	-	4.08 (0.84)
Ingroup *Mean*	3.25	0.03	4.10	
(*SD*)	(1.63)	(0.03)	(0.81)	

Note. * $p < .05$. Correlations in the top-right diagonal represent participants in the outgroup condition; correlations in the bottom-left diagonal represent participants in the ingroup condition.

willingness ratings, such that men expressed far more willingness to respond positively to the date request ($M = 4.40, SD = .98$) than women ($M = 2.90, SD = 1.61$; t-test with unequal variances, $t(244.37) = 10.34$, $p < .001, d = .93$).

3.3. Sex differences in intergroup dating preferences

To examine sex differences in intergroup dating preferences, responses to requests from ingroup and outgroup members were compared separately for men and women. There was no evidence for a strong within-group dating preference for either sex: 93.0% of men agreed to the request in the ingroup condition compared to 88.6% in the outgroup condition, $\chi^2 (1) = .50, p = .479$; similarly, 51.0% of women in the ingroup condition agreed to the request relative to 51.7% in the outgroup condition, $\chi^2 (1) = .01, p = .920$. This lack of intergroup bias was also reflected in the willingness ratings. There was no evidence that men in the ingroup condition were more willing to agree to the date request ($M = 4.44, SD = .88$) than men in the outgroup condition ($M = 4.36, SD = 1.08$), $t(85) = 0.37, p = .713, d = .08$. Women in the ingroup condition were also no more willing to accept the date request ($M = 2.91 SD = 1.68$) compared to women in the outgroup condition ($M = 2.90, SD = 1.54$), t-test with unequal variances, $t(258.84) = 0.05, p = .964, d = .01$.

3.4. Conception risk and vulnerability to sexual coercion

In the next analysis, we examined whether women who perceive themselves as more vulnerable to sexual coercion exhibit a greater bias against dating outgroup men when conception risk is elevated. A multiple regression analysis was conducted using the SPSS macro, PROCESS (Model 3; Hayes, 2013). For each analysis we report the bootstrapped 95% bias-corrected confidence intervals.[3] Only female participants with complete data on all relevant variables, and whose menstrual cycle data met the criteria for the scoring of conception risk, were included ($n = 117$; descriptive statistics for these variables can be found in Table 1). The dependent variable was the ratings of participants' willingness to respond positively to the date request. The predictors included in the analysis were: *group condition* – dummy coded signifying whether the date request came from an ingroup (0) or outgroup member (1), *conception risk*, and *vulnerability to sexual coercion*. All two-way and three-way interactions among these variables were also included. All variables used in the construction of interactions were centered within the PROCESS macro. Participant relationship status (0 = single, 1 = non-single) was entered as a covariate.[4]

---

[3] Bootstrapping methods can produce asymmetrical confidence intervals; this asymmetry reflects the actual asymmetry of the sampling distribution produced by the resampling procedure (Hayes, 2013).

[4] The same pattern of results was obtained when relationship status was not included as a covariate, however, the 3-way interaction dropped to marginal significance ($\beta = -0.45, b = -28.89, t(109) = -1.86, CI = [-59.70, 1.92], p = .066$).

Table 2
Regression results for willingness to accept date request as a function of group condition, conception risk (C-risk), and vulnerability to sexual coercion (VSC).

Variable	b	SE	β	t	CI
Relationship Status	−0.72	0.34	−0.44	−2.14*	−1.38, −0.05
Group Condition	−0.26	0.30	−0.16	−0.88	−0.85, 0.33
Conception Risk	1.01	4.96	0.02	0.20	−8.82, 10.84
VSC	−0.12	0.20	−0.06	−0.61	−0.52, 0.28
Condition x C-Risk	−9.42	9.99	−0.18	−0.94	−29.22. 10.37
Condition x VSC	−0.98	0.41	−0.50	−2.37*	−1.80, −0.16
C-Risk x VSC	−9.06	7.39	−0.14	−1.23	−23.72, 5.59
Condition x C-Risk x VSC	−30.67	15.32	−0.48	−2.00*	−61.03, −0.31

Note. * $p < .05$. Relationship status is coded 0 (single), 1 (non-single). Group condition is coded 0 (ingroup), 1 (outgroup).

Results of the analysis (Table 2) revealed the predicted three-way interaction between group condition, conception risk, and vulnerability to sexual coercion ($\beta = -0.48, b = -30.67, SE = 15.32, t(108) = -2.00$, 95% CI = $[-61.03, -0.31], p = .048$). Decomposing this interaction (Fig. 1) revealed that the two-way interaction between conception risk and vulnerability to sexual coercion was not statistically significant in the ingroup condition ($\beta = 0.07, b = 4.30, SE = 8.88, t = 0.48$, 95% CI = $[-13.30, 21.91], p = .629$) but was significant in the outgroup condition ($\beta = -0.41, b = -26.37, SE = 12.48, t = -2.11$, 95% CI = $[-51.09, -1.64], p = .037$). The simple slopes for the two-way interaction in the outgroup condition indicated that, among women reporting low levels of vulnerability to sexual coercion (1 *SD* below the mean), conception risk was positively, but not significantly, related to willingness to accept the date request ($\beta = 0.33, b = 17.24, SE = 12.79, t = 1.35$, 95% CI = $[-8.12, 42.60], p = .181$). The reverse was true for women reporting high levels of vulnerability to sexual coercion (1 *SD* above the mean), such that conception risk was negatively associated with willingness to respond positively to the date request from an outgroup member ($\beta = -0.50, b = -25.85, SE = 12.47, t = -2.07$, 95% CI = $[-50.57, -1.14], p = .041$).

4. Discussion

Previous research has demonstrated that women exhibit increased attitudinal bias against outgroup men when threats to reproductive choice pose the greatest fitness costs, especially among women reporting greater vulnerability to these threats (Navarrete et al., 2009). The current work conceptually replicates these findings but critically advances them by demonstrating that the psychological system that evokes attitudinal bias purported to protect reproductive choice extends to *behavioral* outcomes. Specifically, women were less willing to accept date requests from outgroup members, but not ingroup members, under conditions of elevated threat to reproductive choice. The current work also permitted exploratory analysis of women's dating behavior in an ingroup context, as well as whether men exhibit evidence of an ingroup or outgroup dating preference.

4.1. Sex differences in intergroup date request responses

Consistent with much theorizing and empirical work in evolutionary psychology (e.g. Buss & Schmitt, 1993; Clark & Hatfield, 1989), men were more likely to respond positively to date requests than were women, regardless of group membership. However, neither men nor women exhibited an overall ingroup dating preference. Although previous research has found evidence of a within-race dating preference among women (Fisman et al., 2006; Sprecher, Sullivan, & Hatfield, 1994), there was no such evidence for an overarching within-group dating preference in the current study. This finding is not entirely unexpected, given the expectation that there may be competing mechanisms at play in producing evaluations of outgroup men as a function of conception risk. Although the system we propose here
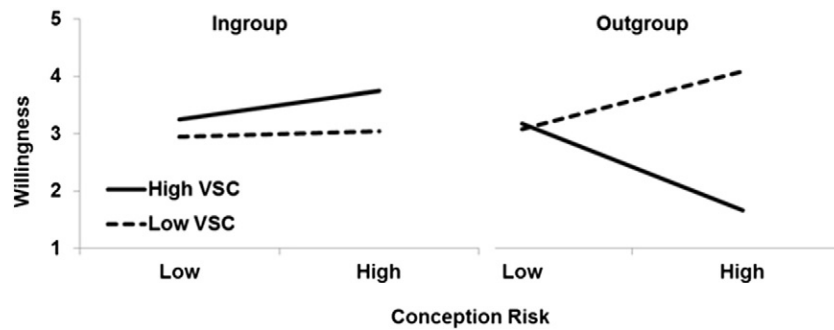
Fig. 1. Willingness response to date request by group condition, conception risk, and vulnerability to sexual coercion (VSC).

functions to produce negative evaluations of outgroup men and subsequent behavioral avoidance, mechanisms in place to reduce inbreeding and increase genetic diversity of one's offspring may function to produce greater affinity toward outgroup men (Roberts & Little, 2008; Wedekind et al., 1995). Which of these mechanisms is activated may depend on the perceived threat of the situation. In the current data there is some evidence for this pattern, as there is a positive (non-significant) relationship between conception risk and willingness to agree to the date request for women in the outgroup condition, but only among those women who report low levels of vulnerability to sexual coercion. A similar pattern was also reported by McDonald et al. (2011) and is consistent with recent research documenting an increase in preferences for outgroup men as a function of conception risk (Salvatore, 2012).

There was also no evidence of an intergroup dating bias among male participants. Given that men have not historically been the victims of sexual coercion or intergroup violence at the hands of outgroup *women*, we did not expect men to show a strong ingroup dating preference. In contrast, we were interested in whether the potential genetic advantages of intergroup mating would produce a *preference* for outgroup women, but found no evidence for such a preference. This null result may be due to the general tendency for men to be less choosy than women when selecting short-term mates (Buss & Schmitt, 1993), or additionally, it is possible that preferences for outgroup women are activated only under certain conditions.

4.2. Conception risk and vulnerability to sexual coercion

As predicted, women in the fertile window of their menstrual cycle who also appraised themselves as vulnerable to sexual coercion were least likely to accept a date request from an attractive man when he was identified as an outgroup member as opposed to an ingroup member. These findings are consistent with the notion that women may be equipped with a psychological system that functions to protect reproductive choice by promoting the avoidance of individuals perceived to pose an elevated threat of sexual coercion. Further, we also provide evidence that the mechanisms of the system are calibrated to produce more avoidance when threats to reproductive choice are most costly (i.e. when they are most likely to result in conception) and when they are most likely (e.g. when women appraise themselves as more vulnerable to such threats). Consistent with our theoretical framework, this suggests that the underlying psychological system is flexible and influenced by a number of functionally relevant factors including self-perceived vulnerability and biologically-based risk of conception.

Although previous research has reported results consistent with our current findings, such studies have focused primarily on attitudinal outcome variables. Here we demonstrate that these biased attitudes may translate into actual behavioral avoidance of the threat-eliciting stimuli. Previous research was also limited by the primary focus on intergroup contexts delineated by racial categories. The current research used a minimal groups context to reduce the impact of culturally acquired racial stereotypes, and to allow for clearer inferences about the working

of a deep-seated coalitional psychology of intergroup bias. Indeed, the uniformity of effects in both racial and minimal group contexts is consistent with the notion that the purported psychological system evolved during a time in human evolutionary history in which groups were defined by coalitional alliances rather than essentialized racial categories.

Though our key prediction in the current study was that women would exhibit increased bias against outgroup men as a function of increased conception risk and self-appraised vulnerability to sexual coercion, there are additional predictions that could be made with respect to these variables. For example, past research has reported that White women express greater fear of Black men (but not White men) as a function of their self-appraised vulnerability to sexual coercion, regardless of any influence of conception risk (Navarrete et al., 2010, Study 3). Along these lines, a significant interaction between group condition and vulnerability to sexual coercion was found in this study. The nature of this interaction can be seen in the correlation matrix (Table 1): vulnerability to sexual coercion is positively associated with willingness to accept the date request in the ingroup condition, but negatively associated with willingness to accept the date request in the outgroup condition. However, closer examination of the interaction reveals that it is primarily driven by women in the outgroup condition at high levels of conception risk, which is consistent with the higher-order three-way interaction. We attribute this pattern to the cost of enacting avoidance strategies (e.g. time, attention, energy, and foregone opportunities). To minimize costs and maximize benefits, the threat-management system we propose for avoiding sexual coercion should be calibrated so that avoidance-based behaviors are most likely to occur when threats pose the greatest cost (at peak conception risk) and are most probable (when targets are outgroup men and women appraise themselves as vulnerable).

An additional prediction that could have been made is with respect to the activation of a sexual-coercion threat management system during interactions with ingroup members. Past research has demonstrated that women exhibit greater vigilance and defensive mechanisms when faced with threatening stimuli at peak conception risk, without reference to the source of the threat (e.g. Bröder & Hohmann, 2003; Chavanne & Gallup, 1998; Fessler et al., 2014; Garver-Apgar et al., 2007; Guéguen, 2012; Petralia & Gallup, 2002). Given these findings, we might have expected women at peak conception risk who appraise themselves as vulnerable to sexual coercion to deny date requests from all men, regardless of whether it came from an ingroup or outgroup member. We did not find strong evidence of this among women in the ingroup condition. This may be due to the nature of the context in which the date request occurred, which was not a particularly threatening context. In contrast, for example, participants in Petralia & Gallup (2002) were asked to imagine walking to their car late at night while being pursued by a strange man. It may be that the threat level needed to activate the sexual coercion avoidance system is greater in an ingroup context compared to an outgroup context, and that this threat level was not reached in the current study. More research is certainly needed to examine this possibility.

4.3. Limitations

Although we describe the use of minimal group markers in the current study as a strength of the design, it could be considered a weakness, given the potential that such relatively trivial markers of group membership lack ecological validity. As such, the markers might represent rather weak cues of coalitional boundaries, and therefore produce small psychological effects. However, the appeal of the minimal group paradigm is precisely because it elicits reactions similar to those found in real, more enduring group contexts, despite minimal group categories being novel, temporary and even trivial. Indeed, early research used similarly trivial indicators of group membership (Tajfel et al., 1971) and produced evidence of behavior-based intergroup discrimination. Moreover, despite the modest categorical cues, in the current design the correct group membership of interaction partners was identified 84.3% of the time, implying that the group distinction was salient to participants.

A clear limitation of the current research is the relatively small sample of women with usable conception risk data. Though we collected a sample of 263 women, only 117 met all criteria for inclusion in the main analysis. However, we still view these results as an important contribution to the literature given the examination of a behavioral outcome variable. Indeed, research often requires making tradeoffs. Here we prioritized collecting data in-person on behavioral outcomes, and sample size suffered as a result. However, past research has produced conceptually similar results (Navarrete et al., 2009: McDonald et al., 2011), thereby providing convergent evidence for our claims.

We also recognize that the forward counting method of scoring conception risk has multiple drawbacks in comparison to other methods, such as the backward counting method and confirmation of LH surge via ovulation test strips. In particular, the forward counting method is more prone to errors in recall of menstrual cycle onset, and is influenced more by the greater variability in the follicular phase of the cycle relative to the luteal phase (Baird et al., 1995; Fehring, Schneider, & Raviele, 2006). For these reasons, we consider our results preliminary, and in need of replication. However, this method is typically the most time-efficient and cost-effective means of collecting conception risk data, which were priorities in the current study. We tried to offset the potential unreliability of the data by collecting as large a sample as possible and assigning conception risk values on the basis of participants' reported cycle regularity (Wilcox et al., 2001). We also scored conception risk as a continuous measure rather than dichotomizing it into high and low fertility periods, as this is typically a more powerful means of analysis (DeCoster, Iselin, & Gallucci, 2009; Fitzsimons, 2008; MacCallum, Zhang, Preacher, & Rucker, 2002), and also avoids issues of defining high versus low fertility windows of the menstrual cycle based on potentially arbitrary distinctions (Gelman & Loken, 2013).

5. Conclusions

Psychological theories that attempt to explain the underlying motivations for intergroup bias often assume that such motivations are the same for both men and women (e.g. social identity theory; Tajfel, 1974). Although some motivations may be uniform across the sexes, differences in the level of intergroup bias expressed and the character of that bias suggest that men and women may also be equipped with unique motivations underlying their behaviors and attitudes toward outgroups. Social dominance research (Sidanius & Pratto, 1999) has long emphasized the role that gender plays in intergroup relations, yet this perspective has primarily focused on understanding the motives for prejudice and discrimination among men. The current research adds to a new and growing body of findings exploring a female-specific psychology of intergroup bias, providing evidence that women may possess a suite of psychological mechanisms that function to protect reproductive choice by avoiding agents that historically posed a threat of sexual coercion. We believe that this line of inquiry will continue to generate exciting new findings in an area of psychology that current psychological perspectives are hard-pressed to explain.

References

Baird, D. D., McConnaughey, R., Weinberg, C. R., Musey, P. I., Collins, D. C., Kesner, J. S., et al. (1995). Application of a method for estimating day of ovulation using urinary estrogen and progesterone metabolites. *Epidemiology, 6*, 547–550.

Bateman, A. J. (1948). Intra-sexual selection in *Drosophila. Heredity, 2*, 349–368.

Bröder, A., & Hohmann, N. (2003). Variations in risk taking behavior over the menstrual cycle: An improved replication. *Evolution and Human Behavior, 24*, 391–398.

Brownmiller, S. (1975). *Against our will: Men, women and rape.* New York: Simon & Schuster.

Buss, D. E. (1998). Women at the borders: Rape and nationalism in international law. *Feminist Legal Studies, 6*, 171–203.

Buss, D. M., & Schmitt, D. P. (1993). Sexual strategies theory: An evolutionary perspective on human mating. *Psychological Review, 100*, 204–232.

Chagnon, N. A. (1988). Life histories, blood revenge, and warfare in a tribal population. *Science, 239*, 985–992.

Chang, I. (1997). *The rape of Nanking: The forgotten holocaust of World War II.* New York: Basic Books.

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

Chivers, M. L., Seto, M. C., Lalumière, M. L., Laan, E., & Grimbos, T. (2010). Agreement of genital and subjective measures of sexual arousal in men and women: A meta-analysis. *Archives of Sexual Behavior, 39*, 5–56.

Clark, R. D., & Hatfield, E. (1989). Gender differences in receptivity to sexual offers. *Journal of Psychology and Human Sexuality, 2*, 39–55.

DeCoster, J., Iselin, A. M. R., & Gallucci, M. (2009). A conceptual and empirical examination of justifications for dichotomization. *Psychological Methods, 14*(4), 349–366.

Devine, P. G., & Elliot, A. J. (1995). Are racial stereotypes really fading? The Princeton trilogy revisited. *Personality and Social Psychology Bulletin, 21*, 1139–1150, http://dx.doi.org/10.1177/01461672952111002.

Epp, M. (1997). The memory of violence: Soviet and East European Mennonite refugees and rape in the Second World War. *Journal of Women's History, 9*, 58–87.

Fehring, R., Schneider, M., & Raviele, K. (2006). Variability in the phases of the menstrual cycle. *Journal of Obstetric, Gynecologic, and Neonatal Nursing, 35*, 376–384.

Fessler, D. M., Holbrook, C., & Fleischman, D. S. (2014). Assets at risk: Menstrual cycle variation in the envisioned formidability of a potential sexual assailant reveals a component of threat assessment. *Adaptive Human Behavior & Physiology*, http://dx.doi.org/10.1007/s40750-014-0006-0 (Advance online publication).

Fisman, R., Iyengar, S. S., Kamenica, E., & Simonson, I. (2006). Gender differences in mate selection: Evidence from a speed dating experiment. *Quarterly Journal of Economics, 121*, 673–697.

Fitzsimons, G. J. (2008). Editorial: Death to dichotomizing. *Journal of Consumer Research, 35*(1), 5–8.

Gangestad, S. W., Garver-Apgar, C. E., Simpson, J. A., & Cousins, A. J. (2007). Changes in women's mate preferences across the ovulatory cycle. *Journal of Personality and Social Psychology, 92*, 151–163.

Garver-Apgar, C. E., Gangestad, S. W., & Simpson, R. (2007). Women's perceptions of men's sexual coerciveness change across the menstrual cycle. *Acta Psychologica Sinica, 39*, 536–540.

Garver-Apgar, C. E., Gangestad, S. W., Thornhill, R., Miller, R. D., & Olp, J. J. (2006). Major histocompatibility complex alleles, sexual responsivity, and unfaithfulness in romantic couples. *Psychological Science, 17*, 830–835.

Gelman, A., & Loken, E. (2013). *The garden of forking paths: Why multiple comparisons can be a problem, even when there is no "fishing expedition" or "p-hacking" and the research hypothesis was posited ahead of time.* (Unpublished commentary).

Guéguen, N. (2012). Risk taking and women's menstrual cycle: Near ovulation, women avoid a doubtful man. *Letters on Evolutionary Behavioral Science, 13*, 1–3.

Haselton, M. G., & Gangestad, S. W. (2006). Conditional expression of women's desires and men's mate guarding across the ovulatory cycle. *Hormones and Behavior, 49*, 509–518.

Hayes, A. F. (2013). *Introduction to mediation, moderation, and conditional process analysis.* New York: The Guilford Press.

Keeley, L. (1996). *War before civilization: the myth of the peaceful savage.* New York, NY: Oxford University Press.

Kurzban, R., Tooby, J., & Cosmides, L. (2001). Can race be erased? Coalitional computation and social categorization. *Proceedings of the National Academy of Sciences, 98*, 15387–15392.

Lalumière, M. L., Harris, G. T., Quinsey, V. L., & Rice, M. E. (2005). *The causes of rape: Understanding individual differences in the male propensity for sexual aggression.* Washington: American Psychological Association.

Larson, C. M., Haselton, M. G., Gildersleeve, K. A., & Pillsworth, E. G. (2013). Changes in women's feelings about their romantic relationships across the ovulatory cycle. *Hormones and Behavior, 63*, 128–135.

Larson, C. M., Pillsworth, E. G., & Haselton, M. G. (2012). Ovulatory shifts in women's attractions to primary partners and other men: Further evidence of the importance

of primary partner sexual attractiveness. *PloS One, 7*(10), e44456, http://dx.doi.org/10.1371/journal.pone.0044456.

Lawson, J. E. (1989). 'She's a pretty woman…for a gook': The misogyny of the Vietnam War. *Journal of American Culture, 12*, 55–65, http://dx.doi.org/10.1111/j.1542-734X.1989.1203_55.x.

MacCallum, R. C., Zhang, S., Preacher, K. J., & Rucker, D. D. (2002). On the practice of dichotomization of quantitative variables. *Psychological Methods, 7*(1), 19–40.

McDonald, M. M., Asher, B. D., Kerr, N., & Navarrete, C. D. (2011). Fertility and intergroup bias in racial and minimal group contexts: Evidence for shared architecture. *Psychological Science, 22*(7), 860–865, http://dx.doi.org/10.1177/0956797611410985.

Mezey, G. (1994). Rape in war. *Journal of Forensic Psychiatry, 5*, 583–596.

Navarrete, C. D., & Fessler, D. M. (2006). Disease avoidance and ethnocentrism: The effects of disease vulnerability and disgust sensitivity on intergroup attitudes. *Evolution and Human Behavior, 27*, 270–282.

Navarrete, C. D., Fessler, D. M. T., Fleischman, D. S., & Geyer, J. (2009). Race bias tracks conception risk across the menstrual cycle. *Psychological Science, 20*(6), 661–665.

Navarrete, C. D., McDonald, M. M., Molina, L. E., & Sidanius, J. (2010). Prejudice at the nexus of race and gender: An out-group male target hypothesis. *Journal of Personality and Social Psychology, 98*, 933–945, http://dx.doi.org/10.1037/a0017931.

Navarrete, C. D., & Tybur, J. (2013). The psychology of intergroup prejudice from an adaptationist perspective. In C. Stangor, & C. Crandall (Eds.), *Stereotyping and Prejudice, Frontiers in Social Psychology Book Series* NY: Psychology Press.

Neuberg, S. L., Kenrick, D. T., & Schaller, M. (2011). Human threat management systems: Self-protection and disease avoidance. *Neuroscience & Biobehavioral Reviews, 35*(4), 1042–1051, http://dx.doi.org/10.1016/j.neubiorev.2010.08.011.

Niarchos, C. N. (1995). Women, war, and rape: Challenges facing the International Tribunal for the former Yugoslavia. *Human Rights Quarterly, 17*, 649–690.

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

Pietraszewski, D., Cosmides, L., & Tooby, J. (2014). The Content of our cooperation, not the color of our skin: An alliance detection system regulates categorization by coalition and race, but not sex. *PloS One, 9*(2), e88534, http://dx.doi.org/10.1371/journal.pone.0088534.

Pinker, S. (2011). *The better angles of our nature.* New York: Viking.

Roberts, S. C., & Little, A. C. (2008). Good genes, complementary genes and human mate preferences. *Genetica, 132*, 309–321.

Roland, C. G. (1997). Massacre and rape in Hong Kong: Two case studies involving medical personnel and patients. *Journal of Contemporary History, 32*, 43–61.

Rosenman, S. (2000). The spawning grounds of the Japanese rapists of Nanking. *Journal of Psychohistory, 28*, 2–23.

Salvatore, J. F. (2012). *Strangers with benefits: Ovulation and attraction to outgroup men.* Master's thesis, University of Tennessee. http://www.trace.tennessee.edu/utk_gradthes/1201.

Sanday, P. R. (1981). *Female power and male dominance: On the origins of sexual inequality.* New York: Cambridge University Press.

Seifert, R. (1996). The second front: The logic of sexual violence in wars. *Women's Studies International Forum, 19*, 35–43.

Senn, C. Y., & Dzinas, K. (1996). Measuring fear of rape: A new scale. *Canadian Journal of Behavioural Science, 28*, 141–148.

Sidanius, J., & Pratto, F. (1999). *Social dominance: An intergroup theory of social hierarchy and oppression.* New York: Cambridge University Press.

Simmons, J. P., Nelson, L. D., & Simonsohn, U. (2012). A 21 word solution. *Society for Personality and Social Psychology Dialogue Newsletter.*

Smuts, B. (1996). Male aggression against women: An evolutionary perspective. In D. M. Buss, & N. Malamuth (Eds.), *Sex, power, conflict: Evolutionary and feminist perspectives* (pp. 231–268). New York: Oxford University Press.

Sprecher, S., Sullivan, Q., & Hatfield, E. (1994). Mate selection preferences: Gender differences examined in a national sample. *Journal of Personality and Social Psychology, 66*, 1074–1080.

Stringer, C., & McKie, R. (1997). *African exodus: the origins of modern humanity.* London, UK: Cape.

Tajfel, H. (1974). Social identity and intergroup behaviour. *Social Science Information, 13*(2), 65–93, http://dx.doi.org/10.1177/053901847401300204.

Tajfel, H., Billig, M. G., Bundy, R. P., & Flament, C. (1971). Social categorization and intergroup behavior. *European Journal of Social Psychology, 1*, 149–178.

Thornhill, R., & Palmer, C. (2000). *A natural history of rape: Biological bases of sexual coercion.* Cambridge, MA: MIT Press.

Trivers, R. L. (1972). Parental investment and sexual selection. In B. Campbell (Ed.), *Sexual selection and the descent of man* (pp. 136–179). Chicago, IL: Aldine-Atherton.

Ullman, S. E., & Knight, R. (1991). A multivariate model for predicting rape and physical injury outcomes during sexual assaults. *Journal of Consulting and Clinical Psychology, 59*(5), 724–731.

Van den Berghe, P. L. (1978). Race and ethnicity: A sociobiological perspective. *Ethnic and Racial Studies, 1*, 401–411.

Wedekind, C., Seebeck, T., Bettens, F., & Paepke, A. J. (1995). MHC dependent mate preferences in humans. *Proceedings of the Royal Society B: Biological Sciences, 260*, 245–249.

Wideman, L., Montgomery, M. M., Levine, B. J., Beynnon, B. D., & Shultz, S. J. (2013). Accuracy of calendar-based methods for assigning menstrual cycle phase in women. *Sports Health: A Multidisciplinary Approach, 5*, 143–149.

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*(4), 211–215, http://dx.doi.org/10.1016/S0010-7824(01)00191-3.

Wilcox, A. J., Weinberg, C. R., & Baird, D. D. (1995). Timing of sexual intercourse in relation to ovulation: Effects on the probability of conception, survival of the pregnancy, and sex of the baby. *The New England Journal of Medicine, 333*(23), 1517–1521.