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# Cue-based estimates of reproductive value explain women's body attractiveness

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ABSTRACT

Women's body attractiveness is influenced by specific anthropometric cues, including body mass index (BMI), waist-to-hip ratio (WHR), waist-to-stature ratio (WSR), and shoulder-to-waist ratio (SWR). Despite the existence of multiple functional hypotheses to explain these preferences, it remains unclear which cue-based inferences are most influential in regulating evaluations of women's body attractiveness. We argue that (i) the common link to the morphological cues that influence women's body attractiveness is that they all reliably indicate high reproductive value (as defined by youth and low parity); and (ii) ancestrally, selection pressures related to tracking between-women differences in reproductive value would have been among the strongest acting on adaptations for body evaluation. An empirical study then tested the resulting prediction that cue-based estimates of reproductive value function as powerful regulators of women's body attractiveness judgments. Subjects viewed standardized photos of women in swimsuits (with heads obscured), and were assigned to either estimate components of their reproductive value (age or number of offspring) or rate their attractiveness. Structural equation modeling revealed that a latent variable capturing estimated reproductive value was almost perfectly correlated with a latent variable capturing body attractiveness. Moreover, unique associations of women's BMI, WHR, and WSR with their body attractiveness were entirely mediated via estimated reproductive value. These findings provide strong support for the longstanding hypothesis that women's body attractiveness is primarily explained by cue-based estimates of reproductive value – expected future utility as a vehicle of offspring production.


## 1. Introduction

Adaptationist approaches to explaining human physical attractiveness posit the existence of specialized evaluative mechanisms designed to produce attraction to cues that ancestrally predicted fitness-related properties of potential partners (Buss, 2012; Gangestad & Scheyd, 2005; Sugiyama, 2005, 2016). Some of the most robust and well-known findings in this literature pertain to the anthropometric features that influence the attractiveness of women's (non-facial) bodies, which include low waist-to-hip ratio (WHR; Singh, 1993, Singh & Young, 1995; Furnham, Moutafi, & Baguma, 2002; Furnham, Mistry, & McClelland, 2004; Furnham, Petrides, & Constantinides, 2005), low waist-to-stature ratio (WSR; Lassek & Gaulin, 2016), low body mass index (BMI; Singh & Young, 1995; Tovee, Maisey, Emery, & Cornelissen, 1999; Wang, Djafarian, Egedigwe, et al., 2015), and high shoulder-to-waist ratio (SWR; Grillot, Simmons, Lukaszewski, & Roney, 2014). Although the exact preferred values of these cues vary across societies in relation to local ranges of variation (Sugiyama, 2004; Tovee, Swami, Furnham, & Mangalparsad, 2006) and socioecological conditions such as resource scarcity (Hill, DelPriore, Rodeheffer, & Butterfield, 2014; Marlowe & Westman, 2001), their relevance within populations is cross-culturally consistent (Furnham et al., 2002; Marlowe, Apicella, & Reed, 2005; Mo et al., 2013; Sugiyama, 2005, 2016).

Theorists have hypothesized that bodily cues such as thinness and small relative waist size are interpreted by partner choice mechanisms as indicators of fecundity (Grillot et al., 2014; Confer, Perilloux, & Buss, 2010), fertility (Furnham et al., 2004), youthfulness (Furnham et al., 2004; Singh, 1993; Singh & Young, 1995; Wang et al., 2015), maternal investment behavior (Furnham et al., 2004), energy balance (Gangestad & Scheyd, 2005), or possession of specialized gluteofemoral fat stores important for offspring neurodevelopment (Lassek & Gaulin, 2008). Although there is evidence consistent with most of these non-mutually exclusive hypotheses, there is currently no consensus regarding which cue-based inferences – and therefore, which functional imperatives – are most influential in regulating body attractiveness judgments.

A common feature of the cues tied to women's body attractiveness is that they all covary with female reproductive value, i.e. the maximum

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number of offspring a woman is actuarially expected to produce moving forward from a given point in time (Fisher, 1930; cf. Buss, 2012; Symons, 1979). Among humans, reproductive value is primarily determined by age and parity, such that post-pubertal women who are young and nulliparous have greater reproductive value than older women with higher parity (Buss & Schmitt, 1993; Kenrick & Keefe, 1992; Symons, 1979). Waist size increases with both age and parity as a function of changes in abdominal fat deposition, which directly increases WHR and WSR (Lassek & Gaulin, 2006). WHR is further increased by parity-related depletion of specialized gluteofemoral deposits that are employed to build neural tissue in offspring (Lassek & Gaulin, 2006). These specific modulations of fat distribution occur in coordination with other developmental changes in metabolism (e.g., decreased resting metabolic rate; Hunter, Weinsier, Gower, & Wetzstein, 2001) that tend to produce positive associations of women's age and parity with overall fatness and body size, at least in well-nourished sedentary populations (Deurenberg, Westrate, & Seidell, 1991; Gallagher et al., 1996; Kim, Stein, & Martorell, 2007; Lassek & Gaulin, 2006). In sum, small relative waist size and low BMI are both reliable indicators of women's reproductive value as defined by youth and low parity.

The importance of reproductive value as a determinant of women's social attractiveness must be understood within the context of humans' unique life history and socioecology. Since humans last shared a common ancestor with Chimpanzees, our lineage acquired a suite of coevolved life history features – the "human adaptive complex" – that is defined by an extended lifespan, prolonged offspring dependency, a skill intensive foraging niche, and massive intergenerational transfers from parents (and grandparents) to offspring (Kaplan, Hill, Lancaster, & Hurtado, 2000). The functional imperatives created by these life historical changes, in turn, selected for a corresponding shift from promiscuous mating to mating systems that tend to include long-term pair bonds as a prominent feature (Chapais, 2008; Kaplan et al., 2000). Within (relatively) monogamous pair bonds, fathers have high paternity certainty, which incentivizes paternal investment in shared offspring – a long-term project whose efficiency is enhanced greatly by cooperation between parents and the sexual division of labor (Gurven, Winking, Kaplan, von Rueden, & McAllister, 2009; Kaplan et al., 2000). Against this backdrop, women's reproductive value becomes a crucial criterion of overall mate value. This is because a man's commitment to a particular woman and their shared offspring can potentially be rewarded by a monopoly on her entire reproductive career, the maximum output of which then serves as a limiting factor on the couple's in-pair fertility (Buss, 2012; Buss & Schmitt, 1993; Sugiyama, 2005; Symons, 1979). Moreover, all else being equal, younger women are expected to continue living for longer than older women, so a woman's youth also predicts the length of the time period during which she can invest behaviorally in the couple's children and grandchildren.

Over human history, people would have reliably co-existed with post-pubertal women ranging from adolescent nulligravidas (whose entire reproductive careers can be monopolized within long-term relationships) to menopausal grandmothers (whose reproductive value is zero). Tracking between-women differences in reproductive value would therefore have been strategically imperative for potential mates, intrasexual rivals, kin, and various other social actors whose interests depend on knowledge about the local dynamics of relationships, competition, or resource flows (Buss & Schmitt, 1993; Kenrick & Keefe, 1992; Sugiyama, 2005). Holding reproductive value constant, women surely also varied in their current fecundity and behavioral proclivities of maternal investment. However, ovarian hormone concentrations and fecundity have only a subtle relationship with visual cues in the body (e.g., Grillot et al., 2014), and there is no reason to believe that maternal behavioral variation has been robustly associated with body shape or fatness over human history. Moreover, a recent paper combining a systematic review of the literature and new empirical findings has convincingly falsified the hypothesis that the low BMIs and small waists found most attractive in women's bodies indicate good general health, reproductive health, and fertility (Lassek & Gaulin, 2017) – which renders unlikely some of the most frequently referenced functional explanations for the evolution of preferences for low BMI and small waist size. Thus, it seems likely that attractiveness-linked bodily features have been, and continue to be, more reliable cues to women's reproductive value than to other relevant characteristics.

These lines of reasoning suggest that selection pressures pertaining to estimation of women's reproductive value were likely among the strongest acting on human ancestors' mechanisms for body evaluation (Lassek & Gaulin, 2017; Sugiyama, 2005; Symons, 1979). If so, it follows that cue-based estimates of women's reproductive value may be the primary regulators of body attractiveness judgments. Consistent with this, in well-nourished sedentary populations, (i) BMI and related measures (e.g., body fat percentage, waist size) are consistent positive correlates of age and parity in women of reproductive age (Deurenberg et al., 1991; Gallagher et al., 1996; Kim et al., 2007; Lassek & Gaulin, 2006), and (ii) these measures of fatness correspondingly explain the majority of variance in body attractiveness judgments, with WHR and SWR explaining additional unique variance (Bleske-Rechek, Colb, Stern, Quigley, & Nelson, 2014; Grillot et al., 2014; Mo et al., 2013; Smith, Cornelissen, & Tovee, 2007; Wang et al., 2015). Converging evidence indicates that women with low BMI and WHR, respectively, are perceived as being younger (Furnham et al., 2002, 2004, 2005; Wang et al., 2015). However, despite the vastness of this literature, no study of which we are aware has specifically tested the hypothesis that the associations of women's bodily features with attractiveness judgments are mediated by cue-based estimates of reproductive value (as defined by youth and low parity).

### 1.1. The current study

The current study tested this hypothesis using standardized photographs of women wearing swimsuits who had been measured for BMI, WSR, WHR, and SWR. We asked different groups of raters to view the women's bodies sequentially and either (i) guess their age, (ii) guess their parity (number of offspring), or (iii) rate aspects of their body attractiveness. Because all the women in the photos were in actuality nulliparous young adults, the design we employ effectively holds constant unmeasured cues to actual age and parity. It therefore affords a clean test of the prediction that specific morphological cues are attractive primarily because they register as indicating high reproductive value as defined by youth and low parity.

This design also permitted us to address the question of which bodily dimensions explain the most unique variance in women's attractiveness. As described above, it has often been found that BMI explains much more unique variance in women's attractiveness than WHR or SWR (Bleske-Rechek et al., 2014; Grillot et al., 2014; Wang et al., 2015). However, Lassek and Gaulin (2016) recently reported multiple demonstrations of the novel finding that WSR explains more unique variance in attractiveness than either BMI or WHR. This suggests that small waist size drives the associations of BMI, WHR, and SWR with women's body attractiveness judgments. Thus, an auxiliary goal of the present study was to replicate and extend this finding by testing the comparative power of BMI, WSR, WHR, and SWR in predicting both estimated reproductive value and rated body attractiveness.

## 2. Materials and procedures

### 2.1. Female target stimuli

Targets in the photos were 72 young women (mean age = 20.7, range 19–23), all undergraduate students at a residential university in the Midwestern USA. Although the women were not asked about whether they had children, it would be highly unusual in this traditional college population for them to have been mothers at the time of participation. Indeed, national census data indicates that, among women who claim to have completed at least "some college", only 0.5% of those aged 15–19 years old, and 6% of those aged 20–26, have ever given birth (Monte & Ellis, 2014). Consistent with this, internal data provided to us by the residential university from which our sample was drawn (from years 2013 through 2016) consistently shows that 3% of female undergraduates receiving federal student aid have given birth. Thus, it is conservative to assume that only between 0 and 4 of the 72 target women in the sample had ever given birth.

As described more fully elsewhere (Bleske-Rechek et al., 2014), targets wore a standardized swimsuit provided by the researchers, and were photographed from a fixed distance while standing face forward in front of a white background. For the current study, images were cropped to remove each target's head (see Fig. 1). After being photographed, each target woman was measured for height, weight, and the circumference of her waist (at the narrowest point) and hips (at the widest point). Height and weight were employed in the calculation of BMI, whereas waist and hip circumferences were employed to calculate WHR (Bleske-Rechek et al., 2014). Height and waist circumference were employed to calculate WSR (Lassek & Gaulin, 2016). Following a method reported by Grillot et al. (2014), SWR was taken after the fact by measuring dimensions present in the photographs. Specifically, dots were placed at the widest lateral points of the shoulders and the narrowest lateral points of the waist. Lateral distances between dots were then measured using a digital ruler, and SWR was calculated with these values.

### 2.2. Raters and rating tasks

Raters were 304 participants (131 women; 173 men; mean age = 20.68, range 19–26) recruited via Amazon Mechanical Turk, an online research platform in which people completed our survey in exchange for $1 US. Each rater provided their sex and age, before completing a photo rating task. Raters viewed the 72 target photos in a random order, and the survey software program (Qualtrics) randomly assigned each rater to evaluate the targets on one of four traits. Two of these traits tapped components of estimated reproductive value: estimated age (n = 76; 44 men) and estimated number of offspring (n = 69; 38 men). The other two assessed aspects of body attractiveness: rated attractiveness (n = 79; 44 men) and projected offspring quality (n = 80; 47 men).

**Fig. 1.** Example stimuli from the photo rating tasks.

#### 2.2.1. Estimated reproductive value components

- *Estimated age*: Raters were instructed that their task was to guess each woman's age and enter their estimate into a text box as a number. Before doing this, they read a script stating that all women were between the ages of 15–30.
- *Estimated parity*: Raters were instructed that their task was to guess the number of children each woman had given birth to and enter their estimate into a text box as a number. Before doing this, they read a script stating that all women had between 0 and 4 children.

#### 2.2.2. Body attractiveness components

Rated attractiveness and projected offspring quality were each assessed via multiple items, using 1–7 Likert scales anchored by "strongly disagree" and "strongly agree":

- *Rated attractiveness*: "This woman's body is attractive"; "This woman's body is desirable"
- *Projected offspring quality*: "If this woman were to have a child, it would be healthy"; "If this woman were to have a child, it would make friends easily"; "If this woman were to have a child, it would be popular"

Note that rated attractiveness and projected offspring quality were initially conceptualized as qualitatively distinct variables, with the tentative expectation that projected offspring quality would act as another mediator (in competition with estimated reproductive value). However, as reported below, these variables were so highly correlated ($r = 0.97$) that they could not be treated separately. Thus, we treated them as different indicators of rated body attractiveness.

#### 2.2.3. Composite variable calculation

Raters were in high agreement regarding their perceptions of the targets on all estimated and rated items (all $\alpha > 0.89$). Thus, raters' responses were averaged to produce a mean score for each target woman. All variables were very highly correlated for male and female raters ($rs > 0.93$, $ps < 0.0001$), so the mean scores employed for analysis were computed across raters of both sexes. The items within each rated construct (attractiveness and projected offspring quality) were highly inter-correlated ($rs > 0.96$, $ps < 0.0001$), and we combined them into unit-weighted composites for each estimated or rated trait (see Table 1 for descriptive statistics).

## 3. Results

### 3.1. Zero-order correlations

Targets' BMI, WSR, WHR, and SWR were intercorrelated, such that women with lower BMI had smaller waists relative to their stature, hips and shoulders, respectively (Table 2). In addition, these bodily dimensions were each robustly correlated in the expected directions with estimated age, estimated parity, rated attractiveness, and projected offspring quality.

There were large correlations among all components of estimated reproductive value and body attractiveness (Table 2). Estimated age

**Table 1**
Descriptive statistics for all variables.

| | Mean | SD | Range |
|---|---|---|---|
| WSR | 0.51 | 0.06 | 0.37–0.69 |
| BMI | 24.52 | 3.63 | 17.03–37.27 |
| WHR | 0.81 | 0.06 | 0.69–0.93 |
| SWR | 1.49 | 0.20 | 0–1.74 |
| Estimated age | 23.03 | 1.97 | 18.05–27.58 |
| Estimated parity | 1.52 | 0.80 | 0.15–3.27 |
| Rated attractiveness | 3.93 | 1.06 | 2.09–5.66 |
| Projected offspring quality | 4.66 | 0.75 | 3.23–5.74 |

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**Table 2**
Pearson correlations among all variables.

| | 2. | 3. | 4. | 5. | 6. | 7. | 8. |
|---|---|---|---|---|---|---|---|
| 1. WSR (waist/stature) | 0.82*** | 0.81*** | −0.39** | 0.70*** | 0.83*** | −0.78*** | −0.80*** |
| 2. BMI (body mass index) | | 0.48*** | −0.34** | 0.68*** | 0.82*** | −0.74*** | −0.76*** |
| 3. WHR (waist/hips) | | – | −0.25* | 0.50*** | 0.54*** | −0.57*** | −0.54*** |
| 4. SWR (shoulder/waist) | | | – | −0.24* | −0.41*** | 0.40*** | 0.46*** |
| 5. Estimated age | | | | – | 0.83*** | −0.72*** | −0.72*** |
| 6. Estimated parity | | | | | – | −0.88*** | −0.91*** |
| 7. Rated attractiveness | | | | | | – | 0.97*** |
| 8. Projected offspring quality | | | | | | | – |

* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

and parity were positively correlated ($r = 0.83$). In turn, these estimates were negatively correlated with both components of body attractiveness ($rs > -0.71$). The two components of body attractiveness (attractiveness and projected offspring quality) were essentially redundant ($r = 0.97$).

Finally, we tested whether target women's actual age correlated with their anthropometric features or raters' perceptions. Unsurprisingly, given the very restricted range of target women's actual age, this variable exhibited near zero correlations with all measured anthropometric features ($rs < 0.04$, $ps > 0.71$), and with estimated age, estimated parity, rated attractiveness, and projected offspring quality ($rs < 0.05$, $ps > 0.67$). Thus, targets' actual age was excluded from all multivariate analyses reported below.

### 3.2. Regression analyses predicting estimated and rated variables simultaneously from anthropometric features

The zero-order correlations presented above demonstrate that all measured anthropometric features (BMI, WSR, WHR, and SWR) were robustly associated with all estimated and rated variables. However, because these features were moderately-to-highly intercorrelated, it was of interest to determine the collective and unique explanatory power of these anthropometric variables. To this end, we conducted multiple regression analyses wherein the components of estimated reproductive value (age, parity) and body attractiveness (rated attractiveness, projected offspring quality) were each simultaneously regressed onto the anthropometric predictors.

In initial regression models including all four anthropometric predictors, the collinearity diagnostics indicated that parameter estimates for WHR and WSR were too highly correlated to be included in the same regression equation (variance inflation factors > 7). As such, we proceeded to compute parallel models for all dependent variables that included either WSR (Model A) or WHR (Model B) as a predictor (along with BMI and SWR). These analyses are presented in Table 3.

Across models A and B (Table 3), measured bodily features collectively explained the majority of the total variance in estimated age (model A: 53%; model B: 51%), estimated parity (76%; 72%), rated attractiveness (67%; 65%), and projected offspring quality (72%; 69%).

The standardized regression coefficients ($\beta s$) for specific bodily features indicate that WSR was a stronger unique predictor of all criterion variables than BMI or SWR in model A. In model B, however, BMI was the strongest unique predictor of all criterion variables. These patterns support the deduction that WSR was the strongest unique predictor of all estimated and rated variables.

### 3.3. Structural equation modeling

We next employed structural equations to model the relationships among latent variables defined by multiple indicators (Fig. 2). The first latent variable, estimated reproductive value, captured the variance shared by estimated age and parity. The second latent variable, body attractiveness, captured the variance shared by rated attractiveness and projected offspring quality. In order to test the direct and indirect effects of morphological cues on raters' perceptions, we specified models wherein measured anthropometric features have potential indirect effects on body attractiveness via estimated reproductive value (Fig. 2). As in the multiple regression analyses, model A included WSR, BMI, and SWR as predictors (Fig. 2A), whereas model B included WHR, BMI and SWR as predictors (Fig. 2B). These models were each tested in AMOS (v21.0) using maximum likelihood estimation (Preacher & Hayes, 2008), such that direct and indirect effects were estimated via bias-corrected bootstrapping (2000 bootstrap iterations) along with 95% confidence intervals (CIs).

The models depicted in Fig. 2 both provided an excellent fit to the data; the model fit statistics were in fact identical across models A and B [Model A: $CFI = 0.98$, $\chi^2\ (10) = 2.14$, $p = 0.02$; Model B: $CFI = 0.98$, $\chi^2\ (10) = 2.14$, $p = 0.02$]. In model A, WSR and BMI (though not SWR) each had independent negative direct effects on the latent variable for estimated reproductive value, which in turn had a large positive direct effect on the latent variable for body attractiveness (Fig. 2A; Table 4A). In addition, WSR and BMI both had indirect effects on body attractiveness that were mediated via estimated reproductive value (Table 4A). Finally, SWR had a small direct effect on body attractiveness that was not mediated via estimated reproductive value (Fig. 2A; Table 4A). (Note that direct effects of WSR and BMI on body attractiveness were also tested, but were non-significant and therefore excluded

**Table 3**
Multiple regression models predicting estimated and rated variables simultaneously from anthropometric features.

| | | Estimated age | | Estimated parity | | Rated attractiveness | | Projected offspring quality | |
|---|---|---|---|---|---|---|---|---|---|
| | | $\beta$ | $P$ | $\beta$ | $P$ | $\beta$ | $P$ | $\beta$ | $P$ |
| Model A | BMI | 0.330 | 0.032 | 0.380 | 0.001 | −0.214 | 0.099 | −0.212 | 0.077 |
| | WSR | 0.452 | 0.005 | 0.443 | 0.000 | −0.437 | 0.001 | −0.418 | 0.001 |
| | SWR | −0.033 | 0.785 | −0.111 | 0.203 | 0.242 | 0.019 | 0.299 | 0.002 |
| | Model $r^2$ | 0.530 | | 0.756 | | 0.666 | | 0.715 | |
| Model B | BMI | 0.563 | 0.000 | 0.622 | 0.000 | −0.430 | 0.000 | −0.436 | 0.000 |
| | WHR | 0.222 | 0.029 | 0.161 | 0.036 | −0.234 | 0.007 | −0.167 | 0.038 |
| | SWR | 0.022 | 0.854 | −0.179 | 0.050 | 0.290 | 0.004 | 0.360 | 0.000 |
| | Model $r^2$ | 0.505 | | 0.717 | | 0.651 | | 0.685 | |

*Note.* The only difference between models A and B is whether WSR or WHR is included as a predictor.

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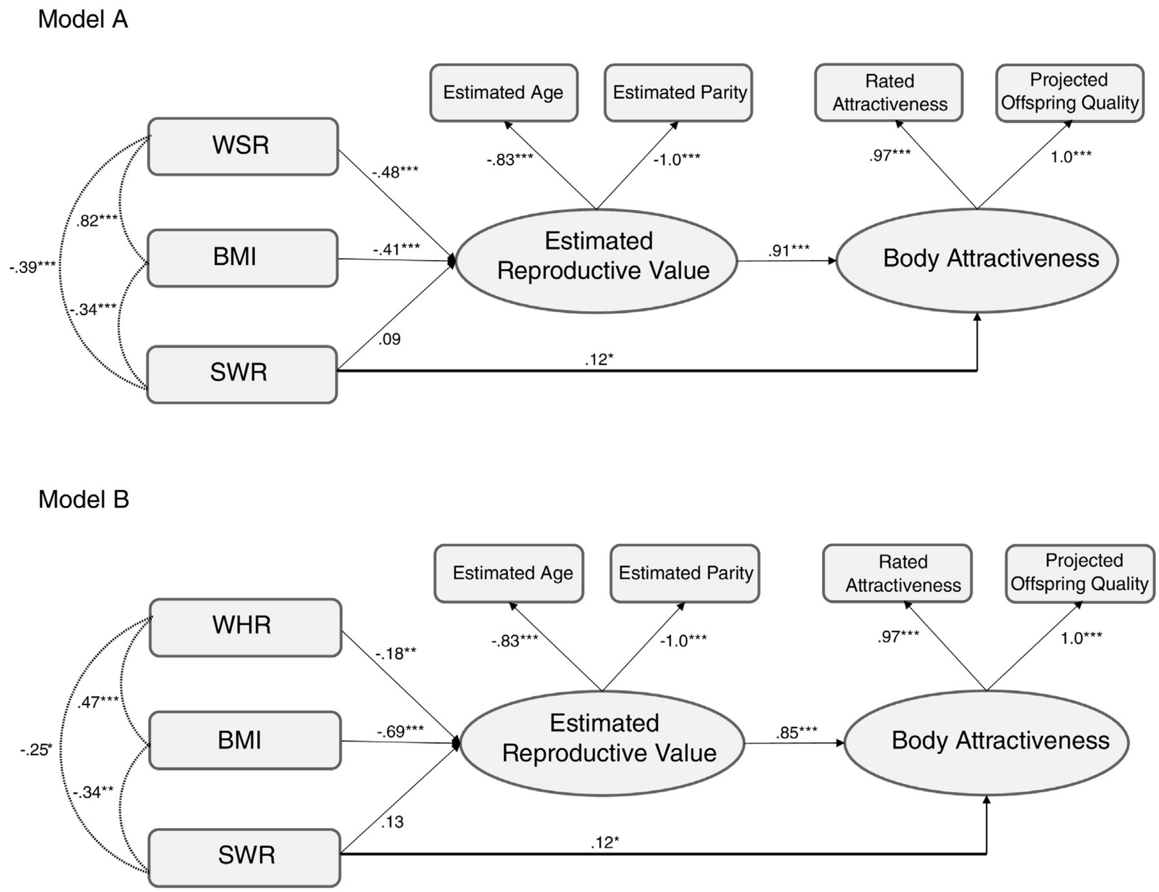


**Fig. 2.** Path diagrams modeling associations among all observed (rectangular) and latent (oval) variables. Path coefficients and correlations are standardized values (see Table 4 for complete model statistics). *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

**Table 4**
Decomposition of standardized direct and indirect effect size estimates.

| | Effect size | Standard error | 95% CI |
|---|---|---|---|
| Model A | | | |
| Direct effects | | | |
| *Reproductive value* ➔ Estimated age | −0.83 | 0.04 | −0.88, −0.74 |
| *Reproductive value* ➔ Estimated parity | −1.0 | 0.02 | −1.0, −0.96 |
| *Body attractiveness* ➔ Rated attractiveness | 0.97 | 0.01 | 0.93, 0.99 |
| *Body attractiveness* ➔ Offspring quality | 1.0 | 0.01 | 0.99, 1.0 |
| *Reproductive value* ➔ *Body attractiveness* | 0.91 | 0.04 | 0.78, 0.97 |
| WSR ➔ *Reproductive value* | −0.48 | 0.10 | −0.66, −0.26 |
| BMI ➔ *Reproductive value* | −0.41 | 0.10 | −0.60, −0.24 |
| SWR ➔ *Reproductive value* | 0.09 | 0.06 | −0.19, 0.06 |
| SWR ➔ *Body attractiveness* | 0.12 | 0.06 | 0.06, 0.24 |
| Indirect effects | | | |
| WSR ➔ *Body attractiveness* | −0.39 | 0.10 | −0.60, −0.22 |
| BMI ➔ *Body attractiveness* | −0.35 | 0.08 | −0.54, −0.22 |
| SWR ➔ *Body attractiveness* | 0.07 | 0.04 | −0.04, 0.15 |
| Model B | | | |
| Direct effects | | | |
| *Reproductive value* ➔ Estimated age | −0.83 | 0.04 | −0.88, −0.74 |
| *Reproductive value* ➔ Estimated parity | −1.0 | 0.02 | −1.0, −0.96 |
| *Body attractiveness* ➔ Rated attractiveness | 0.97 | 0.01 | 0.93, 0.99 |
| *Body attractiveness* ➔ Offspring quality | 1.0 | 0.01 | 0.99, 1.0 |
| *Reproductive value* ➔ *Body attractiveness* | 0.85 | 0.07 | 0.70, 0.95 |
| WHR ➔ *Reproductive value* | −0.18 | 0.07 | −0.32, −0.04 |
| BMI ➔ *Reproductive value* | −0.69 | 0.07 | −0.80, −0.56 |
| SWR ➔ *Reproductive value* | 0.13 | 0.06 | −0.01, 0.23 |
| SWR ➔ *Body attractiveness* | 0.12 | 0.06 | 0.01, 0.25 |
| Indirect effects | | | |
| WHR ➔ *Body attractiveness* | −0.15 | 0.06 | −0.72, −0.44 |
| BMI ➔ *Body attractiveness* | −0.58 | 0.08 | −0.50, −0.06 |
| SWR ➔ *Body attractiveness* | 0.10 | 0.05 | 0.00, 0.19 |

*Note.* These estimates are for the models presented in Fig. 2. The only difference between models A and B is whether WSR or WHR is included as a predictor. Latent variables are in italics.

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from the final model.) In Model B, which replaced WSR with WHR, the patterns of effects were nearly identical (Fig. 2B; Table 4B).

The only substantive difference between models A and B pertained to the effect sizes of WSR and WHR, respectively, relative to the effect sizes for BMI. In Model A, WSR had somewhat larger effects on estimated reproductive value and body attractiveness than BMI (Table 4A). Conversely, in Model B, WHR had much smaller effects on estimated reproductive value and body attractiveness than BMI (Table 4B). Thus, it appears that WSR is the strongest unique predictor among the measured morphological features – which is reinforced by the fact that WSR was also the strongest predictor of all estimated and rated variables in the zero-order correlations (Table 2) and multiple regression models (Table 3) described above.

## 4. Discussion

Findings demonstrated that associations of women's specific bodily features (BMI, WHR, WSR) with judgments of their body attractiveness were statistically mediated by estimates of reproductive value as defined by apparent youth and low parity. The associations among these variables were very large: estimated reproductive value explained was nearly perfectly correlated with women's body attractiveness, and specific bodily features collectively explained over two-thirds of the variance in each of these latent variables. As such, the findings are consistent with the hypothesis that the psychological definition of women's body attractiveness primarily centers on tracking specific physical cues that indicate youth and low parity.

The massive association of cue-based reproductive value estimates with body attractiveness judgments is particularly striking given that (i) completely different groups of subjects evaluated the body photos along each estimated or rated trait, and (ii) the tasks employed to assess estimated reproductive value did not prompt raters to employ any particular criteria in making their guesses about targets' age or number of offspring. Although it would be of interest to replicate our findings using targets who actually vary substantially in age and parity, these features of the current study's design provide evidence that specific bodily features are attractive because they are employed by evaluative mechanisms as valid cues to reproductive value.

Another novel – and telling – finding of the current study was the extremely strong relationship between the two observed indicators of latent body attractiveness: rated body attractiveness and projected offspring quality. Despite being completed by non-overlapping groups of subjects, these variables were so highly correlated as to be statistically indistinguishable. The idea that women's bodies are evaluated on the basis of their apparent utility as vehicles of successful offspring production within long-term relationships is among the oldest in the literature (e.g., Symons, 1979), but we know of no extant empirical finding that so clearly underscores it as this one.

Our results also replicate and extend Lassek and Gaulin's (2016) recent finding that WSR is a stronger (zero-order and unique) predictor of women's body attractiveness than either WHR or BMI. As they argue, this suggests that body evaluation mechanisms may place primary importance on small waist circumference, and that this cue may drive associations of women's attractiveness with other features, such as WHR and (in part) BMI. Moreover, consistent with our broader arguments, the results of the current study suggest that the attractiveness of a small waist is adaptive due to its indication of women's reproductive value. Whether the valuation of a small waist is functional for other reasons than its indication of reproductive value is an open question for future research.

SWR did not explain unique variance in estimated reproductive value, but did have an independent direct effect on body attractiveness. This is consistent with Grillot et al.'s (2014) finding regarding the attractiveness of high SWR, but the functional significance of this finding is currently unclear. Perhaps, rather than indicating high reproductive value, having wide shoulders relative to the waist corresponds with physical fitness and upper-body muscle tone.

### 4.1. Integration with other morphological cues?

In the natural social world, partner choice mechanisms evaluate others holistically by integrating multiple observable cues, some of which were absent in the current stimuli. For example, Lewis, Russell, Al-Shawaf, and Buss (2015) have recently characterized women's "lumbar curvature" (the angle of the spine in the lumbar region as viewed in profile) as an evolved standard of body attractiveness – a hypothesis based in part on the idea that a particular lumbar curvature is biomechanically optimal for balancing the demands of pregnancy and locomotion. Additionally, the voluminous body of research on evolved standards of facial attractiveness suggests that facial cues are likely employed as indicators of numerous functionally relevant parameters, including age (e.g., Confer et al., 2010; Furnham et al., 2004; Gangestad & Scheyd, 2005; Little, Jones, & DeBruine, 2011). When facial and body attractiveness judgments are made in isolation, they each explain unique variance in overall attractiveness (Bleske-Rechek et al., 2014). However, the relative influence of facial and bodily cues on reproductive value estimates is currently unclear. The extent to which lumbar curvature, specific facial features, or other cues, influence women's attractiveness because they indicate reproductive value (in addition to other parameters, e.g., genetic quality) is an important question for future research.

### 4.2. Implications for the design logic of evaluative adaptations

Perhaps the primary limitation of the current study is that it solely employed subjects from a modern industrialized society – which is relevant given documented variation across human populations in the correlations of women's bodily features with age, parity, or attractiveness (Kim et al., 2007; Marlowe et al., 2005). Cross-cultural tests of the findings presented herein could be crucial for elucidating the specific design features of mechanisms regulating attraction to cues in women's bodies. Of particular interest is the question of whether preferences for bodily cues (e.g., low WSR, WHR, or BMI) are substantially 'pre-programmed' versus developmentally plastic. Pre-programmed preferences would be theoretically expected if specific morphological features were very reliably correlated with women's reproductive value over human evolutionary history, which would have likely selected for mechanisms designed to produce attraction to those indicative features.

It need not be the case, however, that mechanisms for body evaluation contain pre-programmed preferences for specific body shapes and sizes. It could also have been the case that the correlations of women's body shapes with reproductive value varied significantly across ancestral human populations. If so, selection could have favored developmentally plastic adaptations that track the observable bodily cues that are locally predictive of women's reproductive value (and other functionally important parameters), and contingently produce attraction to those features (Marlowe & Westman, 2001; Scott, Clark, Josephson, Boyette, et al., 2014; Sugiyama, 2004; Tovee et al., 2006). The current findings are consistent with the developmental plasticity account insofar as (i) fatness and BMI are particularly strong correlates of women's age and parity in modern sedentary populations such as the USA, and, correspondingly, (ii) our data demonstrated that waist size and BMI were by far the strongest anthropometric predictors of reproductive value estimates and body attractiveness judgments. By hypothesis, if there exist populations wherein waist size and/or fatness are positively (rather than negatively) correlated with reproductive value (e.g., because of age-related maternal depletion effects in societies wherein older women do much physical work), a developmentally plastic adaptation would be expected to produce a preference for fatter women (Lassek & Gaulin, 2017).

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Of course, these are not mutually exclusive possibilities: mechanisms for body evaluation could contain some pre-programmed biases (priors), which are then subject to developmental (re)calibration based on the local correlation of body cues with reproductive value. Likewise, it might be the case that preferences for certain bodily features are substantially pre-programmed (e.g., for small relative waist size) whereas others are calibrated based on cues sampled in development (e.g., for some optimal level of fatness). Either way, the arguments advanced above suggest that women's body attractiveness may universally be defined primarily by bodily features that are ancestrally and/or locally predictive of reproductive value. We look forward to cross-cultural research that can address such crucial theoretical distinctions regarding mechanism design.

### 4.3. Concluding remarks

To our knowledge, this was the first empirical test of the hypothesis that specific bodily features influence women's body attractiveness because they are perceived as indicating high reproductive value. The results provide strong support for this longstanding hypothesis, and further suggest that cue-based estimates of reproductive value are very powerful regulators of women's body attractiveness judgments – to the point that these internal variables are nearly psychologically isomorphic. Especially when viewed in light of recent evidence falsifying the popular idea that attractive female bodily features indicate good health and high fertility (Lassek & Gaulin, 2017), our findings suggest that women's body attractiveness is defined primarily by cues that indicate high reproductive value as defined by youth and low parity.

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