Darwinian Happiness: Subjective Well-Being as a Signal of Evolutionary Fitness

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Abstract

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The general premise behind evolutionary theory as it pertains to emotion and cognition is that, over the course of human evolutionary history, challenges often occurred for which some emotional or cognitive responses were more fitness-enhancing than others. While the adaptive values of negative affect (NA) and, to a somewhat lesser extent, positive affect (PA) have been investigated previously, similar work with regard to subjective-well being (SWB) has been rare. This study used structural equation modeling to explore a signal hypothesis of subjective well-being, in which the component of SWB known as satisfaction with life (SWL) is hypothesized to play an important role in indicating to an individual how well his or her execution of adaptive traits is maximizing the individual's evolutionary fitness. Consequently, in samples of male (n = 107) and female (n = 106) college students, SWL, PA, and NA were regressed onto eight latent constructs purportedly indicative of evolutionary fitness: physical health, attractiveness, body-mass index, short-term mating behaviors, social instrumentality, material well-being, general intelligence (g), and fluctuating asymmetry. Relationships among the latent variables, as well as between the two groups, suggested that the use of these eight prospective measures in modeling fitness was tenable and that these constructs were equivalent between genders. In the structural models, markedly different patterns emerged for the two groups. Among males, social instrumentality was shown to be the nearly exclusive predictor of SWL, PA, and NA; among females, a much broader array of variables appeared to be relevant in predicting the components of subjective well-being. These findings suggest that, while gaining mastery over one's social environment may be of principal importance in maximizing the SWB of young males, SWB of young females may be significantly influenced by additional factors such as high attractiveness, avoidance of short-term mating strategies, and access to material resources, despite several seemingly paradoxical relationships among these factors. Overall, these findings offered qualified support to the signaling hypothesis, while a discussion of study limitations elucidated several reasons why findings from the model for each gender may have offered differential support for the hypothesis.

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Dissertations can be onerous tasks. Although I certainly felt this on occasion, the healthiness of our graduate program truly minimized such feelings. I credit Drs. Ray Higgins and Sarah Kirk in fostering such an environment. It is difficult to imagine what my graduate school experience would have been like without them.

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Introduction and Background

In their *Handbook of Positive Psychology*, Snyder and Lopez (2002) introduce positive psychology as a new and exciting paradigm of human behavior from a viewpoint emphasizing human strengths. Admittedly, the book performs well in integrating a multitude of theoretical perspectives, ranging from the strongly cognitive to the biological to the interpersonal, demonstrating how many different orientations may be employed to investigate positive psychology constructs.

One exception to this smorgasbord of theoretical orientations concerns the dearth of evolutionary explanations offered for positive psychological phenomena. Seligman (2002b) suggests one might conclude from this that human strengths are not naturally selected for—i.e., they do not come about from adaptation to environmental demands. From his perspective, human strengths may not result from uniform, natural selective pressures occurring across the species, but may instead represent individual differences reflecting an individual's unique needs—not altogether an unreasonable explanation, given evolutionary psychology's predominant focus on shared, species-typical characteristics (P. H. Hawley, personal communication, September 24, 2007). Seligman also cautions, however, that the apparent lack of evolutionary explanations might also be explained by mere oversight: Because people take for granted that positive psychological processes exist, their attention might be directed more towards the proximal mechanisms by which the strengths are manifested and developed, rather than towards the ultimate mechanisms serving as their underlying causes.

Neither of these competing explanations has been adequately investigated—nor will an investigation into the source of this omission be the focus of this paper. Instead, I suggest that several converging lines of evidence support the notion that the evolutionary perspective can offer a useful conceptual framework for investigating positive psychological events. Consequently, the aim of the present study will be to investigate a single explanation exploring the potential adaptive function of one positive psychology construct—subjective well-being—and contrasting the evidence in favor of this explanation against a similar explanation that has been posited for positive and negative affect. Additionally, by applying evolutionary theory to positive psychology, I hope to promote a level of consilient integration with other scientific disciplines (Wilson, 1998) that demonstrates positive psychology's consistency with, rather than uniqueness from, other branches of scientific inquiry.

Levels of Happiness—Positive Affect Versus Subjective Well-Being

According to Martin Seligman (2002a), "*happiness and well-being are the desired outcomes of Positive Psychology* [emphasis in the original]" (p. 261). It is unclear, however, how he is defining these central constructs. Daniel Nettle (2005) provides a useful set of definitions in his treatise *Happiness: The Science Behind Your Smile*. Nettle models happiness as existing upon three distinct levels (aptly named "level one," "level two," and "level three"). The first of these is happiness in a strictly hedonic, emotional sense—the chief manifestations of which might be called "joy" or "pleasure." As such, level-one happiness quickly responds to real-time events, with minimal cognitive contribution. Level-two happiness, in contrast, *does* require cognitive appraisal of one's affective condition, perhaps involving evaluation of one's accomplishments or relativistic judgments. These judgments might include social comparisons or consideration of one's performance in multiple life areas—with individual differences occurring with regard to which areas are assessed or what emphasis is given to each area. This form of happiness is what researchers more commonly refer to as "subjective well-being" (Diener, 2000), although it would be more accurate to refer to level-two happiness specifically as the "life satisfaction" component of SWB. Nettle also identifies a third form of happiness, a collection of life strengths and accomplishments. Traditionally, this level has been called "eudaimonia," although positive psychologists often use the less technical phrase "the good life," presumably to make the idea more accessible.

Distinguishing among the multiple levels has major implications for understanding happiness from an evolutionary perspective. The general premise behind the evolutionary theory of emotion and cognition is that, over the course of human evolutionary history, challenges often occurred for which some emotional or cognitive responses were more fitness-enhancing than others. Individuals whose cognitive-emotional processes were more suited for adjusting to these environmental parameters experienced differential reproductive success over their conspecifics, thereby increasing the frequency of these traits in subsequent generations (Nesse, 1990; Tooby & Cosmides, 1990).

Interestingly, the task of ascribing natural selection to emotion has already been performed (and widely accepted) for negative emotions. The basic principle here is that sadness (as well as other negative mood states) promotes avoidance, withdrawal, or repair behavior in the face of threat or loss (e.g., Cacioppo et al., 2006; Seligman, 2002a). Ways in which experiencing negative emotion could lead to an increase in fitness abound, the following being only the proverbial tip of the iceberg: (a) avoiding further mistakes and losses; (b) avoiding situations or actions associated with loss; (c) gaining time for reflection about what caused the negative emotion, in order to design corrective approaches in the future; (d) pulling for help from others (especially kin); (e) warning kin of potential threats; and (f) submission in order to evade further attack or to repair compromised social relationships (Nesse, 1998). Additionally, many of the evolutionary obstacles to achieving happiness have also been documented (Buss, 2000). With these tasks having already been performed, it then becomes important to theorize about the ways in which natural selection has shaped the human brain's acquisition of level-one and level-two happiness devices.

Evidence of Selection for Level-One Happiness

Functions of positive emotions. In the case of level-one happiness, that natural selection has played a significant role is posited via traditional approach-avoidance models. Just as natural selection has organized the human brain to generate aversive, negative emotions in order to deter continuation of a particular behavior (Sloman, Gilbert, & Hasey, 2003), it also has provided humans with a breadth of positive emotions whose function is to stimulate behaviors that will aid in the exploration of new environments (Bergsma, 2000; Seligman, 2002a). When serving in this capacity, such emotions are said to contribute what one might call "approach" or "continue" signals (Fredrickson, 2002). Desire and pleasure, for example, might reflect the existence of a physical goal and induce behavioral responses aimed toward meeting that goal. Hope and happiness, in contrast, might reflect social goals and induce commensurate behaviors (Nesse, 1998).

Evidence for this functional explanation first comes from the *positivity offset* phenomenon (Cacioppo & Gardner, 1999), which describes an individual's propensity to experience mild positive affect in neutral environments—those in which there are no reinforcers or punishers. This phenomenon occurs in spite of the negativity bias of human emotions—that is to say, negative or threat situations tend to prompt more intense behavioral and emotional responses than positive circumstances do (Baumeister, Bratslavsky, Finkenauer, & Vohs, 2001). The general premise behind this traditional model of affect is that the experience of negative emotion is most useful when it is of limited duration and of sufficient intensity to encourage the organism to alter its behavior. The same cannot be said for positive emotions—here, high intensity and duration would contribute to passivity or a continuation of potentially harmful behavior in single-minded pursuit of a goal, isolated from its environmental contexts (Bergsma, 2000), with such context-insensitivity reflecting a pathological process (Sloman et al., 2003).

A particular twist to the traditional view espoused in positive psychology comes from the so-called "mismatch hypothesis," otherwise labeled by Cosmides and Tooby (1999) as "environmental mutation." These terms describe the phenomenon in which changes in the environment over time (i.e., moving from the environment of evolutionary adaptedness [EEA] to a modern environment) result in physiologically and psychologically indicated conditions no longer being met for individuals. The prototypical example of this phenomenon would be the modern obesity epidemic: the human brain, being hardwired to seek out and consume high-calorie food resources—a fruitful strategy in the EEA, when rich resources would have been difficult to come by—does a disservice to the human body when this same strategy is adopted in the context of a calorie-rich modern environment, one in which overconsumption is the greater ill.

Combining the mismatch hypothesis with the traditional approach-avoidance conceptualization of positive and negative emotions, one would anticipate that negative emotions likely ensue when the conditions of the EEA are not met (or are not sufficiently approximated) *and* an approach-oriented strategy is demanded but cannot be met (e.g., if a person is expecting to enjoy a certain level of social support, and in the absence of any, cannot identify a useful source of it due to the isolating effects of modern living); or, when the EEA's conditions are met *and* the situation requires an avoidance-oriented strategy (e.g., conflict with an out-group against which the in-group's resistance would be futile). However, it would not logically follow that positive emotions will occur in any situation in the modern environment in which an approach-based solution will lead to an increase in individual fitness. Instead, one would expect positive emotions to result in situations in which an approach-based solution would have led to greater fitness *if the conditions of the EEA were to hold true*. As Grinde (2002) phrased it, "whereas happiness is relevant for biological success only to the extent that the state of mind influences fitness, the appropriateness of the environment is relevant for happiness" (p. 333).

To restate this point: positive emotions may drive approach-based behaviors, but the utility of these behaviors (and, consequently, the emotions driving them) must not be automatically considered to be beneficial to the organism's fitness without first considering the modern environmental context. This serves as a major caveat in attempting to apply evolutionary theory to the principles of positive psychology, and likely explains why attempts to do so have been limited. In the line of thought adopted by many positive psychologists, the time point of interest is the present, where so-called positive cognitions are regarded, essentially by fiat, as beneficial to the organism's functioning. From the evolutionary psychologist's perspective, by contrast, interest lies in tracing the current utility of cognitive-emotional processes that, in the ancestral environment, would have sponsored greater fitness. In sum, an evolutionarily informed positive psychologist must consider the possibility that some "positive" emotions and cognitions may be passé or even detrimental to the individual's ability to function in the modern milieu.

Disabling the smoke detector principle. Nesse and Williams (1995) use the analogy of a smoke detector to explain the phenomenon of apparently extreme negative emotions occurring in response to what turn out to be benign triggers. Their elucidation centers upon the notion that negative emotions do not need to respond *specifically* to certain, dire situations but instead will respond to any situation in which the magnitude of the threat of experiencing some sort of harm or detrimental effect, weighted by its likelihood of occurring, is greater than the cost of acting on the negative emotion. For example, experiencing enough fear to cause oneself to panic and shinny up a tree is worth the caloric expenditure if wolves frequent the area, despite the fact that sometimes it is a squirrel, rather than a wolf, that is rustling in the underbrush. In modern terms, this is equivalent to having one's hair stand up on end when the fire alarm goes off, even if nine times out of ten the offending source is a burned bag of popcorn or some other nonthreatening stimulus.

This same line of thinking should not, however, apply to positive emotions. A little extra fear might waste the nutritional equivalent of a meal; excessive joy, however, can contribute to blindness toward environmental threats and waste the equivalent of a lifetime's worth of meals. (Consider modern clinical manifestations of both emotional responses: first consider the likelihood of dying or otherwise irreparably harming one's fitness during a few minutes of fear; then, consider the likelihood of the same during an equivalent time period while in a state of mania. The risks, it seems, are incomparably different.) As such, it does not improve fitness to surpass an elation threshold easily the same way that it pays to have a quick trigger on one's anxiety response. The role of natural selection in shaping positive emotions, then, should have contributed to a more restrictive ceiling on the display of positive emotions than for negative emotions.

Broaden-and-build theory. Another model of the function of positive emotions has been offered by Barbara Fredrickson (1998). Known as broaden-and-build theory, this model proposes that positive emotions "*broaden* people's momentary thought-action repertoires and *build* their enduring personal resources [italics in the original]" (p. 122). While the "broaden" aspect might appear similar to the functions of positive emotions described above, Fredrickson (2002) was careful to point out that her theory eschews the notion that positive emotions are associated with specific action tendencies—i.e., that each positive emotion is designed to correlate with a single behavioral response (or a constrained set of responses). This perspective actually is a very significant contrast to the traditional perspective taken on the emotion-behavior link—instead of serving to reduce one's behavioral options in a given situation, positive emotions under this model seem to offer an expansionist option to one's repertoire, giving the individual a wider range of cognitive and behavioral options.[i]

One piece of circumstantial evidence supporting this aspect of the broaden-and-build model is the observation that the number of discrete positive emotions is dwarfed by the number of discrete negative emotions (Nesse, 1998). Broaden-and-build includes an amalgamation of general intellectual and "growth"-related goals, without much specificity in regard to what the positive emotion appear to be driving. Whereas negative emotions tend to have clear corresponding behavioral end states (e.g., fight, flight, submission, etc.), positive emotions do not, lending credence to Fredrickson's hypothesis that overall expansion of the individual's cognitive and behavioral options can issue from any in a range of different emotional phenomena.

The evolutionary implications of broaden-and-build, however, especially lie within the "build" part of the model. The resources that an individual builds as a result of experiencing and responding to positive emotions, Fredrickson (2002) argues, are enduring, remaining within the individual's arsenal long after the emotion has dissipated. Because these resources include lessons and urges useful to an organism's fitness level—predator-avoidance behaviors learned during play, reciprocity arrangements developed out of increased social engagement, and general intellectual growth stimulated by creative enterprises, to name just a few—positive emotions serve adaptive functions. Thus, to the extent that positive emotions were heritable, the propensity to experience positive emotions was likely to become an enduring legacy in the human genome.

Finally, evolutionary theory provides a theoretical link between broaden-and-build theory and the phenomenon referred to as "depressive realism." Depressive realism refers to the tendency for individuals to predict the likelihood of events (as well as to make other heuristical evaluations) more accurately when suffering from depression—even when circumstances are mundane rather than uniquely threatening (Seligman, 2002a). Contrast this with people not experiencing depression, whose evaluations of the likelihood of mundane events tend to overestimate beneficial outcomes, generally demonstrating spikes in their skepticism (i.e., becoming more accurate in their heuristical appraisals) only when circumstances become threatening. Here, too, might lie an interesting phenomenon: positive emotions are likely to be adaptive and abundant the vast majority of the time, when a broaden-and-build approach is likely to be successful, whereas negative emotions are likely to become adaptive under mundane conditions when they become unusually threatening and when overexposure is likely to lead to a decrease in fitness. Hence, a baseline depressogenic state might protect individuals from becoming increasingly inured to harmful environments and prevents cognitive adaptation from occurring.

Application to game theory. Another extraordinarily interesting area of positive psychology regards the systematicity and predictability of positive emotions. As Nesse (1998) has pointed out, the *unpredictability* of some negative emotions (namely, those involved in interpersonal confrontations), rather than just the emotions themselves, may confer selective advantage. Work by John Maynard Smith (1982) has used game theory to demonstrate how, when competing for resources or avoiding becoming prey, for example, erratic behavior can actually reduce costs and increase gains for an individual. Intuitively, this finding is appealing, in that one can see how easy it would be to manipulate or take advantage of a person who acts in a purely predictable manner. Erratic emotions, on the other hand, prevent anticipation of the individual's behavior. The question remains whether the same may be said for positive emotions. Several theorists (e.g., Seligman, 2002a) point out that the above examples of competitively driven negative emotions constitute examples of zero-sum games, with discrete winners and losers, whereas positive emotions tend to come into play for non-zero-sum games in which one participant's gain does not have to correspond to another's loss. It has even been argued that the reason these non-zero-sum games even can come into existence is due to the predictability of reciprocal behavior (Wright, 2000), and that positive emotions serve as indicators that reciprocity likely can be expected and will operate as catalysts for continued cooperative behaviors. This game-theoretical distinction lends further credence to specific "expansionist" theories of the function of positive emotions (see Seligman, 2002a), such as broaden-and-build theory (Fredrickson, 1998, 2002).

It is worth noting that, under the non-zero-sum model of positive psychology, discussion is not merely limited to the functions of the emotion of happiness. This is not to say that happiness is unimportant; indeed, happiness may facilitate cognitive processes that thereby make cooperative behaviors more likely to occur. That being said, however, other emotions seem to offer equal or better promise as the drivers for non-zero-sum strategies. Trust and comfortableness, for example, may potentiate beliefs of friendship and anticipation of reciprocity, thereby heading off defection during joint tasks (Nesse, 1998). The particular subject of reciprocity has important implications in positive psychology due to the influence of kin relationships. Because of the pressures resulting from gene-level inclusive fitness, as opposed to an organism-level view of fitness (Dawkins, 1976), one would expect to see that individuals are more easily led to develop trust in others in ways congruent with their degree of genetic relatedness. As such, positive psychology, in its promotion of emotions that lead to non-zero-sum games, might actually be running an uphill battle in attempting to encourage trust between unrelated individuals. Because unrelated individuals may not be evolutionarily predisposed to high levels of trust in one another, positive psychology likely will have to capitalize on environmental cues suggestive of relatedness (e.g., geographic proximity, caretaking behaviors, juxtaposition with obvious out-groups) in order to increase the frequencies of such positive social emotions.

Evidence of Selection for Level-Two Happiness

Linking subjective well-being to emotions. Although it would be something of an exaggeration to say that a "traditional" functional model of level-two happiness, otherwise known as the *life satisfaction* component of SWB, exists in the same sense as for the level-one construct, an analogous model has been proposed (Grinde, 2002). Under this model, acting in a manner consistent with evolutionarily driven needs of the human body yields positive emotions, and these emotions, when appraised as beneficial by the individual, in turn yield greater subjective well-being.

The obvious dilemma confronting such a model is that acting in a way consistent with the human body's evolutionary design does not need to yield positive emotions. As mentioned above, the experience of many negative emotions, under the evolutionary perspective, are "design-syntonic," so to speak, and are informed by many thousands of years of evolution. Thus, one of the ironic pieces of evidence for natural selection's influence on subjective well-being capitalizes on the imperfect correlation that exists between level-one and level-two happiness. Because the correlation is not perfect, this suggests that some of the variance in level-two happiness can, in fact, be attributable to the other dimension of level-one affect: negative emotions. Because subjective well-being is a relatively stable construct across development—a few systematic deviations notwithstanding (Diener, Suh, Lucas, & Smith, 1999)—it is clear that some negative emotion, at least when it is limited in its duration, does not have a long-term detrimental impact on an individual's satisfaction with his or her life situation.

In theory, though, some brief negative emotions may actually bolster an individual's long-term subjective well-being. Returning to the earlier discussion of the evolutionary functions of negative emotions, every one of the six functions mentioned would protect the health of the individual (and increase his or her fitness level) if the negative emotions were produced in an appropriate situation. For example, if the environment truly has become hostile to the organism, such that it would be fitness-enhancing to sit tight and wait for conditions to improve, then negative emotions such as despair, which might induce withdrawal and anergia, would serve the individual well. Although it is clear that large stretches of time marked by negative emotion have deleterious consequences on health (e.g., Hariri & Weinberger, 2009), and thereby on overall fitness, this does not imply that negative emotions in small doses cannot help maintain salubrious living conditions and thereby promote higher subjective well-being. From this theory one can posit an answer to the psychological gene therapy question, "If we can change genes that cause diseases, why shouldn't we change the genes that make us unhappy?" (Bergsma, 2000, p. 404)—the genes that allow humans to experience negative affect may not merely be doing an evolutionary service, but may be supporting mechanisms of level-two happiness as well.

Fortunately, this theory goes beyond mere speculation. Several lines of research suggest that not merely positive but also negative affect are related to subjective well-being (Bradburn, 1969; Lowenthal, Thurner, & Chiriboga, 1975).

Such a finding is possible as a result of the relatively weak correlations between the two valences of emotions (Diener & Emmons, 1984). This is not to say that people experiencing high subjective well-being *frequently* experience negative emotions—instead, the role of negative emotions in predicting well-being appears to correspond more to the intensity of these emotions, rather than due to the actual number of emotional events (Myers & Diener, 1995).

Later research attempted to explain emotions as being only partial mediators between personality features and level-two happiness. In particular, high levels of extraversion and low levels of neuroticism appear to have particularly potent contributions to maximizing the likelihood of an individual reporting high subjective well-being, even stretching years into the future (Costa & McCrae, 1980). These findings should not be construed to mean that high subjective well-being is reserved only for those with specific personalities, but instead that certain personality traits may contribute to an individual's experiencing both positive and negative affect in circumstances when it is most conducive to increasing level-two happiness. These associations do not appear to be solely contingent upon the interpersonal effects of certain personality types, either, as the findings above regarding extraversion seem to be robust regardless of the level of actual social contact being experienced by an individual (Pavot, Diener, & Fujita, 1990).

Subjective well-being as a signal of fitness. Bjorn Grinde (2002) regards subjective well-being not as something that developed in response to explicit selective pressures but instead as an epiphenomenon resulting from a series of selfappraisals. In many ways, he characterizes level-two happiness as a reflection of an individual's fitness level, such that reported subjective well-being should inversely correlate with the body's stress response. Put another way, level-one happiness sets the stage for subjective well-being, the latter coming into fruition when stress is down and positive appraisals of one's emotional state are made. Subjective well-being tends to stabilize above a neutral level (Diener & Diener, 1996), therefore, on account of the obvious difficulties that the human body would have functioning under chronic stress conditions (Grinde, 2002).

One of the problems with Grinde's (2002) approach, however, is that a large emphasis is placed upon the notion of "free will"—the ability for an organism to act against the interests of its genes. Grinde describes most animals as being subject to a high level of genetic (read: evolutionary) determinism, whereas "a human may choose to take actions that are not in the interest of his or her genes" (p. 339). This is something of a mischaracterization of evolutionary theory, which would address the supposed discrepancy by noting that the degree of malleability of one's behavioral repertoire is a consequence of the impossible task of natural selection's imposing strict limits on behavior in the face of a large amount of environmental variability. In other words, if humans appear to be able to "act against their genes" more so than other organisms, the impressive breadth of behaviors is actually written into the genome by natural selection, and does not constitute a deviation from traditional evolutionary perspectives. In the context of positive psychology, then, the range of human strengths, and the ability of humans to pursue a range of behaviors that either augment or decrease their levels of subjective well-being, are a consequence of natural selection, rather than an exception to it.

Supporting Grinde's (2002) "fitness" model of subjective well-being—elsewhere referred to as the "signal theory of happiness" (Veenhoven, 2005)—is the finding that social desirability correlates moderately with subjective well-being (Diener, Sandvik, Pavot, & Gallagher, 1991). The significance of this relationships lies within the known utility of social contacts among human beings (see Putnam, 2000)—as social animals, the ability to make social connections is commonly cited as an adaptive trait with clear fitness-enhancing value in humans (Brown & Brown, 2006; Fredrickson, 2002; Hazan & Shaver, 2004). That social desirability measured through self-report is positively predictive of greater subjective well-being suggests the possibility that recognition of interpersonal value serves as important data in generating a calculation of one's own fitness level; that the same relationship is observed when measured by others lends even more weight to this argument, decreasing the likelihood that this correlation is merely an artifact of some non-adaptive cognitive state (Myers & Diener, 1995).

Additionally, subjective well-being appears to be relatively stable across the lifespan (Inglehart, 1990). Assuming that subjective well-being serves as a cognitive proxy for an individual's fitness level—such that an individual would be informed of the need to make fitness-improving changes in light of dips in one's subjective well-being—the average level of subjective well-being at a particular age should be virtually equivalent to that of any other age, if values from the population at-large are collapsed onto age-specific averages. This is because fitness is measured relative to that of other conspecifics at the same time point, rather than being an absolute measure; as a consequence, it would be sensible to assume that, for adults beyond their reproductive years, fitness will be estimated in light of what they are able to do to care for their progeny, and for adults still in the mating pool, fitness will be a combination of these same skills as well as their continued quality as potential mating partners. Thus, for any given age group, some individuals will be high in subjective well-being relative to others, and the averages from group to group will be rather similar.

Predictions for an evolutionary model also might be made using reverse-engineering logic. The most adaptive design, again, would be to engineer subjective well-being to reflect an individual's ability to influence his or her fitness level in the context of *developmental* constraints.[ii] Receiving a cue that one's fitness could stand to be raised or lowered would be mostly ineffectual if the cue were not responsive to how one is actually capable of responding. That is to say that a dip in an individual's subjective well-being would be functionally worthless unless subjective well-being might be boosted by age-appropriate means. The end prediction taking these developmental constraints into consideration is that the factors associated with subjective well-being should change with age to reflect skills and self-interests consistent with those predicted by evolutionary psychology. And, indeed, that these factors change with age—or, analogously, with respect to an individual's goals, which would also be expected to be evolutionarily informed—has been a relatively robust finding in the literature (Diener & Fujita, 1995; Herzog, Rogers, & Woodworth, 1982).[iii] Similarly, one would expect that, on account of these developmental constraints' changes over time, subjective well-being would be most strongly informed by relatively recent events despite its overall temporal stability. This, too, turns out to be the case, with the greatest influences being attributable to events occurring within the last three months (Suh, Diener, & Fujita, 1996).

Decreasing marginal utility of wealth and modernity. The availability of material resources also has been cited as predictive of greater subjective well-being, the correlation being cited at between +.62 (Diener, 2000) and +.67 (Myers & Diener, 1995). More notable about these data, however, are their nonlinear natures: The correlations appear to be driven mostly by rather strong associations as resources increase from poverty levels to subsistence levels, with the correlation dropping off abruptly as wealth increases from there. Thus, within many wealthy, modernized nations, barely significant correlations (e.g., Diener, Sandvik, Seidlitz, & Diener, 1993) may be attributable primarily to a restriction of range, whereas no such problem exists when collecting data in countries where poverty is more the norm—and, consequently, where wealth is a better predictor of subjective well-being (Diener & Diener, 1995).

That increasing wealth seems to serve the level-two happiness of those in need better than it does the already prosperous is fully consistent with an evolutionary model. Returning to the discussion of the EEA, human needs in hunter-gatherer societies were quite minimal, focusing mainly on survival-related resources such as food, shelter, and the most basic of tools (Lee & DeVore, 1968). Failure to procure these resources would have been quite damaging to one's fitness level. As a result, any cognitive-emotional impetus to correct the offending scarceness would have been highly adaptive. However, these needs would only have had to be fulfilled up to a point. Once one's minimal needs had been satisfied, greater material wealth would have quickly diminished in value.[iv] Arguments regarding the human need for continuing close interpersonal connections would have remained applicable, however, suggesting that social capital, as opposed to material wealth, would still have had more than negligible additional value. It is telling that the measures of "wealth" cited above focus on some form of tangible capital, as opposed to other, perhaps more enduring, forms of wealth.

It merits noting that other theorists, such as Ruut Veenhoven (2005), cite correlational data that do not demonstrate such a drop-off in the relationship between wealth and subjective well-being above a certain point. Despite the apparent incongruity of these findings with those noted above, one must note that Veenhoven's approach is to consider happiness as being a function of subjective well-being within the context of possible opportunities. Operationally, what such studies call "happiness" is really subjective well-being multiplied by expected lifespan. Although the data, to this author's present knowledge, have never been formally analyzed in such a way, one would strongly suspect that the continued wealth-happiness relationships at the upper ends of these distributions are attributable far more to the age-extending effects of greater wealth (ability to afford optimal medical care, ability to finance health research, etc.) than to the contributions that material wealth might have on subjective well-being itself.[v]

Hedonic treadmill theory. That one can even talk about an individual's "level" of subjective well-being is a consequence of the observation that even major life events do not appear to change level-two happiness substantially over the long term. Rooted in adaptation-level theory (Helson, 1964), Brickman and Campbell's (1971) hedonic treadmill model describes subjective well-being as a psychological phenomenon to which individuals automatically become habituated. The prototypical example of this habituation pattern was Brickman, Coates, and Janoff-Bulman's (1978) "lottery winners" study, in which the researchers found that people who had won substantial sums of money in lotteries did not report being significantly happier in the present than they reported having been prior to their change in fortunes. Although this theory has subsequently been revised to reflect many of the findings mentioned above—e.g., positivity offset, marginal influences of select external factors, and individual differences (Diener, Lucas, & Scollon, 2006)—the hedonic treadmill continues to be an apparent obstacle in positive psychology's professed aim to increase well-being.

The revised hedonic treadmill model, again, dovetails quite nicely with the evolutionary perspective. Imagine what would happen to an organism finding itself stuck at a hedonic high point, without any habituational means to return it to its normal set point. Because this organism would continuously be receiving feedback that it was functioning in a way congruent with the interests of its genes, this feedback—albeit informative at first—quickly would become noise that would blind the individual to further input about the congruency of its actions to its fitness interests. (This would appear to be less of a problem if incongruence led to a *decrease* in well-being, since this would bring happiness closer to its initial set point.) In contrast, the hedonic treadmill permits the experience of increased subjective well-being in response to congruent feedback, with this appraisal diminishing once the evaluation had been made, so that future feedback can be efficiently processed as well.

Conceptualizing a Model of Fitness Signaling

This review of the extant literature converges upon the sense that, whereas affective components—both positive and negative—may play a role in promoting the execution of evolutionary adaptations, this need not be the whole story. Indeed, because affective awareness actually can be low for many individuals (e.g., Lion, 1992), it seems more fruitful to regard types of affect as adaptations unto themselves rather than as reliable markers of adaptive fitness per se. The signal theory of happiness instead suggests that life satisfaction may be a useful indicator of fitness insofar as it demands a cognitive evaluation of one's condition rather than merely prompting a behavioral response. As such, while certain patterns of affective responses ought to be predicted by an individual's fitness level (i.e., an individual with greater fitness ought to experience moderate, positive affect with relatively high frequency under mundane conditions and marked but temporally limited negative affect under unusual, threatening conditions), it is left more to speculation as to what degree life satisfaction should be predicted by fitness. Three possibilities emerge: (a) life satisfaction *is* an adaptive (or exaptive) cognitive mechanism and serves as a signal for one's fitness level; (b) life satisfaction *is* an adaptive cognitive mechanisms, but not for the reasons posited above; and (c) life satisfaction is *not* an adaptive cognitive mechanism, and the evidence cited above comes about as consequence of life satisfaction's emergence as an epiphenomenon accompanying affective states and other cognitive processes. In the case of the last two possibilities, then, one would expect a measure of fitness not to significantly predict life satisfaction; in the case of the former, this association ought to emerge.

Thus, any attempt to develop a model to test this hypothesis would require the construction of a measure of fitness. This is not a task to be taken lightly, as it turns out.

Considerations in the Measurement of Fitness

Elsewhere (Borgerhoff Mulder, 2007), the question of the usefulness of attempting to measure evolutionary fitness comes down to the temporal unit of analysis—the fitness of an individual can be considered either within the current environmental context or with a historical perspective on the genotype. Stated as a question, should researchers be attempting to measure fitness with regards to the way that adaptations increase gene frequencies with respect to modern-day selection pressures—which assumes that humans are fitness maximizers, as traditional sociobiologists might argue (Alexander, 1979)—or with regards to the pressures from the EEA, a perspective preferred by the evolutionary psychologists (Buss, 1995)?

Although indicators of fitness may partially overlap between these two perspectives, different issues do arise when the expected (EEA) and actual (modern) environment diverge on characteristics focal to sexual selection, physical health, and resource control, among other fitness-relevant factors. Consequently, this study sought to incorporate indicators congruent with both perspectives, while keeping mindful of these during interpretation of the data.

Also important is not to fall into the "rational fitness maximization" trap (Kaplan & Gangestad, 2007) for positing the existence of a cognitive fitness indicator. Humans, like all organisms, execute adaptive responses—but just because they execute these in ways that one *can* explain in rational terms, there is no inherent reason why the decision to execute such adaptive responses *must* be made via rational consideration. In fact, one may easily surmise instances in which rational cost-benefit analysis may be impossible to execute in maximizing fitness. For example, in choosing between selected strategies occurring as a result of frequency-dependent pressures, it would be virtually impossible to calculate the odds of the best solution without knowing the strategies being used by other individuals in the population. Access to Gallup Polling aside, selecting a strategy through use of "rational" means on questions such as these simply would be impossible, which likely explains why heuristics are so commonly used in human cognition. Likewise, adaptations may come into conflict with each other. Although an individual might be forced to choose between the execution of one adaptive trait versus another, situations such as these suggest that more optimal strategies might be plausible—just not accessible given limits to the size and sophistications of the adaptive arsenals. What the system needs is an appraisal mechanism that permits an individual to determine if the heuristics one uses to execute adaptations are working adequately, or if remediation is indicated. The difference between this and a rationally driven fitness maximization device should be apparent.

This perspective is consistent with viewing the brain as an "active fitness projector" (Reeve & Sherman, 2007). Labeling the brain in this way is to argue that humans fluidly change their behaviors in ways that suggest that the consequences of their conduct are measured in terms of changing inclusive fitness levels. One example of such behavior might be changing an individual's response to dyadic tasks—behavior may quickly change when reciprocation is or is not meted out by the task partner (e.g., Skyrms, 2000), leading to conditions that are more likely to improve the target individual's fitness. Researchers in this area argue that some cognitive mechanism must exist that permits individuals to project the ramifications of their behaviors onto the future in order to select responses that maximize their fitness. Although this resembles and may, indeed, include some rational process, the system, again, does not require rationality or even conscious awareness. And, although it is possible to imagine that the human brain includes such a projector as a part of every (or, perhaps, many) adaptive response, it seems unlikely that natural selection would continue to reinvent such projectors for every new trait. Instead, from a reverse-engineering standpoint, it seems both sensible and functionally efficient to devise a relatively flexible active fitness projection system that can be brought online in a number of different adaptive tasks. In short, it is not unreasonable to suppose that such a device may have been selected for as a subsidiary tool for multiple contingencies.

But this requires a return to the primary question: if this study is seeking to affirm the existence of an evolved cognitive device that informs its bearer of its level and projection of fitness, what is the appropriate yardstick for measuring fitness? Measuring fitness in a single slice of time inherently has problems; even retrospective methods may fail to capture the construct in its entirety. Four principal complications emerge, and although these are described in detail elsewhere (Reeve & Sherman, 2007), they are worth outlining here: (a) recognizing *inclusive* fitness (Hamilton, 1964) requires assessment of all descendants and kin, a daunting task; (b) quality of offspring must be considered in addition to quantity; (c) any sophisticated measure of an individual's fitness must occur several generations after his or her reproductive age as passed, in order to assess postreproductive contributions and to allow sex-ratio factors to play themselves out; and (d) resources (in humans) do not merely get conferred from one generation to the next but may be invested for descendant generations. These problems are not posed in order to demoralize those seeking to measure an individual's fitness in the here and now. Instead, they are posed to support the argument that any here-and-now measure of fitness will need to cast a net far beyond a "counting babies" (Crawford, 1993) strategy and focus more on other predictors of future fitness—i.e., a model based upon statistical likelihood rather than immediate production of offspring.

Potential Fitness Indicators

Indicators of fitness will reflect traits and strategies that increase the likelihood that an individual's genes will be transmitted to subsequent generations (Dawkins, 1976). Among these, a model of fitness should include indicators relevant to sexual selection—honest indicators of fertility and health (Buss, 1989)—that highlight the individual's value as a potential mate. In a review of the extant literature, several potential indicators emerge from these general criteria.

*General intelligence (*g*).* Several explanations for the evolutionary relevance of general intelligence (*g*) have been posed. One of these, proposed by Kanazawa (2004), suggests that *g* offered an advantage in relatively novel problem solving processes for which other domain-specific mental technologies had not yet been selected. Unlike more common problems in the EEA, such as reciprocating altruistic acts or responding to defection from others, responding to relatively nonrecurrent problems—upon which selection pressures had been unable to act—may have demanded a more diffuse set of abilities. Under this particular conceptualization, *g* can be considered a plausible indicator of fitness due to its intrinsic value in problem solving.

Similarly, the improvisational intelligence model (Cosmides & Tooby, 2002) outlines the possibility that *g* could have evolved as an emergent property of other cognitive specializations. If such specializations are activated as bundles, individuals might demonstrate greater competence at dealing with counterfactual or hypothetical problems. In this case, there is no domain-specific character to *g*; instead, *g* emerges when multiple domains are activated in response to an adaptive challenge that does not already have a domain dedicated to providing a solution.

In contrast, Miller (2000) has eschewed the notion that *g* exists as a consequence of *natural* selection and has focused instead upon potential *sexual* selective pressures. Here, *g* is not assumed to confer any generic evolutionary advantage, but instead offers advantage in negotiating social status challenges. As such, higher *g* facilitates social status advancement. Higher social status in turn would have amplified one's access to resources for offspring; thus, one would expect *g*, under this theory, to be more advantageous to a male's fitness level than to that of a female (see *Social instrumentality and material resources* below).

A fourth conceptualization of *g* as an adaptation was posited by Luxen and Buunk (2006), who adopted a perspective similar to Miller's (2000). Here, *g* acts as an honest indicator of fitness—in particular, of developmental stability. This extension of Handicap Theory (e.g., Zahavi & Zahavi, 1997) requires that the establishment and maintenance of structures contributing to general intelligence consume substantial resources; as a result, high *g* serves as an honest indicator of an individual's fitness, given that the individual's overall survivability has not been impeded by it. Thus, while Miller purports that *g* may serve some advantageous function (or act as its proxy), Luxen and Buunk argue that its adaptabiveness may merely rest in its ability to communicate the organism's health and fitness to potential mates. Although it might be argued that an honest signal such as *g* might be potentially useful in mate assessment by both males and females, the human species' slight population bias toward females, indicative of an orientation in which females bear a heavier burden of selecting higher-value mates (Trivers, 1972), suggests that honest indicators might be somewhat more adaptive when manifested by males than by females.

In each of these cases, *g* is posited to offer some value as a predictor of an organism's fitness. In the case of Kanazawa's (2004) and Cosmides and Tooby's (2002) models, general intelligence helps to solve some sort of adaptive challenge independent of communication between conspecifics. In contrast, Miller's (2000) and Luxen and Buunk's (2006) models employ *g* as a device for communicating one's fitness level, either indirectly through a social status mediator, or directly as an expensive adaptation. Regardless of the individual approach used, multiple theoretical conceptualizations agree that *g* should serve as one indicator of individual fitness, a line of reasoning supported by multiple studies showing shared variance between general intelligence and other purported fitness indicators (e.g., Bates, 2007; Luxen & Buunk, 2006; Prokosch, Yeo, & Miller, 2005), despite particular qualms about any individual conceptualization of *g*'s adaptiveness (e.g., Borsboom & Dolan, 2006). Just as body symmetry has been tapped as a morphological indicator of developmental stability, *g* has been hypothesized to serve as an indicator of developmental stability at a neurological level (Prokosch et al., 2005). Consequently, it may be conceptualized as a generalized fitness factor.

Fluctuating asymmetry. Fluctuating asymmetry has been defined as random deviation between lateral characteristics in individuals that otherwise are symmetrical in the overall population (Palmer & Strobeck, 1986, 1997). These deviations reflect errors that occurred during development—from various proximal causes, such as greater exposure to toxins (Parsons, 1990), parasites, environmental extremes, maternal health, protein homozygosity, etc. (see Kowner, 2001, for a review)—consequently resulting in structures less optimally designed to cope with adaptive problems than indicated by the general developmental blueprint. Due to ease of measurement, most studies attempting to quantify fluctuating asymmetry measure size deviations among the extremities such as the ears, wrists, fingers, ankles, and feet; however, developmental instability is also purported to be reflected in size differences in less accessible bilateral components such as neurological structures.

That random differences in lateral symmetry of the body might correspond to neurological and cognitive asymmetry has not been confined to the realm of mere speculation. In fact, one study investigating this relationship found significant correlations between a composite measure of body fluctuating asymmetry (combining measures of the ears, wrist, ankle, and foot) and several brain areas, including the corpus callosum and sections of the somatosensory cortex (Thoma, Yeo, Gangestad, Lewine, & Davis, 2002). Although care should be taken not to extrapolate too broadly on the relationship of specific areas of body and neurological asymmetries, data suggest that the existence of body asymmetries provide greater-than-chance estimates of some manner of significant neurological asymmetries, which would in turn predict differential levels of cognitive functioning between individuals of differing bodily asymmetries.

Because of its detrimental (albeit largely hypothetical) effects on the ability to solve adaptive problems, fluctuating asymmetry has also been cited as an indicator of evolutionary fitness (Moller, 1997, 1999; Moller, Gangestad, & Thornhill, 1999). Fluctuating asymmetry has been associated with several evolutionarily significant factors, including number of sexual partners (Thornhill & Gangestad, 1994), age of first copulation (Thornhill & Gangestad, 1994), number of medical disorders (Milne et al., 2003), psychological distress (Shackelford & Larsen, 1997), and physical distress (Shackelford & Larsen, 1997). It also has been linked to several cognitive-emotional phenomena, such as romantic jealousy (with less-symmetric individuals manifesting greater jealousy in mating situations (Brown & Moore, 2003), emotional distress (Shackelford & Larsen, 1997), and aggression in boys (Manning & Wood, 1998).

Physical health. The literature from ethology strongly predicts that sexual selection is partly driven by the search for honest indicators of a potential mate's physical health (Hamilton & Zuk, 1982). The potential evolutionary utility of good physical health is posited to include the production of healthier, better quality offspring, a substantial reproductive lifetime, and ability to acquire and invest resources in offspring. Although there is some doubt in the literature as to how "honest" some of these indicators might be (e.g., Weeden & Sabini, 2005), the signal theory of happiness simply requires that the individual making life satisfaction judgments—as opposed to potential mates—be able to assess in some fashion his or her physical health status. This approach has been supported elsewhere in the literature. For example, specialization in one's social niche, including the execution of reciprocation adaptations, has been identified as a potential buffer through which an individual's physical health shortcomings may be compensated (Sugiyama & Sugiyama, 2003).

In the context of the present study, changes in one's physical health and well-being that would represent a change in one's fitness level would be expected to have an effect on one's level-two happiness. As such, one important measure of fitness would be one's own physical health, and in particular evidence of negative immunological responses (Buchanan, 2000), given how good health reflects long-term genetic quality.

Physical health of kin is also worthy of mention. In addition to reflecting one's inclusive fitness, given that kin share substantial proportions of one's own genes, changes in the health of both related and non-related kin will likely predict fluctuations in one's support system. Thus, physical health of close-order relatives is likely to serve as a partial representation of one's fitness level due to its reflections of gene-level susceptibility to pathogens or other aversive factors, decreases in the level of available social and resource support, or a combination of the two. Given the logistical limits of the current study, kin-based health will not be included in the analysis; however, it certainly would merit consideration in future studies along this vein.

Number of children, pubertal development, and frequency of intercourse. The "counting children" method has elsewhere been shunned as a valid measure of fitness, inasmuch as it ignores inclusive fitness factors and effects in subsequent generations (Reeve & Sherman, 2007). Nevertheless, the influence of this particular indicator should not be discounted without due consideration. In the context of the present study, an entirely different rationale has been adopted for its exclusion: the lack of sufficient variability in the study sample. Given the constrained (undergraduate) target population, with most of its members never having reproduced, it was determined that there would be insufficient variability in the sample (and conflating factors for those who *had* had offspring) to make practical use of this indicator.

Frequency of intercourse, however, may serve as a useful proxy for reproduction. Caution should be inserted into interpreting this indicator. Although the relationship between fitness and reproduction appears theoretically uncomplicated for males (as long as resource investment in all offspring is not a necessity), a much more ambiguous picture emerges among females (e.g., Weeden, Abrams, Green, & Sabini, 2006). In Belsky's (2007) theoretical review paper, three factors—pubertal timing, paternal influence, and life course (i.e., risk of mortality prior during one's reproductive lifetime, orientation to immediate versus delayed payoffs, and attachment)—emerged as potent predictors of the "mate quality" versus "mate quantity" reproductive strategies. Additionally, as pubertal timing tends to be linked to age at first copulation (in and of itself linked to fitness indicators; see Thornhill and Gangestad [1994]) among women (Biro & Dorn, 2006; French & Dishion, 2003; Udry & Campbell, 1994), frequency of sexual intercourse is likely to reflect both present reproductive fitness and developmental reproductive strategies. In short, the emergence of these multiple strategies suggests that frequency of intercourse may be reduced among women employing the "quality" strategy and increased for those pursuing the "quantity" strategy. Combining these findings under the current study's theoretical framework, one would expect to see happiness predicted by intercourse and age at first copulation differently depending upon the particular strategy being employed by any given woman.

Number of sexual partners and types of sexual activities. Number of lifetime sexual partners has been correlated with fluctuating asymmetry for both sexes (Thornhill & Gangestad, 1994), suggesting that this may be a potential indicator of fitness. Concerns very similar to those of reproductive frequency apply to the number of sexual partners an individual has had. Underlying the idea of unrestricted sexual pairing is the assumption that these episodes indicate a low level of investment in the relationship (Simpson & Gangestad, 1991), with this dearth of investment assumed to carry over into resource investment into the relationship in the event of the production of offspring. In the case of males, this presents little complication: the assumed relationship again is relatively straightforward, with a larger number of sexual partners associated with an increased likelihood of offspring, reflecting greater fitness.

Returning to consideration of females' multiple strategies, the picture, again, is cloudier. Fink and colleagues (2007) have noted that short-term (quantity-based) reproductive strategies among women are associated with higher levels of instrumental personality features (e.g., assertiveness, independence), as opposed to expressive features (e.g., emotionality, compassion) more consistent with the female sex role. Following on Simpson and Gangestad's (1991) suggestion that consistent sex-typing is an indicator of higher mate value, this would suggest that greater numbers of sexual partners among females likewise would reflect lower fitness. Again, connecting this to the signal theory of happiness, the obvious conclusion would be that larger numbers of lifetime sexual partners would be associated with reduced level-two happiness.

However, that conclusion ignores two fundamental issues. First, it assumes that an individual's metric of her fitness is calibrated with regards to hypothetical fitness—that is to say, her potential inclusive fitness given the opportunity to select any reproductive strategy. Alternatively, if these strategies are conceptualized in a more compartmentalized fashion, with an individual assessing her fitness level within the context of that strategy, the possibility emerges that higher level-two happiness might emerge for short-term strategy-selecting individuals who are successful at attracting a large number of mates.

Second, these above conclusions rely on the notion that sex is an act likely to lead to offspring. However, there are any number of sexual activities (e.g., oral sex, anal sex, sexual touching, etc.) that do not run any risk of producing offspring and therefore do not intrinsically fall into a quantity-based reproductive strategy. Here, non-copulative behaviors may actually be conceptualized as encouraging potential male mates to invest themselves into a romantic relationship, thus putting themselves into a position where they are more likely to invest resources in the female partners and any children that she may bear. Thus, any attempts to measure fitness on the basis of number of partners must consider the context of the female's strategy and must not conflate the adaptive significance of the myriad sexual activities in which the female could choose to engage.

Social instrumentality and material resources. One of the primary tenets of sexual selection centers on the search for mates who are capable of investing the greatest level of resources to the mate-seeker and his or her offspring (Trivers, 1972). One of the means of acquiring and monopolizing these resources in primate species is through social dominance and achievement of a high position within the social hierarchy (Barkow, 1989), a strategy that is purported to be important for both sexes but especially for males. The impact of social status on reproductive success has been empirically confirmed for non-human male primates (Smith, 1994) and for males in at least one human community (Mealey, 1985).

Wealth and material resources also cannot be overlooked in a discussion of status. First, personal wealth may be conceptualized as another factor of social status—indeed, "socioeconomic status" is often used in this way in many psychological studies (e.g., Mealey, 1985). Second, the fact that humans are notable in their ability to acquire material resources in a manner that permits parents to bequeath them to offspring increases the importance of measuring this construct, not merely for a given individual in the "here and now" but also with respect to the material wealth that they are likely to inherit even beyond their principal reproductive time spans.

Attractiveness. As discussed above, the "good genes" or aesthetic model of sexual selection asserts that judgments of a mate's value are likely to be based upon phenotypic indicators of fertility, youth, and other characteristics likely to predict reproductive success and good health. Historically, the argument has been made that humans' ratings of others' attractiveness reflects an attempt to make such an evaluation. Although Weeden and Sabini's (2005) review of the literature suggested that empirical support for this theory was limited to women, others (e.g., Geary, 2005) have offered several reasonable explanations for why this apparent lack of support may be misleading. Arguments in favor of using attractiveness as a "good genes" indicator have most recently been bolstered by studies linking attractiveness to fluctuating asymmetry and other fitness indicators in women (Hönekopp, Bartholomé, & Jansen, 2004), to waist-hip ratio in women (Streeter & McBurney, 2003; Weeden & Sabini, 2007), and to actual gene loci posited to reflect one aspect of genetic quality (Roberts et al., 2005).

Waist-hip ratio and body-mass index. Body fat distribution has been posited to influence reproductive fertility among females (Wass, Waldenstrom, Rossner, & Hellberg, 1997). Two major measures of this distribution have emerged as front-runners in the race to determine which of the two is the more salient cue used to evaluate reproductive fitness. On one hand, an extensive literature exists suggesting that waist-to-hip ratio (WHR) is particularly relevant, citing evidence that redistribution of fat leads to a change in mate value judgments (Singh & Randall, 2007; Streeter & McBurney, 2003). This research suggests an optimal WHR of .7

(Streeter & McBurney, 2003), and has supported this assertion with other findings showing that this ratio is most strongly sought after by males seeking a short-term partner (Schmalt, 2006) and who are thus assumed to be seeking mates with whom they will have the highest likelihood of one-shot reproductive success. Conversely, another set of researchers has suggested that body-mass index (BMI) serves as a more salient marker of fitness (e.g., Smith, Cornelissen, & Tovée, 2007). Their arguments also are supported by evidence suggesting that BMI-driven attractiveness ratings enjoy cross-cultural support above that found for WHR (Swami & Tovée, 2005), and by findings that judgments of attractiveness based upon BMI are consistent between male and female raters, a finding consistent with mate selection theory (Tovée & Cornelissen, 2001).

Study Hypotheses

Although no single indicator from the list above might be expected to fully capture the breadth of fitness, the relationships shared among them may begin to form a more comprehensive picture than other methods that have been proposed. In the present study, structural equation modeling (SEM) was used to isolate the factors from a set of fitness-relevant instruments that reflect the above indicators to test the principal hypothesis that an individual's level-two happiness serves as a signal of one's overall fitness. These models were constructed to address theoretical questions, including: (a) to what degree is fitness represented by an individual's sexual behaviors, material well-being, general intelligence, fluctuating asymmetry, and other potential indicators of fitness; (b) to what degree do the loadings of these indicators differ as a function of sex; (c) how do factors representing fitness differ between sexes; and (d) how do latent constructs representing fitness predict satisfaction with life, positive affect, and negative affect, relative to the model loosely hypothesized by Grinde (2002)?

Method

Participants

Participants consisted of 217 undergraduate students at the University of Kansas who signed up for the study from the psychology department's research pool. Three participants (2 male, 1 female) were excluded from the analyses due to identifying their sexual orientation as homosexual. One additional male participant was excluded due to having failed to complete most of the written measures. The final sample included 107 male participants and 106 female participants. Demographic characteristics of this sample of convenience are provided in Table 1.

Measures

Positive and Negative Affect Schedule (PANAS). The PANAS (Watson, Clark, & Tellegen, 1988) comprises two sets of 10 descriptors of positive and negative affect. Participants were asked to indicate to what extent they experienced each affect within "the past few days" on a five-point scale (1 = very slight or not at all; 5 = extremely). Scores for positive affect words and negative affect words were summed independently, forming two scales, with higher scores indicating greater endorsement of each affective valence. The PANAS scales have been demonstrated to be reliable measures (8-week test-rests r = .39 - .71, depending upon temporal instructions), with

Table 1

Descriptive Statistics of Demographic Variables

	Males		Females	
Variable	*Mean*	*SD*	*Mean*	*SD*
Age*	19.41	1.76	18.83	1.17
Ethnicity				
Hispanic	3		5	
Black	6		4	
White	94		85	
Native American	0		1	
Asian*	3		14	
Non-white Caucasian	3		4	

*$p < .05$

high internal consistencies (α = .84 - .90).

Satisfaction With Life Scale (SWLS). The SWLS (Diener, Emmons, Larsen, & Griffin, 1985) was developed to measure the cognitive judgment component of SWB. Consisting of five items, rated on a 7-point scale (1 = strongly disagree, 7 =strongly agree), the SWLS asks participants to rate how much they concurred with several statements about the quality of their lives in general. The instrument yields scores between 5 and 35, with higher scores indicating higher life satisfaction. Test-retest reliability has been demonstrated to be acceptable ($r = .82$ over two months), and the test has been shown to have good internal consistency (α = .87), with items loading onto a single factor (Diener et al., 1985) that converges with other measures of life satisfaction (Pavot, Diener, Colvin, & Sandvik, 1991). Furthermore, the SWLS does not appear merely to be a reflection of affective states (Pavot & Diener, 1993), allowing it to be particularly useful as a measure of level-two happiness in the present study.

Wechsler Adult Intelligence Scale—Third Edition (WAIS-III) Matrix Reasoning subtest. The WAIS-III (Wechsler, 1997) is an updated version of an intelligence test first developed in 1939. Matrix Reasoning, one of the 14 subtests of the WAIS-III, consists of 26 nonverbal problems requiring the ability to complete patterns and solve visual analogies by completing colored matrices with missing parts from five possible choices. This subtest has been demonstrated to be internally consistent and loading relatively strongly onto *g*, $r = .72$ (Sattler, 2001). Although several other subtests load more strongly onto *g* than Matrix Reasoning, this subtest has a loading equal to or greater than any other performance-based task on the WAIS-III (Sattler, 2001), making it most suitable for modification to a self-administered form in this study to measure the general intelligence factor.

Fluctuating asymmetry. No accepted standard has yet been established for which physical traits to use in the measurement of body-wide fluctuating asymmetry. However, several measurements have become relatively prominent in the literature; Table 2 offers a summary from a literature review of thirteen studies for the frequencies of different bodily measurements, showing that foot, ankle, elbow, wrist, and ear widths as well as lengths for the ear, second, fourth, and fifth digits tend to be

Table 2

Indicators of Fluctuating Asymmetry Used in Previous Research

	Width							Length				
Study	Knee	Palm	Foot	Ankle	Wrist	Elbow	Ear	Ear	2D	3D	4D	5D
Prokosch et al., 2005			X	X	X	X	X	X	X	X	X	X
Luxen & Buunk, 2006				X	X	X		X	X		X	
Jasienska, Lipson, Ellison, Thune, & Ziomkiewicz, 2006									X		X	
Hönekopp et al., 2004		X	X	X	X	X[a]	X	X	X			X
Zaatari & Trivers, 2007			X	X	X	X				X	X	X
Thoma et al., 2002			X	X	X	X	X	X				
Thornhill & Gangestad, 1994		X	X	X	X	X	X	X				
Gangestad & Thornhill, 2003			X	X	X	X	X	X		X	X	X
Milne et al., 2003			X	X	X	X	X	X				
Brown & Moore, 2003	X	X	X	X	X	X	X		X	X	X	X
Rahman, Wilson, & Abrahams, 2004									X		X	
Manning & Wood, 1998				X[b]				X		X	X	X
Bates, 2007		X		X		X	X	X	X	X	X	X
All studies	1	4	9	11	9	9 (10)	8	9	7	6	9	7

[a] Due to poor reliability, this measurement was subsequently dropped from analyses.

[b] In this study, ankles were measured with regards to circumference, as opposed to width.

common, with measurements of the knee, palm, and third digit being less typical. However, given that the typical study only measured approximately 6.9 different sites, it was decided to select seven sites from those appearing to be most commonly measured: foot, ankle, wrist, and ear widths, and ear, digit 2, and digit 4 lengths. Each site was measured on both sides of the body, with participants queried for any history of significant trauma (e.g., bone breaks, sprains, surgery) for those body parts, with the calculation of a composite score for each individual then being made, following the procedure described below in *Fluctuating Asymmetry Calculation*.

Health history questionnaire. A health history questionnaire modeled after that of Thornhill and Gangestad (2006) was administered to evaluate evidence of poor immunological welfare and the existence of medical disorders that have or likely will impede the individual's functioning. The purpose of these measurements was to identify the existence of genetic susceptibility to physical disabilities or pathologies. Due to the present study's interest in the response of subjective well-being evaluations to fitness-relevant constructs, appreciation of the fact that only recent events tend to affect subjective well-being reliably (Suh et al., 1996) led to an investigation of these phenomena limited to the last three months. This questionnaire is reprinted in Appendix A. Days of any reported illnesses and numbers of discrete reported illnesses were each summed from the measures asking about types of illness to provide composite scores for overall episodes of illness and days ill over the past three months.

Sexual and relationship history questionnaire. Participants' reproductive strategies—and the effectiveness of their execution—were assessed through the use of a self-report questionnaire (Appendix B). Items were designed to serve as individual indicators of a long-term and a short-term sexual strategies factor. Both lifetime and recent (past three month) strategies were assessed through items tapping the frequency with which participants had penile-vaginal intercourse and non-penile-vaginal sexual involvement, number of partners with whom they had had penile-vaginal intercourse and non-penile-vaginal sexual involvement, age of first copulation, and durations of the last five relationships (including dates or one-night stands, in an attempt to estimate relationship stability). As mentioned below, the long-term mating strategies variable was ultimately dropped due to concern about indicator validity.

Social Self-Esteem Inventory (SSEI). The SSEI (Lawson, Marshall, & McGrath, 1979) is a 30-item self-report instrument that measures self-confidence in social situations. Self-esteem measures have elsewhere been used as a facet of measures of social status (Holland & Andre, 1994); thus, in the present study, the SSEI was intended to tap into state-level assessments of social status. From this measure self-esteem scores are generated from a series of 6-point Likert scale items; overall scores range from 30 (low social self-esteem) to 180 (high social self-esteem). The SSEI has been measured as having a 4-week test-retest correlation of $r = .88$ and an internal consistency of $\alpha = .96$. Convergent validity of the SSEI has been evidenced through its prediction of self-reported minimal dating among college students (Leck, 2006).

NEO Five-Factor Inventory (NEO FFI) Extraversion (E) scale. The Extraversion scale from the five-factor model (Costa & McCrae, 1992) is designed to measure an individual's level of gregariousness, assertiveness, and general excitement seeking. High scorers on the NEO E scale tend to enjoy being with other people and approach interpersonal tasks with considerable energy. This scale has been shown to have high internal consistency (α = .77), which suggests that E is tapping into a relatively stable construct (Costa & McCrae, 1992). A measure of extraversion was particularly useful in the context of the present study insofar as it also has been identified as an important predictor of social status among both male and female college undergraduates, using various data sources to operationalize status (Anderson, John, Keltner, & Kring, 2001).

Resource control measure. Designated in this study as the Resource Control Questionnaire-II (RCQ-II), this ten-item instrument was developed by Hawley (personal communication, March 27, 2008) largely based on a short measure used in previous research (Hawley, Little, & Card, 2008) to assess self-reported resource control strategies within a social context. The individual items can be found in Appendix C. Responses are scored on a 4-point Likert scale (1 = not at all true, 4 = completely true). The study cited above found adequate internal consistency on a six-item version of the measure (α = .70), while the present study found even greater consistency (α = .83) on the ten-item version. The RCQ-II, the NEO E, and the SSEI were all conceptualized as indicators of a social instrumentality construct.

Material wealth measure. Participants' material wealth was assessed by self-report of both personal, familial, and expected income, as well as any wealth likely to be inherited within participants' reproductive lifetimes. Individual items included the amount of money in participants' bank accounts, participants' total estimated net worth, average yearly income of the participants' financial support network, anticipated income and vocation five years after leaving college, the amount of money that they could get from their support network for a dire financial need given one week's notice, and the amount they expected to inherit from relatives, trust funds, or other irregular sources within the next twenty years. This questionnaire is reprinted in Appendix D. Suitable variables were loaded onto a single material well-being factor in the analysis as described below.

Attractiveness rating. Still color photographs of participants' faces were taken using a Canon DC230 digital camcorder at a resolution of 1152 x 864 pixels. Participants were instructed to adopt neutral expressions for the photographs. Researchers taking the photographs were also instructed to photograph participants wearing glasses both with and without the glasses, so that statistical correction for this variable could occur for those participants for whom only photographs with glasses had been taken. A total of 15 participants had both photographs taken, while 8 had only photographs with glasses taken.

Because attractiveness is implicated in the "good genes" view of sexual selection (e.g., Thornhill & Gangestad, 1994), as well as in same-sex competitor assessments (see Tovée & Cornelissen, 2001), attractiveness of each participant (or for each photo for those participants having both with- and without-glasses photographs) was rated by both same-sex and opposite-sex members of a rating panel. These ratings consisted of independent assessments from a panel of 8 raters (5 female, 3 male), who were presented the photographs in independently randomized orders. Following the metric suggested by Thornhill & Gangestad (1994), ratings of facial photos of subjects were made on a ten-point scale (1 = extremely unattractive; 10 = extremely attractive). Raters were instructed not to rate the attractiveness of participants with whom they were acquainted.

Waist-hip ratio. Waist-hip ratios were calculated to the nearest .25 inches[vi] using a tape measure, with participants standing with feet approximately 15 cm apart. Waist measurements were taken at the midpoint between the bottom of the rib cage and the iliac crest, or the narrowest part of this region if visually identifiable. Hip measurements were taken parallel to the ground at the largest circumference between the gluteofemoral fold and the waist. Deviations scores from "optimal" values with regard to health and attractiveness were then obtained by calculating the absolute value of the difference of WHR from .7 for females and from .9 for males.

Body-mass index. Body-mass index was measured using a digital scale (.2 lb. gradations) and a measuring stick, calibrated to the nearest .25 inches. BMI was calculated using the following formula: BMI = weight (lb) x 703 / [height^2 (in^2)]. Deviations scores from "optimal" values with regard to health and attractiveness were then obtained by calculating the absolute value of the difference of BMI from 20 for females and from 22 for males.

Procedure

Self-assessment measures were administered to participants in a randomized order. Following completion of these measures, pictures of the participants were taken using a digital camera, and measurements of fluctuating asymmetry, WHR, and BMI were performed by the principal investigator or a trained research assistant.

Individuals conducting body measurements were of the same sex as the participant in order to reduce participants' discomfort. During data collection, participants' identities were coded so as to disassociate identifying information from participants' data, as well as to provide an extra layer of protection against connecting self-report and measurement data with participants' pictures. Following data collection, participants were debriefed on the goals of the study.

Missing Values

Missing values constituted a relatively small proportion of the data set (Table 3). In order to reduce the loss of information from the sample, as well as to avoid deleterious consequences of ignoring data, missing values were imputed using the EM imputation algorithm in the PRELIS 2.80 program. This imputation process included all continuous variables described in this study with the exception of physical measurements made of the participants, attractiveness ratings (see immediately below), and age of first penile-vaginal intercourse[vii], as well as a large number of variables from a more expansive data set from which these data were drawn. The total percentage of missing data values was 1.49%. By employing an EM imputation algorithm using a near totality of available data, critical characteristics of the sample were maintained.

A separate EM imputation process, limited to the attractiveness data, was used for values missing from the attractiveness ratings. Among these ratings missing values (i.e., non-ratings of participants acquainted to the rater) again constituted a relatively small proportion of the data set (1.58%), ranging between 0% and 4.37% of the data for individual raters (Table 3). Following imputation, scores of the 15

Table 3

Percent of Missing Scores for Each Variable

Measure/Variable	Percent Missing
PANAS "Jittery"	0.469
RCQII Item 1	0.939
RCQII Item 2	1.408
RCQII Item 3	0.939
RCQII Item 4	0.939
RCQII Item 5	0.939
RCQII Item 6	0.939
RCQII Item 7	0.939
RCQII Item 8	0.939
RCQII Item 9	0.939
RCQII Item 10	0.939
RCQII Item 11	0.939
RCQII Item 12	1.408
RCQII Item 13	1.408
Number of PVI Partners (Lifetime)	2.347
Number of Non-PVI Sex Partners (Lifetime)	4.225

Table 3, continued

Percent of Missing Scores for Each Variable

Measure/Variable	Percent Missing
Number of PVI Partners (3 Months)	0.939
Number of Non-PVI Sex Partners (3 Months)	1.408
Episodes of PVI (3 Months)	4.695
Episodes of Non-PVI Sex (3 Months)	6.573
Recent Change in PVI Frequency	1.878
Recent Change in Non-PVI Sex Frequency	1.878
SSEI Item 1	0.469
SSEI Item 2	0.469
SSEI Item 3	0.469
SSEI Item 4	0.469
SSEI Item 5	0.469
SSEI Item 6	0.469
SSEI Item 7	0.939
SSEI Item 8	0.469
SSEI Item 9	0.469
SSEI Item 10	0.469
SSEI Item 11	0.469

Table 3, continued

Percent of Missing Scores for Each Variable

Measure/Variable	Percent Missing
SSEI Item 12	0.469
SSEI Item 13	0.469
SSEI Item 14	0.469
SSEI Item 15	0.469
SSEI Item 16	0.469
SSEI Item 17	0.469
SSEI Item 18	0.469
SSEI Item 19	0.469
SSEI Item 20	0.469
SSEI Item 21	0.469
SSEI Item 22	0.469
SSEI Item 23	0.469
SSEI Item 24	0.469
SSEI Item 25	0.469
SSEI Item 26	0.469
SSEI Item 27	0.469

Table 3, continued

Percent of Missing Scores for Each Variable

Measure/Variable	Percent Missing
SSEI Item 28	0.469
SSEI Item 29	0.469
SSEI Item 30	0.469
SWLS Item 1	0.939
SWLS Item 2	0.469
SWLS Item 3	0.469
SWLS Item 4	0.469
SWLS Item 5	0.469
SWLS Item 6	0.469
SWLS Item 7	0.469
SWLS Item 8	0.469
Number of Colds (3 Months)	2.347
Days of Colds (3 Months)	2.347
Number of Respiratory Flus (3 Months)	1.878
Days of Respiratory Flus (3 Months)	0.939
Number of Other Respiratory Infections (3 Months)	1.408
Days of Other Respiratory Infections (3 Months)	1.878

Table 3, continued

Percent of Missing Scores for Each Variable

Measure/Variable	Percent Missing
Number of Stomach Flus (3 Months)	1.408
Days of Stomach Flus (3 Months)	0.939
Number of Stomach Infections (3 Months)	1.408
Days of Stomach Infections (3 Months)	1.878
Number of Any Other Infections (3 Months)	2.347
Days of Any Other Infections (3 Months)	3.286
Times Prescribed Antibiotics (3 Months)	1.878
Change in Health over the Last Week	0.939
Attractiveness (Male Rater #2)	4.367
Attractiveness (Female Rater #1)	.437
Attractiveness (Female Rater #2)	2.183
Attractiveness (Female Rater #3)	.437
Attractiveness (Female Rater #4)	3.057
Attractiveness (Female Rater #5)	2.183

Note. All other variables had zero missing values.

participants for whom both with-glasses and without-glasses photographs were taken were isolated. For each rater, without-glasses scores for these 15 individuals were regressed onto the variables of patient gender, with-glasses scores, and the interaction term of the two (after mean-centering the continuous variable). For the remaining 8 participants for whom with-glasses photographs alone had been obtained, predicted scores from the regression equations were calculated to provide expected without-glasses ratings.

Without-glasses ratings (using predicted scores if actual ones were unavailable) were then compiled and used as the basis of attractiveness measurements. Ratings were converted to z-scores within participant genders with respect to each rater, to control for individual differences in raters' approaches to the assessments and any differential ratings attributable solely to the gender of the participant being rated. A composite attractiveness value was then calculated as an average of raters' scores, weighted to allow for equal contributions from both female and male raters.

Fluctuating Asymmetry Calculation

Using digital calipers read to the nearest .01 mm, each trait was measured a minimum of two times for reliability, with the measurers being instructed to take a third measurement if the first two were clearly measured unreliably (i.e., differed by more than 1.50 mm). This guideline was followed by measurers the vast majority of the time (Table 4). If this third measurement was nearer to either of the first two measurements, it replaced the outlier in calculating fluctuating asymmetry for that trait. The final two scores for each trait were then averaged. For participants reporting significant trauma in one or more body parts, either on the health history questionnaire or when directly queried by the measurers, those traits were excluded from calculation of the final fluctuating asymmetry scores (Table 4). Also excluded

Table 4

Percent of Missing Scores for Each Variable

Measure	Percent Failing Third Measurement Guideline	Percent Not Measured at Least Twice	Percent Excluded Due to Injury
REW	3.286%	0.000%	0.000%
REL	3.286%	0.000%	0.000%
RWW	2.817%	0.000%	0.000%
R2D	3.756%	0.469%	0.469%
R4D	4.225%	0.000%	0.469%
RAW	5.164%	1.878%	2.817%
RFW	7.981%	0.939%	0.000%
LEW	3.286%	0.000%	0.939%
LEL	3.286%	0.000%	0.939%
LWW	2.817%	0.469%	0.000%
L2D	3.756%	0.469%	0.469%
L4D	3.756%	0.469%	0.469%
LAW	6.103%	1.878%	3.286%
LFW	7.512%	0.939%	0.939%

Note. REW = right ear width; REL = right ear length; RWW = right wrist width; R2D = right digit 2 (index finger) length; R4D = right digit 4 (ring finger) length; RAW = right ankle width; RFW = right foot width; LEW = left ear width; LEL = left ear length; LWW = left wrist width; L2D = left digit 2 (index finger) length; L4D = left digit 4 (ring finger) length; LAW = left ankle width; LFW = left foot width.

were traits for which two usable measurements on each side were not retained (see Table 4). Due to the degree of missing or unusable data provided for measurements of ankle width, as well as concerns about repeatability, this trait was ultimately dropped from the final calculations of composite fluctuating asymmetry. Concerns about the repeatability of foot width also led to its being dropped from final calculations. The reliabilities of measurement (comparing the first and second right-left difference scores) for each of the five remaining traits are summarized in Table 5.

Table 5

Reliabilities for All Fluctuating Asymmetry Traits Used in the Final Analysis, Comparing Signed Asymmetries from the First and Second Measurements

Trait	*r*
EW	.819
EL	.842
WW	.773
2D	.798
4D	.744

Note. EW = ear width; EL = ear length; WW = wrist width; 2D = digit 2 (index finger) length; 4D = digit 4 (ring finger) length.

Fluctuating asymmetry was calculated according to accepted standards (Palmer & Strobeck, 1986), such that absolute percent asymmetry for individual body parts were calculated and then summed for individuals' composite fluctuating asymmetry indices:

$$\text{CFA} = \sum \frac{|\text{L - R}|}{.5(\text{L+R})}.$$

This measurement method ensured that asymmetries for each trait were adjusted with regards to the relative size of the trait being measured. These scores were then transformed to *z*-scores.

Additionally, another measure of fluctuating asymmetry was calculated in order to establish an individual participant's global fluctuating asymmetry relative to the global fluctuating asymmetry of others in the sample. For this measure, the absolute percent asymmetry for traits were calculated individually but transformed to *z*-scores prior to being summed. As expected, these two measures of fluctuating asymmetry were highly correlated, $r = .911$, $p < .001$. Although the original intent in the analysis was to include each measure of fluctuating asymmetry as an indicator of the latent construct, concerns of multicollinearity forced the adoption of one method of calculation (*z*-score tranformation prior to CFA summing).

Analytic Procedures

Structural equation modeling (SEM) was used to examine research questions and to evaluate the veracity of the theoretical models. SEM was particularly relevant to this research, given the assumptions that many manifest variables in the study might contain more than negligible amounts of measurement error (e.g., attractiveness) or were likely to be driven by factors not logistically conducive to direct measurement (e.g., physical health), both of which were addressed through the use and analysis of latent variables. Additionally, the use of means and covariance structures permitted the analysis of measurement equivalence between groups (namely, gender). A sequence of test was employed to test the reasonableness and characteristics of the hypothesized models, in the following order:

(a) testing of the measurement model specifying the relationships between manifest variables and latent constructs;
(b) testing the measurement equivalence of the model between males and females;
(c) testing the equivalence of latent variances and associations between the two groups;
(d) testing the equivalence of latent construct means between the two groups; and
(e) testing the structural models suggesting causal relationships among the latent constructs in each group.

Although these tests were first used on the two-group model as a whole, some steps (e.g., evaluation of equivalence of variances) were also conducive to analysis of individual latent variables. This series of analyses was performed using LISREL 8.80.

Twelve latent variables were ultimately selected for inclusion in the measurement model: satisfaction with life (SWL), positive affect (PA), negative affect (NA), physical health (Health), attractiveness (Attract.), deviation of waist-hip ratio from the "optimal" value for each gender (WHR Dev.), deviation of body-mass index from the "optimal" value for each gender (BMI Dev.[viii]), short-term mating strategies (STMS)[ix], social instrumentality (SI), material well-being (MWB), the *g*-factor of intelligence (*g*), and fluctuating asymmetry (FA). Three of these latent constructs (WHR Deviation, BMI Deviation, and FA) were represented by single indicators, whereas the other seven were represented by two to five indicators. In order for the three singly indicated variables to be identified in the model, their residuals were constrained to a value of zero, in addition to constraints intended for scale setting. Consequently, these three "latent" variables were functionally equivalent to manifest variables in the data analysis. For SWL, the five items of the scale were used as individual indicators of the construct.

For the other eight latent variables, parceling was used in a variety of ways to construct appropriate indicators. For PA and NA, an item-to-construct balancing technique was used to create locally just-identified conditions. This method was favored in order to maximize the likelihood that, if measurement variance was later found in the model, this could be attributed to constructs in which this variance would be most meaningful (viz., the fitness indicators), as opposed to those for which it would be less meaningful and theoretically ambiguous (viz., the criterion variables in the structural models). The technique of item-to-construct balancing has well-established support in the literature (Little, Cunningham, Shahar, & Widaman, 2002).

For *g*, items were parceled in a quasi-item-to-construct parceling method. For these parcels, the three (theoretically) most difficult items were used to anchor the three parcels, with the remaining items distributed evenly among the parcels, again in terms of difficulty, so that approximately equal levels of difficulty could be assumed to exist for each parcel.

In contrast, facet-representative parceling methods were used to construct indicators for Health, Attract., STMS, SI, and MWB. In the case of Health, days of reported illness, number of reported illnesses, and number of times antibiotics were prescribed to the participant were each used as separate indicators. For Attract., two parcels were used: one of ratings made by male raters, and one of ratings made by female raters. STMS was indicated by age at first participation in penile-vaginal intercourse (PVI), number of PVI partners over the lifetime, and number of PVI partners over the last 3 months. SI included parcels representing resource control (measured by the RCQ-II), self-perceived adeptness in social situations (measured by the SSEI), and extraversion (measured by the NEO E subscale). Finally, for MWB, the three indicators corresponded to three aspects of perceived current or expected financial welfare: the current income of the primary support group (also called "family income"), the amount of money that could be raised in 1 week for a dire need ("1 week's notice", and the participant's anticipated income in 5 years ("future income")[x].

Scale setting of constructs consisted of setting latent variances equal to 1.0. Scale setting is necessary in order to yield identified solutions during parameter estimation. Following initial attempts to specify the model, the WHR Deviation variable was dropped due to poor performance and unexpected relationships with other values that strongly suggested that this variable may have been either inadequately measured in the sample or inappropriately calculated as a deviance from the identified "optimal" value. For this reason, WHR Deviation was not included in the subsequent analyses or the following reports.

Figure 1 illustrates the resulting measurement model being tested, along with constrained parameters.

Results

Investigation of the study's ultimate interests—determining the relationships between fitness-related variables and the affect and SWB variables, with an exploration of gender-based differences—was preceded by a series of tests aimed at the development of structural models. Modeling the data in this manner required a series of nested tests beginning with a measurement model and models designed to evaluate equivalence of constructs between groups. Below are the findings as they relate to this series of nested models, followed by the development of structural paths.

Measurement Model

The first step, evaluating the adequacy of the model with regard to its reproduction of observed relationships among the indicators (with correlations and descriptive statistics to be found in Table 6 and Table 7), was examined using the measurement model described above in *Analytic Procedures*. This freely estimated, two-group configural model appeared to have good fit ($\chi^2_{(704,\, n = 213)} = 831.839$, $p = .00063$, RMSEA = .0415, NNFI = .955, CFI = .963; Table 8). Although LISREL suggested several possible modification indices, none appeared to reflect obvious theoretical, rather than artifactual, considerations.

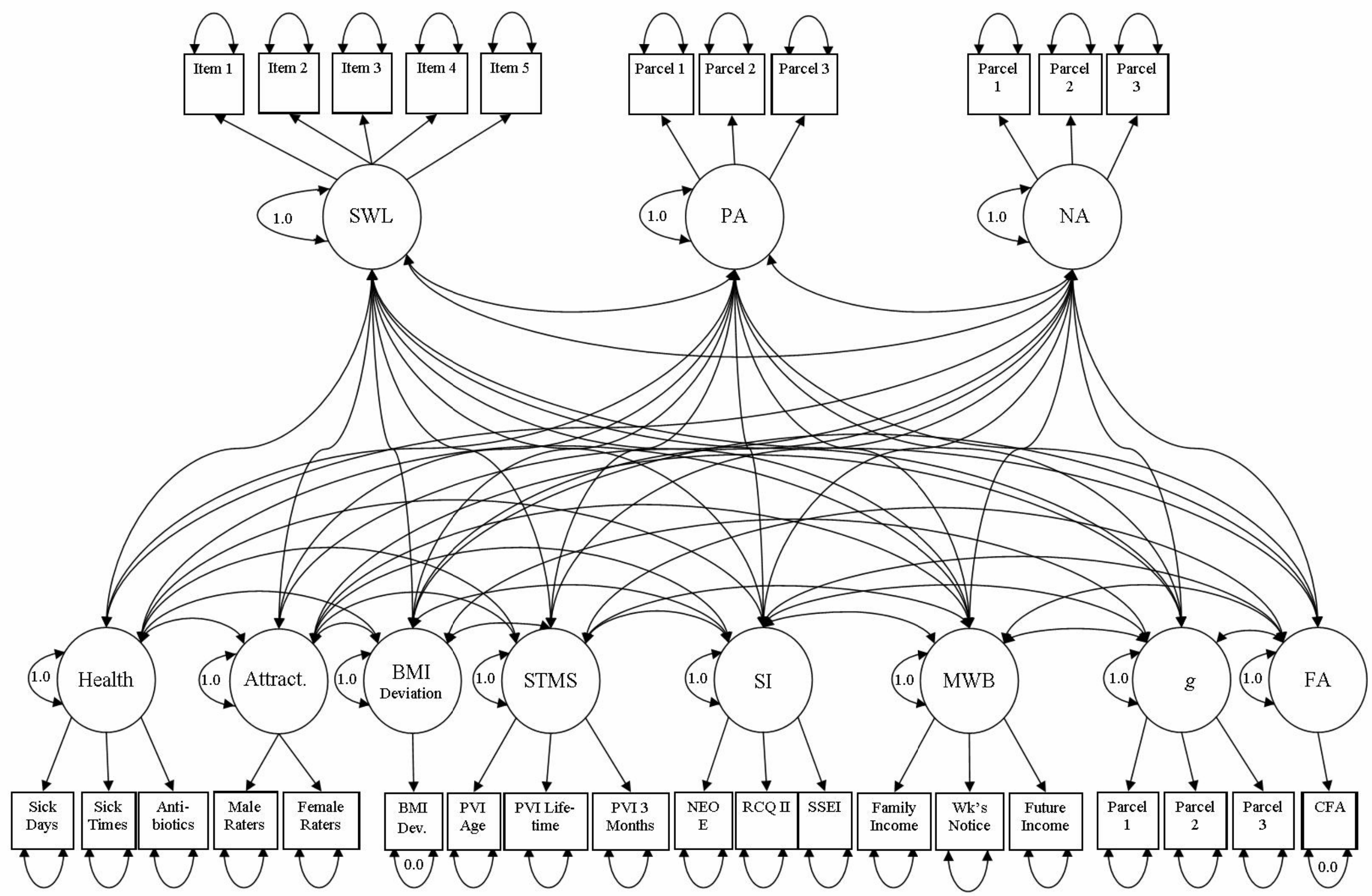

Figure 1. Measurement model being tested, including covariances, variances, residuals, and factor loadings. Also shown are the constrained parameters.

Table 6
Correlations Matrix for All Manifest Variables

		Females (*n*=106)														
		SWLS Item 1	SWLS Item 2	SWLS Item 3	SWLS Item 4	SWLS Item 5	PA Par. 1	PA Par. 2	PA Par. 3	NA Par. 1	NA Par. 2	NA Par. 3	HHQ Days	HHQ Times	HHQ Anti	Attract Male
Males (*n*=107)	SWLS Item 1	--	.689	.646	.388	.319	.286	.270	.312	-.424	-.384	-.354	.083	.093	.085	.111
	SWLS Item 2	.774	--	.646	.470	.256	.276	.205	.292	-.364	-.389	-.351	.156	.049	.092	.152
	SWLS Item 3	.694	.656	--	.575	.446	.370	.233	.412	-.438	-.428	-.454	-.010	-.070	.029	.105
	SWLS Item 4	.611	.564	.717	--	.218	.313	.216	.224	-.127	-.167	-.165	.090	-.044	.135	.008
	SWLS Item 5	.484	.484	.531	.510	--	.288	.122	.209	-.350	-.226	-.234	.041	.089	.039	.090
	PA Parcel 1	.423	.366	.485	.370	.458	--	.587	.690	-.219	-.174	-.095	-.035	-.054	-.031	.056
	PA Parcel 2	.495	.433	.369	.350	.302	.551	--	.633	-.119	-.035	.048	-.076	-.048	-.050	-.001
	PA Parcel 3	.370	.272	.407	.203	.282	.725	.505	--	-.133	-.122	.040	-.048	-.110	-.162	.051
	NA Parcel 1	-.308	-.242	-.318	-.318	-.324	-.242	-.165	-.179	--	.658	.720	.058	-.056	-.049	-.044
	NA Parcel 2	-.397	-.282	-.349	-.299	-.309	-.335	-.206	-.244	.626	--	.713	.100	.008	.003	.090
	NA Parcel 3	-.462	-.291	-.486	-.426	-.487	-.327	-.305	-.288	.690	.652	--	.072	.031	-.041	.066
	HHQ Days Sick	.021	-.111	-.027	-.043	-.058	-.133	-.012	-.082	.115	.108	.063	--	.671	.383	.019
	HHQ Times Sick	-.083	-.137	-.128	-.168	-.104	-.013	-.109	-.012	.160	.053	.106	.615	--	.271	.026
	HHQ Antibiotics	-.036	-.213	-.166	-.068	-.118	-.170	-.091	-.222	-.045	.103	.089	.495	.349	--	.233
	Attract. Male Raters	.077	.091	.033	-.060	.179	.050	.102	.020	-.020	.034	-.016	-.116	-.143	-.104	--

Table 6, continued

Correlations Matrix for All Manifest Variables

	Females (*n*=106)														
	Attract. Female	BMI_ Dev.	PVI 1st Age	PVI Partner Life	PVI Partner 3 mos	NEOE	RCQII	SSEI	Family Income	Wk's Notice	Antic. Income	g Par. 1	g Par. 2	g Par. 3	CFA
SWLS Item 1	.202	-.219	.163	-.105	-.217	.560	.245	.489	.170	.117	.099	.112	.046	.008	-.014
SWLS Item 2	.146	-.230	.202	-.040	-.151	.352	.195	.371	.212	.164	.130	-.015	-.132	-.067	-.155
SWLS Item 3	.156	-.122	.231	-.218	-.063	.377	.104	.290	.188	.141	.145	-.030	-.145	.014	-.054
SWLS Item 4	.133	.016	.095	-.104	-.059	.340	.203	.235	.064	.113	.087	.095	-.155	-.049	-.046
SWLS Item 5	.081	-.068	.132	-.059	.091	.270	.093	.302	.044	.161	.235	.009	.004	-.014	-.116
PA Parcel 1	.018	-.004	-.047	-.121	.062	.488	.281	.389	.034	.117	.075	.008	-.055	-.040	-.054
PA Parcel 2	-.020	-.017	-.157	.123	.020	.518	.136	.327	.052	.113	.089	.060	-.035	.082	-.034
PA Parcel 3	.029	-.043	.031	-.196	-.134	.422	.073	.289	.102	.104	.007	.074	-.062	-.001	-.033
NA Parcel 1	-.086	.210	-.184	.119	-.053	-.315	-.168	-.296	-.146	-.294	-.231	.081	.112	.107	-.156
NA Parcel 2	.046	-.001	-.182	.068	-.055	-.196	-.198	-.260	-.006	-.015	-.054	.155	.121	.291	-.189
NA Parcel 3	.040	-.051	-.281	.074	-.051	-.186	-.183	-.242	-.086	-.098	-.208	.045	.059	.079	-.201
HHQ Days Sick	.076	-.032	-.170	.074	.111	.047	.053	.168	.118	-.025	.050	.002	.091	-.097	-.023
HHQ Times Sick	-.001	-.079	-.186	.132	.054	.108	.163	.129	.056	.050	.043	-.108	.056	-.156	.009
HHQ Antibiotics	.109	-.115	.044	.243	.125	.046	.087	.022	.016	-.178	.149	-.066	.000	.012	.205
Attract. Male Raters	.734	-.509	-.079	.104	.234	.092	.007	.058	.058	.006	.193	.108	.035	.116	-.070

Table 6, continued

Correlations Matrix for All Manifest Variables

		SWLS Item 1	SWLS Item 2	SWLS Item 3	SWLS Item 4	SWLS Item 5	PA Par. 1	PA Par. 2	PA Par. 3	NA Par. 1	NA Par. 2	NA Par. 3	HHQ Days	HHQ Times	HHQ Anti	Attract Male
Males (n=107)	Attract. Female	.072	.057	.010	-.074	.071	.110	.198	.146	.054	.072	.054	-.088	-.088	-.087	.743
	BMI Deviation	-.070	-.075	-.086	-.075	-.081	-.127	-.151	-.142	.081	.000	-.007	.025	.061	.093	-.281
	PVI 1st Age	-.003	.144	-.017	.041	.068	-.218	-.074	-.072	-.118	-.001	-.018	-.017	-.118	-.152	-.179
	PVI Partners (Lifetime)	.018	.051	.029	-.066	-.001	.206	.127	.149	.085	.015	.018	-.012	.106	.045	.139
	PVI Partners (3 months)	.036	.067	.144	.078	.162	.256	.121	.187	.007	-.034	-.093	.140	.266	.161	.130
	NEOE	.462	.341	.387	.249	.276	.483	.538	.430	-.128	-.117	-.191	.027	.089	.044	.122
	RCQII	.261	.268	.282	.307	.206	.456	.307	.318	.012	-.079	.048	-.009	.044	-.077	-.020
	SSEI	.394	.305	.378	.236	.258	.449	.383	.398	-.150	-.209	-.216	.001	.050	-.043	.178
	Family Income	-.075	.059	-.015	.004	.061	-.106	-.061	-.164	.200	.143	.163	.082	.020	.097	-.012
	Week's Notice	-.088	-.030	-.104	-.107	-.049	-.093	-.043	-.152	.183	.164	.206	.020	.020	.015	.016
	Anticipated Income	.075	.058	.148	.189	.036	.079	.031	.006	-.021	-.069	-.047	-.124	.020	.026	-.234
	g Parcel 1	.028	.134	.090	.110	.098	.034	-.052	.041	-.133	-.051	.008	-.117	-.192	-.138	.018
	g Parcel 2	-.078	-.071	.073	.078	.039	-.021	-.092	.044	.054	.017	.036	-.041	-.080	-.152	.017
	g Parcel 3	.145	.157	.131	.188	.246	.184	.063	.175	-.160	-.164	-.245	-.048	-.174	-.090	-.010
	Composite FA	-.022	.071	-.050	-.018	-.070	.003	.030	.014	.112	.270	.126	.065	.034	.035	-.121

Table 6, continued

Correlations Matrix for All Manifest Variables

Males (n=107)	Females (n=106) Attract. Female	BMI_ Dev.	PVI 1st Age	PVI Partner Life	PVI Partner 3 mos	NEOE	RCQII	SSEI	Family Income	Wk's Notice	Antic. Income	g Par. 1	g Par. 2	g Par. 3	CFA
Attract. Female	--	-.448	-.089	.027	.172	.105	.056	.146	.087	.075	.261	.212	.057	.107	-.030
BMI Deviation	-.326	--	.086	-.046	-.108	-.147	-.084	-.165	-.157	-.203	-.125	.077	.097	.093	.099
PVI 1st Age	-.279	.056	--	-.461	-.478	-.059	-.134	-.135	-.141	-.175	-.248	-.020	.045	.011	.110
PVI Partners (Lifetime)	.124	.081	-.415	--	.471	.078	.079	.181	-.042	-.038	.273	-.094	-.101	-.005	.030
PVI Partners (3 months)	.250	-.019	-.443	.515	--	.048	.083	.070	-.055	.071	.162	-.160	-.237	-.088	.152
NEOE	.167	-.089	-.162	.230	.221	--	.329	.677	.089	.158	.064	-.061	-.210	-.137	.036
RCQII	.006	-.084	-.224	.326	.368	.415	--	.504	.087	-.026	.192	.038	-.060	-.001	.116
SSEI	.122	-.135	-.147	.250	.305	.726	.530	--	.109	.181	.165	-.046	-.112	-.100	.030
Family Income	.045	-.015	-.055	.006	.170	.019	-.056	-.125	--	.186	.354	.027	.056	.051	-.008
Week's Notice	.066	.010	-.028	-.063	.019	.041	.053	-.013	.369	--	.241	.132	-.163	-.008	-.093
Anticipated Income	-.135	.021	-.101	-.002	.097	.082	.224	.143	.303	.357	--	.170	.025	.083	-.017
g Parcel 1	-.037	.050	.187	-.104	-.091	.013	.075	.108	.053	.025	-.058	--	.420	.358	-.006
g Parcel 2	-.044	.029	.051	.013	.084	-.101	.096	-.016	.084	.055	.021	.519	--	.286	.039
g Parcel 3	-.049	.114	.013	.021	-.016	.063	.007	.070	-.023	-.103	-.132	.390	.334	--	.149
Composite FA	-.077	.116	.132	-.031	-.054	-.087	-.086	-.065	-.177	-.008	-.110	.010	-.171	-.036	--

Table 7
Descriptive Statistics of Manifest Variables Used in Modeling

Variable	Males *Mean*	Males *SD*	Females *Mean*	Females *SD*
SWLS Item 1	5.12	1.23	5.16	1.33
SWLS Item 2	5.46	1.25	5.28	1.35
SWLS Item 3	5.61	1.26	5.74	1.19
SWLS Item 4	5.18	1.42	5.58	1.16
SWLS Item 5	4.51	1.72	4.87	1.62
PA Parcel 1	3.59	.71	3.29	.84
PA Parcel 2	3.54	.79	3.54	.88
PA Parcel 3	3.72	.68	3.46	.68
NA Parcel 1	2.44	.88	2.56	.88
NA Parcel 2	1.75	.78	1.93	.95
NA Parcel 3	1.70	.73	1.78	.81
HHQ Days Sick	9.49	10.45	9.54	9.84
HHQ Times Sick	1.92	1.89	2.14	1.91
HHQ Antibiotics	.35	.74	.54	.83
Attract. Male Raters	.032	.71	.00000	.78
Attract. Female Raters	.031	.74	.00002	.79
BMI Deviation	1.69	.90	1.70	.99
PVI 1st Age	17.51	1.51	17.37	1.57
PVI Partners (Lifetime)	4.07	6.30	2.45	3.46
PVI Partners (3 months)	1.11	1.18	.78	.77
NEOE	45.44	6.28	46.21	7.10
RCQII	2.70	.45	2.57	.52
SSEI	4.87	.73	4.85	.78
Family Income	11.68	.94	11.47	.88
Week's Notice	8.79	1.95	8.10	1.81
Anticipated Income	11.20	.45	10.96	.45
g Parcel 1	.61	.28	.62	.25
g Parcel 2	.63	.29	.66	.28
g Parcel 3	.53	.27	.53	.27
Composite FA	-.11	.43	.11	.51

Table 8

Fit Indices for the Nested Sequence in the Multiple Group Confirmatory Factor Analysis

Model	χ^2	*df*	*p*	$\Delta\chi^2$	Δdf	*p*	RMSEA	RMSEA 90% CI	NNFI	CFI	Constraint Tenable?
Configural Invariance	831.839	704	.00063	---	---	---	.0415	(.0284, .0524)	.955	.963	---
Weak Metric In. (WMI)[1]	879.413	723	.00006	---	---	---	.0453	(.0335, .0556)	.946	.955	Yes
Strong Metric In. (SFI)[1]	928.932	742	<.00001	---	---	---	.0489	(.0380, .0586)	.937	.946	Yes
Variance Homogeneity[2]	933.489	734	<.00001	54.085	11	<.001	.0508	(.0402, .0603)	.932	.943	No
Equality of Correlations[2]	944.653	778	.00004	65.240	55	.1624	.0451	(.0337, .0550)	.947	.952	Yes
Latent Mean Invariance[3]	1015.955	753	<.00001	87.023	11	<.001	.0575	(.0481, .0664)	.913	.925	No

Note. Variance Homogeneity and Equality of Correlations models were nested in the Weak Metric Invariant model. The Latent Mean Invariance was nested in the Strong Metric Invariance Model.

[1] Evaluated with the RMSEA Model Test, with respect to and nested within the previous models.

[2] Evaluated with the χ^2 Difference Test, comparing to the WMI model

[3] Evaluated with the χ^2 Difference Test, comparing to the SMI model

The second step was to determine if the latent variables appeared to be measuring the same constructs in both males and females. This question was evaluated by investigating if weak and strong metric invariance of the two groups (i.e. invariance of loadings and intercepts) were tenable. Weak metric invariance was first tested using standard procedures by equating the factor loadings in the female group to those in the male group. The model continued to show good fit ($\chi^2_{(723,\ n = 213)}$ = 879.413, p = .00006, RMSEA = .0453, NNFI = .946, CFI = .955; Table 8). After constraining the loadings, the RMSEA of the resulting model continued to fall into the 90% confidence interval of the model in which it was nested (satisfying the so-called "RMSEA Model Test"; Little, 1997) and the CFI decreased by less than .01, a standard benchmark for this fit statistic (Cheung & Rensvold, 2002). Based upon these findings, weak metric invariance appeared to be tenable for the model as a whole.

Strong metric invariance was then tested by equating intercepts of the manifest indicators between males and females. Because this test assumed tenability of weak metric invariance, this test was nested within a model in which loadings were equated between groups. These added constraints yielded a good-fitting model ($\chi^2_{(742,\ n = 213)}$ = 928.932, p < .00001, RMSEA = .0489, NNFI = .937, CFI = .946; Table 8). Again, both the RMSEA Model Test and the CFI benchmark were satisfied. Consequently, the overall model appeared to reproduce the observed covariance matrix with adequate fidelity while simultaneously measuring equivalent latent constructs between the two groups. The values of the indicators' loadings, residuals, and squared multiple correlations for the strong metric invariant model are included in Table 9.

Homogeneity of variances of latent constructs was then evaluated in order to identify potential differences in the manifestation of latent characteristics between males and females. This test was nested within the weak metric invariance model, assuring that any differences in latent variances could be attributed to actual differences in the variables as opposed to differences in the meanings of the constructs between genders. Because this test sought to evaluate specific hypotheses between the error-free latent constructs, as oppose to determining appropriateness and parsimony of a model, a more stringent statistical test of fit ($\Delta\chi^2$) was used. This test found significant differences between males and females in latent variances ($\Delta\chi^2_{(11, n = 213)} = 54.085$, $p < .001$; Table 8). As a result of this significant finding of overall variance differences, follow-up tests of variance homogeneity on individual constructs were performed to identify the heterogeneous variables driving this finding (Table 10). This procedure identified BMI Dev., STMS, and FA as the variables principally responsible for the significant finding in the overall test of variance homogeneity. Latent construct variances from the strong metric invariant model are printed in Table 9. These parameter estimates show that BMI Dev. and FA variances were significantly larger in females than in males, while STMS showed more variability in males than females.

Homogeneity of associations (correlations) was then tested using a similar nesting technique, again within the weak metric invariant model and using the more

Table 9

Loading and Intercept Values, Residuals, and R^2 Values for Each Indicator, and the Estimated Latent Variance from the Strong Factorial Invariance Model of Tenable Variables

	Equated Estimates			Males		Females	
Indicator	*Loading (SE)*	*Intercept (SE)*	*Standardized Loading*[a]	*Theta (SE)*	R^2	*Theta (SE)*	R^2
SWLS: Estimated Latent Variance (Males = 1.000; Females = .846)							
Item 1	1.370 (.116)	5.108 (.146)	.814	.500 (.110)	.790	1.265 (.206)	.557
Item 2	1.361 (.123)	5.366 (.151)	.778	.801 (.143)	.698	1.438 (.229)	.522
Item 3	1.323 (.118)	5.635 (.145)	.841	.818 (.142)	.682	.517 (.111)	.741
Item 4	1.114 (.128)	5.390 (.143)	.636	2.125 (.309)	.369	1.241 (.191)	.459
Item 5	1.592 (.213)	4.643 (.228)	.545	5.658 (.812)	.309	5.431 (.787)	.283
PA: Estimated Latent Variance (Males = 1.000; Females = 1.473)							
Parcel 1	.462 (.039)	3.585 (.049)	.837	.044 (.016)	.828	.181 (.035)	.634
Parcel 2	.392 (.045)	3.642 (.054)	.636	.239 (.036)	.392	.321 (.050)	.414
Parcel 3	.345 (.033)	3.693 (.041)	.828	.083 (.018)	.588	.052 (.015)	.773

[a] Common Metric Completely Standardized Solution

Table 9, continued

Loading and Intercept Values, Residuals, and R^2 Values for Each Indicator, and the Estimated Latent Variance from the Strong Factorial Invariance Model of Tenable Variables

	Equated Estimates			Males		Females	
Indicator	*Loading (SE)*	*Intercept (SE)*	*Standardized Loading*[a]	*Theta (SE)*	R^2	*Theta (SE)*	R^2
NA: **Estimated Latent Variance (Males = 1.000; Females = 1.610)**							
Parcel 1	.529 (.052)	2.438 (.064)	.787	.261 (.043)	.517	.187 (.038)	.707
Parcel 2	.526 (.049)	1.766 (.060	.786	.135 (.028)	.672	.310 (.052)	.589
Parcel 3	.449 (.040)	1.689 (.050)	.868	.076 (.018)	.726	.096 (.023)	.773
Health: Estimated Latent Variance (Males = 1.000; Females = .968)							
Sick Days	-91.592 (9.865)	5.667 (10.261)	-.881	3492.937 (1194.353)	.706	1246.228 (1122.188)	.867
Sick Times	-2.617 (.310)	1.955 (.317)	-.719	6.159 (1.243)	.527	6.411 (1.277)	.509
Antibiotics	-.305 (.047)	.405 (.047)	-.478	.029 (.032)	.307	.408 (.058)	.181

[a] Common Metric Completely Standardized Solution

Table 9, continued

Loading and Intercept Values, Residuals, and R^2 Values for Each Indicator, and the Estimated Latent Variance from the Strong Factorial Invariance Model of Tenable Variables

	Equated Estimates			Males		Females	
Indicator	*Loading (SE)*	*Intercept (SE)*	*Standardized Loading*[a]	*Theta (SE)*	R^2	*Theta (SE)*	R^2
Attractiveness: Estimated Latent Variance (Males = 1.000; Females = 1.368)							
Male Raters	.444 (.041)	.032 (.048)	.866	.057 (.021)	.777	.099 (.028)	.732
Female Raters	.458 (.044)	.032 (.051)	.851	.086 (.024)	.709	.103 (.030)	.735
BMI Deviation: Estimated Latent Variance (Males = 1.000; Females = 1.461)							
BMI Dev.	.803 (.055)	1.692 (.078)	1.000	--- (---)	1	--- (---)	1
Short-Term Mating Strategies: Estimated Latent Variance (Males = 1.000; Females = .182)							
Age at First PVI	-1.664 (.229)	17.353 (.213)	-.550	2.880 (.590)	.490	4.714 (.670)	.097
Number of PVI Partners, Lifetime	22.081 (3.250)	6.061 (2.784)	.597	976.434 (158.498)	.333	60.972 (16.249)	.593
Number of PVI Partners, Last 3 Months	.966 (.125)	.975 (.119)	.698	.961 (.194)	.493	.197 (.038)	.463

[a] Common Metric Completely Standardized Solution

Table 9, continued

Loading and Intercept Values, Residuals, and R^2 Values for Each Indicator, and the Estimated Latent Variance from the Strong Factorial Invariance Model of Tenable Variables

	Equated Estimates			Males		Females	
Indicator	*Loading (SE)*	*Intercept (SE)*	*Standardized Loading*[a]	*Theta (SE)*	R^2	*Theta (SE)*	R^2
Social Instrumentality: Estimated Latent Variance (Males = 1.000; Females = 1.348)							
NEO E	33.512 (3.140)	46.826 (3.759)	.807	471.436 (106.522)	.704	937.934 (184.246)	.617
RCQ II	.121 (.016)	2.659 (.018)	.530	.028 (.004)	.343	.059 (.009)	.248
SSEI	.449 (.042)	4.879 (.050)	.851	.083 (.019)	.708	.096 (.027)	.738
Material Well-Being: Estimated Latent Variance (Males = 1.000; Females = .800)							
Family Income	.245 (.056)	11.699 (.072)	.279	.746 (.103)	.074	.531 (.074)	.083
One-Week's Notice	.939 (.231)	8.928 (.297)	.253	13.130 (1.800)	.063	10.113 (1.407)	.065
Anticipated Income	.236 (.037)	11.199 (.020)	1.104	-.015 (.016)	1.371	-.003 (.013)	1.069

[a] Common Metric Completely Standardized Solution

Table 9, continued

Loading and Intercept Values, Residuals, and R^2 Values for Each Indicator, and the Estimated Latent Variance from the Strong Factorial Invariance Model of Tenable Variables

	Equated Estimates			Males		Females	
Indicator	*Loading (SE)*	*Intercept (SE)*	*Standardized Loading*[a]	*Theta (SE)*	R^2	*Theta (SE)*	R^2
g: Estimated Latent Variance (Males = 1.000; Females = .691)							
Parcel 1	.056 (.007)	.610 .007	.739	.002 (.001)	.565	.002 (.001)	.521
Parcel 2	.055 (.008)	.636 (.007)	.613	.004 (.001)	.428	.004 (.001)	.319
Parcel 3	.041 (.007)	.522 (.006)	.517	.004 (.001)	.294	.004 (.001)	.236
FA: Estimated Latent Variance (Males = 1.000; Females = 2.032)							
CFA	.183 (.013)	-.114 (.018)	1.000	--- (---)	1	--- (---)	1

[a] Common Metric Completely Standardized Solution

Table 10

Fit Indices for the Nested Sequence in Individual Construct Tests of Homogeneity of Variance

Model	χ^2	*df*	*p*	$\Delta\chi^2$	Δdf	*p*	RMSEA	RMSEA 90% CI	NNFI	CFI	Tenable?
SWLS	880.605	724	.00005	1.192	1	.2749	.0453	(.0335, .0555)	.946	.955	Yes
PA	881.171	724	.00005	1.785	1	.1815	.0454	(.0336, .0556)	.946	.955	Yes
NA	881.118	724	.00005	1.705	1	.1916	.0454	(.0336, .0556)	.946	.955	Yes
Health	879.408	724	.00006	.005	1	.9486	.0451	(.0333, .0554)	.947	.955	Yes
Attract.	881.598	724	.00005	2.185	1	.1393	.0454	(.0337, .0557)	.946	.955	Yes
BMI Dev.	887.354	724	.00003	7.941	1	.0048	.0462	(.0347, .0564)	.944	.953	No
STMS	901.585	724	.00001	22.172	1	<.0001	.0482	(.0371, .0581)	.939	.949	No
SI	882.888	724	.00004	3.475	1	.0623	.0456	(.0339, .0558)	.945	.954	Yes
MWB	879.214	724	.00006	.199	1	.6555	.0451	(.0333, .0554)	.947	.956	Yes
g	880.432	724	.00006	1.019	1	.3127	.0453	(.0335, .0555)	.946	.955	Yes
FA	893.411	724	.00002	13.998	1	.0001	.0471	(.0358, .0571)	.942	.951	No

Note. Variance Homogeneity models were nested in the Weak Metric Invariant model. Tenability was evaluated with the χ^2 difference test.

stringent test of fit. Findings suggested invariance in the pattern of correlations between males and females ($\Delta\chi^2_{(55,\, n = 213)} = 65.240$, $p = .1624$; Table 8). However, this finding was tempered by the fact that this test enjoyed large number of degrees of freedom and many near-zero latent correlations, meaning that the significance of any otherwise notable differences in correlations between males and females was able to be understated by this test. Consequently, this finding of invariance did not render inappropriate the later systematic and differential elimination of paths between latent constructs when constructing the structural models (described below).

Finally, the equivalence of the latent means between groups was tested, using a model nested within the strong metric invariance model. As with the tests of homogeneity of variance and equality of correlations tests, the change in χ^2 between models was used to quantify deterioration in fit. These latent means were found to be different between males and females ($\Delta\chi^2_{(11,\, n = 213)} = 87.023$, $p < .001$; Table 8). Because the latent means in the male group were arbitrarily fixed to zero, the Wald statistic calculated from the values of the latent means (and their standard errors) in the female sample could be used to identify specific mean differences between the two genders. These tests are reported in Table 11. FA was found to be greater in females, while PA and MWB were found to be greater in males, with all other latent means found to be invariant between the two genders.

Table 11

Results of Tests of Latent Mean Differences

Construct	Latent Mean Males (Fixed)	Latent Mean Females	*SE* Females	Wald (z)
Satisfaction with Life (SWLS)	0	.062	.141	.441
Positive Affect (PA)	0	-.613	.174	-3.510*
Negative Affect (NA)	0	.235	.170	1.377
Physical Health (Health)	0	.057	.150	.382
Attractiveness (Attract)	0	-.070	.163	-.432
BMI Deviation (BMI Dev.)	0	.014	.153	.090
Short-Term Mating Strategies (STMS)	0	.169	.131	1.288
Social Instrumentality (SI)	0	-.102	.164	-.620
Material Well-Being (MWB)	0	-.995	.201	-4.951*
Generalized Intelligence (*g*)	0	.197	.154	1.276
Fluctuating Asymmetry (FA)	0	1.226	.189	6.473*

*$p < .001$

Structural Models

Because this study sought to uncover how well different ostensible operationalizations of fitness ("fitness constructs") predicted cognitive-affective constructs, and the degree to which PA and NA predicted SWL, all associations between latent constructs in the measurement model were initially converted to unidirectional regression weights. To identify the most potent predictors of interest, non-significant regression paths were sequentially removed from the models for each gender until only significant paths remained. The significance tests for these paths, as well as fit of the corresponding models, are shown in Tables 12 and 13 for males and females, respectively.

The resulting structural models, following elimination of nonsignificant paths, are presented in Figures 2 (males) and 3 (females)[xi]. Although all covariances were retained in the analyses of these models, only those reaching significance are presented in the figures. Specific findings from these structural models will be described and elaborated upon below, due to the large number of significant associations and pathways. However, the general findings show that the best predictor of criterion variables among males was the SI variable (excluding SWL regressed onto PA and NA), with very few other significant predictors. In contrast, a much wider array of significant predictors emerged for the female sample. Additionally, both groups evidenced a modest number of significant intercorrelations among fitness-level predictors (5 for males, 8 for females). However, these intercorrelations represented a definite minority of possible significant relationships among these

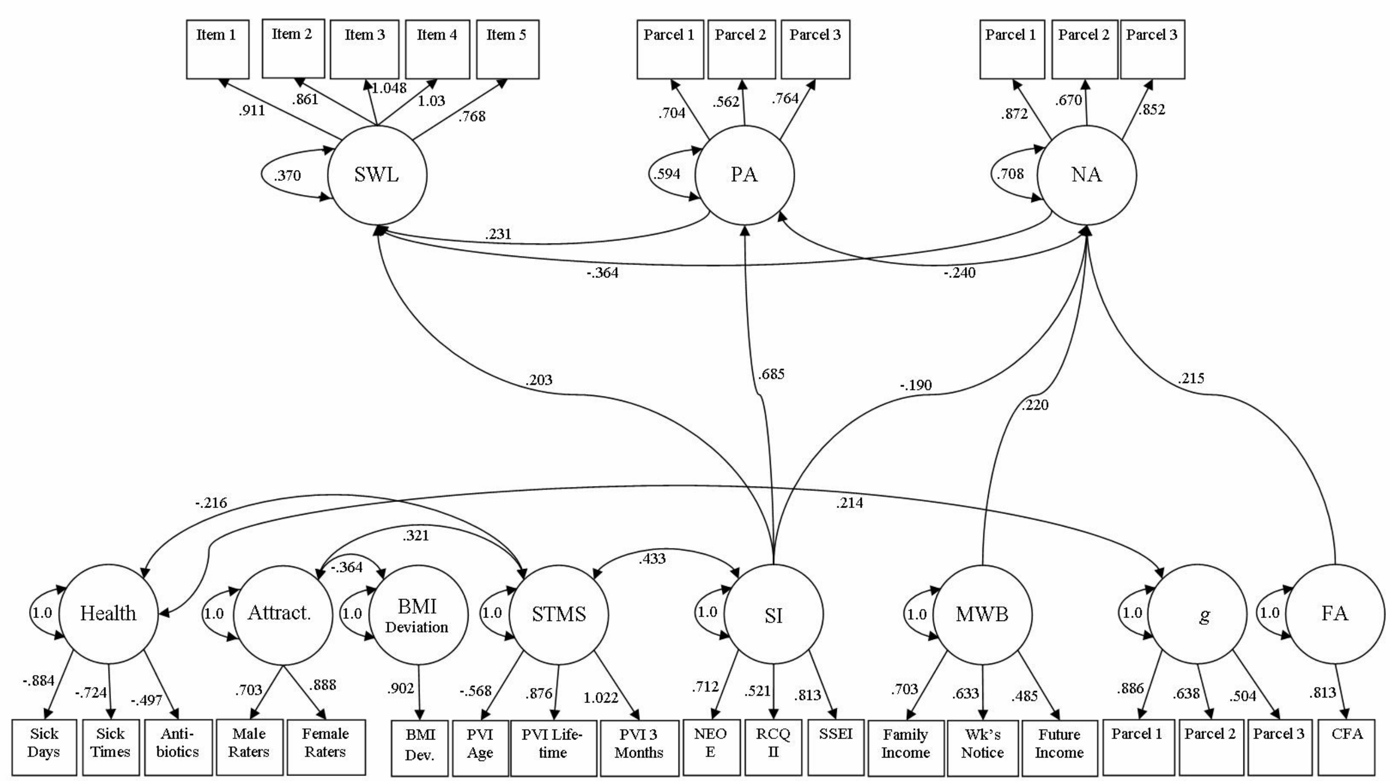

Figure 2. Structural model for males, illustrating parameter estimates solely for significant paths and associations.

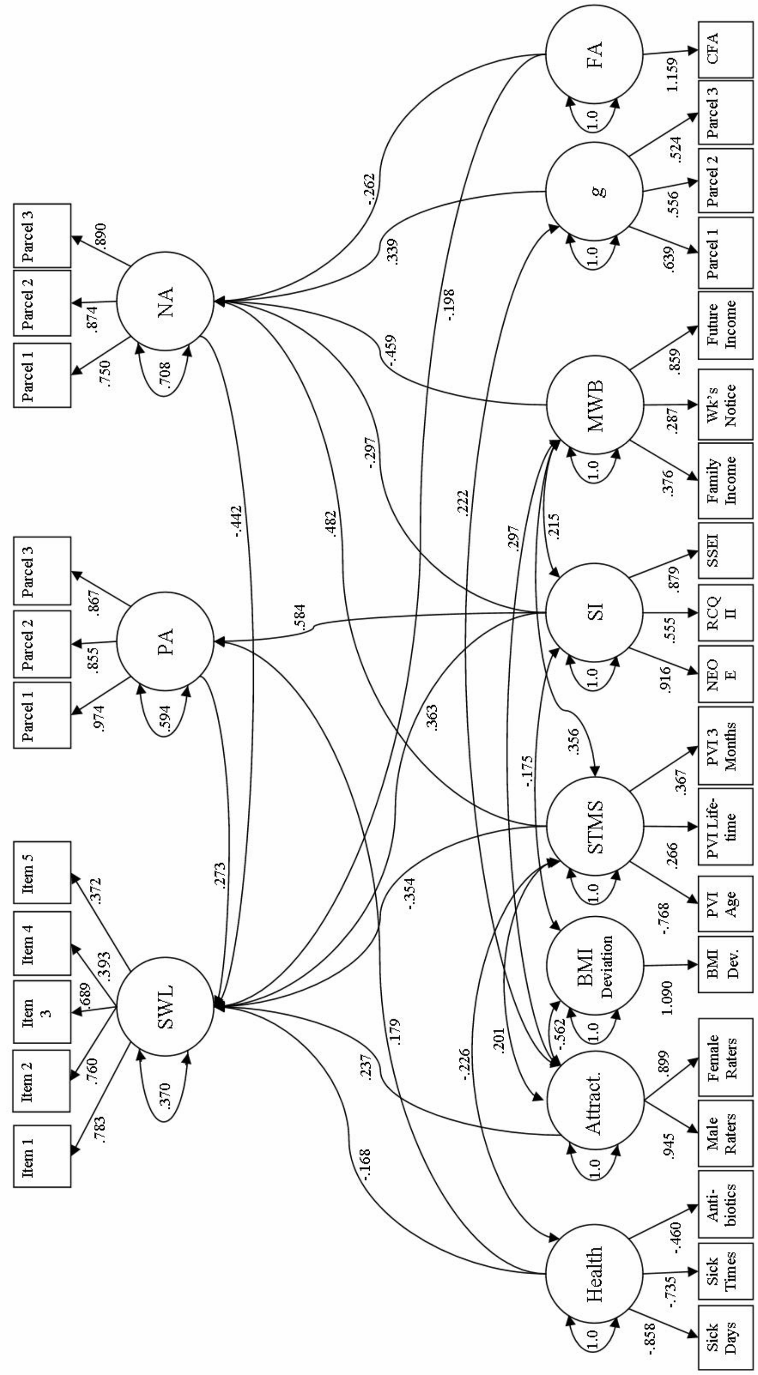

Figure 3. Structural model for females, illustrating parameter estimates solely for significant paths and associations.

Table 12

Model Fit Statistics, Betas, and Significance Tests Used in the Systematic Elimination of Nonsignificant Paths: Males

Step	χ^2	*df*	RMSEA	Criterion	Predictor	β	*SE*	Wald
Start	831.84	704	.041	Health	SWL	.008	.157	.049
1	831.84	705	.041	STMS	NA	.011	.178	.062
2	831.73	706	.041	BMI Dev.	NA	.008	.120	.066
3	831.72	707	.041	BMI Dev.	SWL	.009	.133	.065
4	831.71	708	.041	*g*	PA	.017	.148	.114
5	831.78	709	.041	*g*	NA	-.029	.127	-.231
6	831.82	710	.040	*g*	SWL	.052	.140	.367
7	832.08	711	.040	Attract.	PA	-.056	.151	-.372
8	832.51	712	.040	Attract.	SWL	.074	.135	.549
9	832.15	713	.040	FA	PA	.108	.126	.855

* $p < .05$

Table 12, continued

Model Fit Statistics, Betas, and Significance Tests Used in the Systematic Elimination of Nonsignificant Paths: Males

Step	χ^2	*df*	RMSEA	Criterion	Predictor	β	*SE*	Wald
10	831.78	714	.040	BMI Dev.	PA	-.102	.117	-.873
11	832.13	715	.039	STMS	PA	-.171	.164	-1.044
12	835.45	716	.040	Health	NA	.157	.127	1.243
13	836.06	717	.040	Attract.	NA	.144	.110	1.302
14	837.68	718	.040	MWB	PA	-.202	.152	-1.322
15	837.68	719	.040	FA	SWL	.192	.136	1.413
16	839.83	720	.040	Health	PA	-.188	.129	-1.458
17	840.77	721	.040	MWB	SWL	.251	.160	1.573
18	843.95	722	.040	STMS	SWL	.251	.158	1.589
19	846.64	723	.040	SI	SWL	.334	.184	1.813*

*$p < .05$

Table 13

Model Fit Statistics, Betas, and Significance Tests Used in the Systematic Elimination of Nonsignificant Paths: Females

Step	χ^2	*df*	RMSEA	Criterion	Predictor	β	*SE*	Wald
Start	846.64	723	.040	*g*	SWL	.008	.268	.029
1	846.57	724	.040	MWB	PA	-.010	.195	-.050
2	846.57	725	.040	Attract.	NA	-.019	.207	-.090
3	846.68	726	.040	Attract.	PA	-.032	.191	-.167
4	846.43	727	.039	BMI Dev.	SWL	-.049	.178	-.278
5	846.30	728	.039	Health	NA	.096	.141	.682
6	846.71	729	.039	STMS	PA	.111	.149	.746
7	848.26	730	.039	BMI Dev.	NA	-.111	.147	-.757
8	849.11	731	.039	BMI Dev.	PA	.111	.124	.892
9	849.11	732	.039	FA	PA	-.125	.121	-1.030
10	850.88	733	.039	MWB	SWL	.248	.229	1.082
11	851.21	734	.039	*g*	PA	.162	.150	1.087
12	849.59	735	.038	Health	SWL	.275	.165	1.667*

*p < .05

variables (28 possible in each group). Finally, a significant correlation was found between PA and NA among males, a finding that was not reproduced among females.

Discussion

Using the SEM framework, this study succeeded in adequately modeling the relationship between purported measures of evolutionary fitness and cognitive-affective constructs associated with subjective well-being (SWB). The study's findings offer a variety of conclusions about the appropriateness of measuring fitness in a prospective, multidimensional manner and provide an illustration of how these fitness-related constructs describe the population being investigated. Additionally, these findings permit the evaluation of the signal theory of happiness within an empirical framework, as set forth by Grinde (2002).

Although the relationship between fitness and SWB remains the central study hypothesis, discussion of these findings is heavily contingent upon technical characteristics of the model, especially as regards cross-gender measurement. Consequently, initial consideration of the construction and performance of the models will best support analysis of the principal findings.

Invariance of Loadings and Intercepts

The success of the final configural model in judging the constructs of interest to be comparable between genders provides support for the premise that SWB (decomposed into its constituent components of satisfaction with life, positive affect, and negative affect) is represented equivalently between males and females by the commonly-cited measures used in this study. This finding, in turn, lends support for the use of instruments like the SWLS and the PANAS in describing phenomena differentially occurring in males and females. In short, because the manifest indicators from the SWLS and the PANAS appear to be performing similarly between genders, a high level of confidence can be placed in the validity of the latent constructs used in the study.

Furthermore, the finding of invariance of loadings and intercepts also supports the notion that the purported indicators of fitness are valid, measuring equivalent constructs between groups. Unlike the SWL, PA, and NA variables, for which there is little theoretical foundation for expecting incomparability between genders, fitness indicators enjoy no such assumptions. This fact has permitted the rejection of several theoretically plausible formulations of constructs. First, the findings of invariance for the attractiveness latent variable permit comparison of the "good" genes (e.g., Thornhill & Gangestad, 1994) and the "competitor" models of attractiveness judgment. The former model purports that opposite-sex attractiveness serves as the most significant adaptation regarding the observable fitness of a potential mate—it would anticipate the emergence of an attractiveness construct in which the judgments of female raters would be higher loading among male participants, and vice versa among female participants. Conversely, the "competitor" model suggests that there is high adaptive value in accurately sizing up one's competition for mates—one way of doing so being a judgment of the competitor's attractiveness. Under this model, one would expect the attractiveness construct to have a disproportionately high loading onto the judgments of same-sex raters, as compared with opposite-sex raters.

Ultimately, the finding of strong metric invariance (despite very slight biases in each group in favor of the strengths of opposite-sex ratings) suggests that attractiveness ratings tend to load equivalently on the latent construct regardless of the gender of the rater, suggesting that both “competitor” and “good genes” processes occur simultaneously and with relatively equal relevance.

Another plausible non-invariant configuration could have been applied to the variable representing material well-being (MWB). The slight polygynous tendency among humans, as reflected in sex ratios and differences in mandatory minimal investment in offspring (Bateman, 1948; Trivers, 1972), suggests that access to resources often plays a greater role in the selection of mating partners by females than selection of mating partners by males (Buss & Barnes, 1986). In addition to supporting the notion that access to material resources may be a more salient representation of evolutionary fitness in males compared to females (see below), this difference in sexual selection strategy also puts a premium on males’ abilities to convince potential mating partners of their access to extant resources and to future resources.[xii] On the other hand, because females are required to put a greater minimal investment of resources into reproduction than are males, and because females and their blood relatives can be fully assured of their genes appearing in offspring (whereas cuckoldry and paternal uncertainty are distinct liabilities for males), females’ own MWB is potentially disproportionately influenced by the availability of kin resources, when compared other indicators. In the findings of this study, however, evidence of invariance in the construct formulations of MWB did not reach significance, suggesting that access to material resources is relevant to both genders in ways that are equivalently represented by the three indicators used in the models. Of note, however, are the different loadings from the "one-week's notice" and "anticipated income" variables, which suggests possible multicollinearity in the data that, while not especially detrimental to the model, should be taken into consideration and replaced with less correlated substitutes in future studies.

Variance of Latent Constructs

Tests of homogeneity of variances identified three sources of heterogeneity among the latent constructs, one of which conformed to a plausible hypothesis regarding gender-level differences in evolutionary fitness variables. The greater variability of adherence to short-term mating strategies (STMS) observed among males supports the notion that there is a potentially higher payoff with respect to an abundance of short-term mating opportunities for attractive males than for attractive females (Bateman, 1948). (Conversely, this would predict that the payoff for females would be more focused on the *quality* of mates, rather than quantity.) As predicted by sexual selection theories in biology, then, males in this sample showed much greater variability in their applications of short-term mating strategies than did females.

Heterogeneity uncovered in the other two latent constructs, body-mass index (BMI) deviation and fluctuating asymmetry (FA), are more difficult to explain in theoretically informed manner. The greater variance observed among females for BMI Deviation may be attributed to the fact that the “optimal” body mass selected for males (BMI = 22) was closer to the mean of the male sample distribution than was the “optimal” body mass selected for females (BMI = 20). Given that the literature provides little guidance for interpreting such a finding, it may simply be a spurious result stemming from the above calculation.

Similarly, no sophisticated theoretical rationale has been articulated for expected differences in the variance of FA between genders, although this may be largely due to failure to make this comparison. In a few cases, comparisons have been reported elsewhere. For example, Bates (2007) found significantly greater FA among *females*, and suggested that this might be a consequence of soft tissue changes during female sexual cycles (Scutt & Manning, 1996), or due to selection pressure against canalization in males, although it is unclear why any evolutionary process would select for variability on FA in particular. In contrast, Stibick (2004) found no FA difference between genders, although females were insignificantly higher by approximately .5 SD; even smaller insignificant differences were found by Manning (1995). With regard to the current study findings, although the biology literature suggests that greater investment of resources in males versus females may yield greater genetic payoff to the parents under certain conditions (Trivers & Willard, 1973)[xiii], which could plausibly have an impact in gene expression relevant to FA, this explanation has two problems. First, it exaggerates the influence that environmental contributions, as opposed to genetic contributions, purportedly have on developmental stability. Second, it would assume that parents were largely knowledgeable about the genders of their children during intrauterine development, a prospect that is tenuous at best. Instead, this variance difference seems best attributed to measurement error (which, due to the single-indicator method used for this variable, was *not* eliminated from the latent construct), or possibly to problems regarding the construct validity of FA itself (an issue taken up in a subsequent section).

Mean Level Differences

Affect. The finding of significant gender differences across latent means is interesting with regard to both theory and previous findings. The observed mean difference on Positive Affect (but not Negative Affect) is consistent with at least one previous survey of affect at the manifest variable level (e.g., Andrews & Withey, 1976), which also found greater PA among males than among females. This finding, however, contradicts other work suggesting that females tend to experience greater intensities of both positive affect (PA) and negative affect (NA; Hwang, 2001), which has been supported in cross-national surveys (Fischer & Manstead, 2000). At least one study more similar to the present research in its use of latent affect constructs also reported greater amounts of both positive and negative affect in women (Kawata, 2006), neither of which was reproduced in the these findings. The meaningfulness of these discrepancies among the studies utilizing latent variables is questionable, given substantial differences in the populations being surveyed (middle-aged and elderly, rural participants living in North Carolina versus young adults attending a large public university in suburban Kansas), especially in light of abundant evidence suggesting that affect tends to change as a function of age (Charles, Reynolds, & Getz, 2001; Mackinnon et al., 1999; Mather & Carstensen, 2003).[xiv]

Several explanations to this conundrum—none mutually exclusive—are feasible. First, and most simply, surprisingly little consideration has gone into the differentiation of affective experiences in males and females. Unknown or little-investigated variables (e.g., age, culture, education) may play important roles in understanding affect, but which have been largely neglected in the literature. Second, the method of parceling used in this study may yield a substantially different solutions than analyses relying on manifest variables or even other analyses using latent variables (e.g., if the items are parceled differently or are loaded onto the construct individually). It is important to note that the specification of this current model focused on improving overall fit and increasing the odds of weak metric invariance for the model, not on making mean equality more likely.[xv] Third, many of these studies of gender differences in the construct of affect differ slightly in how the construct is devised—e.g., attempting to describe expression of affect versus perceived expression of affect versus experience of affect.[xvi]

Material Well-Being. MWB was found to have a greater latent mean in males than females. This finding is unlikely to reflect an actual difference in material well-being of females versus males, given the fact that the population studied in this research likely is largely reliant on family support for achieving financial and material goals. Instead, this seems well explained by the notion that males may be adaptively advantaged in advertising their strengths as potential mates if they are good salespeople regarding the amount of support they will be able to provide to their mate and offspring (Greenlees & McGrew, 1994). The first conceptualization of this phenomenon (see *Invariance of Loadings and Intercepts* above) postulated that the two items measuring family income and immediate availability of support would be good measures of present-moment access to material resources, while future income would be more future-oriented and, therefore, more amenable to a "sales pitch" to potential mates. However, nothing would preclude males, were they adaptively inclined to exaggerate their material well-being, from overestimating (or over-valuing) their access to material resources in the present as much as they might do prospectively. Indeed, the current findings are somewhat supportive of this notion. This hypothesis, however, would be even better supportive were there to have emerged a significant correlation between MWB and social instrumentality (SI), suggesting a connection between what males report as their resources and the social skills necessary to represent themselves convincingly as being high in MWB.

Fluctuating Asymmetry. The finding of greater latent mean-level FA in females compared to males is very difficult to explain, for the same reasons as discussed above (see *Variance of Latent Constructs*). This author is unaware of any cogent argument existing for why females might be systematically predisposed to developmental asymmetry compared to males. These seemingly inexplicable findings with regard to both mean and variance of FA point to a problem with the data, either in measurement (especially given the difficulties involved in performing size measurements on soft, pliable tissues with large numbers of individual differences occurring the identification of anchor points) or in conceptualization of the variable.

The lack of consistency in previous findings, discussed above, unfortunately fails to shed light on which of these possibilities is more likely.

With an interest in further evaluating the validity of the FA construct, correlations between the items were calculated for both males and females (Table 14). In all but one case (Wrist Width–Digit 2 Length $r(103) = .220$, $p = .0129$ [one-tailed]), despite relatively large sample sizes, correlations did not reach significance ($p > .0674$). In fact, of the remaining 19 correlations measured, 9 of these were in the negative direction. Reliability was poor, Cronbach's $\alpha_{males} = .199$, Cronbach's $\alpha_{females} = .087$. Such seemingly unrelated items are unlikely to represent indicators of a unitary construct. Consequently, FA will not be further discussed with regard to the overall confirmatory factor analysis or structural models.

Table 14

Correlations of Fluctuating Asymmetry Items

		Females (*n*=106)				
		Ear Width	Ear Length	Wrist Width	Digit 2 Length	Digit 4 Length
Males (*n*=107)	Ear Width	--	-0.066	-0.013	0.123	0.047
	Ear Length	-0.148	--	-0.012	-0.053	0.011
	Wrist Width	-0.107	0.139	--	-0.019	0.107
	Digit 2 Length	-0.070	-0.007	0.220*	--	0.061
	Digit 4 Length	0.024	0.138	0.065	0.111	--

*$p < .05$, one-tailed

Interrelationships of Fitness-Level Variables

Based on the lack of significant correlations with other variables, especially for males, *g* did not appear to emerge as a particularly "honest" indicator of fitness. However, given the restricted range of the variable within the study's undergraduate student sample, skepticism regarding the relevance of this null finding is warranted. The notion of restricted range is reinforced by the study's failure to find a significant positive correlation of *g* with social instrumentality, despite abundant evidence of a relationship between *g* and social status having been established elsewhere in the literature (Miller, 2000).

For both genders, a strong correlation emerged between attractiveness and deviation from optimal BMI. Whereas a theory proposing that body fat distribution affects fecundity—and, by extension, judgments of attractiveness— in a way that is unique for women (Singh & Singh, 2006; Wass et al., 1997), the current significant findings in both female and male models suggest that the reasons for this relationship go beyond direct reproductive potential—although the considerably larger correlation between BMI Deviation and attractive among females merits mention. It also bears repeating that these effects emerged despite the use of a latent attractiveness variable using raters from both genders, which likely would have diluted significant relationships if the fitness-related influence of BMI were specific to a gender-specific construct such as fecundity. Instead, it appears that BMI represents some other, more general component of fitness consistent with mate selection theory (Tovée & Cornelissen, 2001).

Perhaps the most intriguing of the relationships to emerge from these models was the positive association between attractiveness and short-term mating strategies in both genders. As expected, more attractive individuals reported increased participation in penile-vaginal intercourse (PVI). Post hoc tests in manifest space (Table 15) somewhat confirm this association between attractiveness (to both genders) and sexual opportunity, even when the PVI variables are replaced with non-PVI sexual behavior variables. This suggests that attractiveness may offer enhanced opportunities for sexual behavior, and that individuals tend to make use of these opportunities in practice.

Also of note was the significant correlation between short-term mating strategies and material well-being among females. This finding suggests that access to resources may have a substantial association with the mating strategy selected, and the gender-specificity of this finding is plausibly congruent with an evolutionarily informed account. One purely speculative hypothesis is that a female's increased access to resources may permit her to enjoy a greater range of mating opportunities due to diminished concern about the ability of any specific mate to provide resources. Alternatively, research elsewhere has performed more detailed examination of similar phenomenon and have found that males prefer sexual interaction with medium-, rather than high-socioeconomic status females due to concerns about violation of gender roles and assumptions about fidelity (Greitemeyer, 2007). Consequently, a positive association between STMS and MWB in females may be more a

Table 15

Correlations Between Non-PVI Sex Items and Attractiveness

		Females (n=106)				
		Sex Partners (Lifetime)	Sex Partners (Last 3 Months)	Sex Times (Last 3 Months)	Attractiveness (Male Raters)	Attractiveness (Female Raters)
Males (n=107)	Sex Partners (Lifetime)	--	.195*	.310**	.201*	.084
	Sex Partners (Last 3 Months)	.583**	--	-.030	.180	.137
	Sex Times (Last 3 Months)	.226*	.257**	--	.022	.118
	Attractiveness (Male Raters)	.223*	.229*	.126	--	.734**
	Attractiveness (Female Raters)	.180	.280**	.109	.743**	--

*$p < .05$, two-tailed

**$p < .01$, two-tailed

consequence of male responses to sexual engagement than to the execution of an autonomous strategy.

That a similar association between STMS and MWB did not emerge among study males is less intuitive, inasmuch as women judge wealthy males to be more desirable, on average, than their less well-to-do counterparts (Buss & Barnes, 1986). It could conceivably reflect the development of salesmanship skills among males in convincing prospective mates of their access to resources. However, this hypothesis would appear to demand a significant association between social instrumentality and MWB to emerge, an association which instead occurred among females and *not* males. Alternatively, it could merely be the case that material well being is a less relevant metric for fitness in a young, undergraduate population, and that this factor might become increasingly relevant with age or in a population that is not choosing to forgo immediate wealth for an educational investment.

The finding of significant association between MWB and attractiveness in females but not males supports expectations derived from evolutionary theory. Because human males have been subjected to strong selection pressures favoring the adaptation of mechanisms to detect reliable indicators of health, youth, and fertility among prospective female mates (Buss & Schmitt, 1993), it is hypothesized that females have been subjected to similar pressures to use all available resources to exaggerate the appearance of such fitness indicators (e.g., Feinberg, DeBruine, Jones, & Perrett, 2008; Fink & Penton-Voak, 2002). This phenomenon is supported by empirical work suggesting that, although both females and males can adopt ornamentation to augment their attractiveness vis-à-vis its effects on apparent social status, it is females in particular who can most accentuate their attractiveness through physique-centered ornamentation (Hill, Nocks, & Gardner, 1987), and may even time their presentations for maximal reproductive effect (Haselton, Mortezaie, Pillsworth, Bleske-Rechek, & Frederick, 2007). This phenomenon has more generally been demonstrated in the present findings: instead of attractiveness corresponding to specific physical accoutrements, it was associated with more global access to material resources, which hypothetically could be used to improve one's presentation in any number of lifestyle domains—in this case, physical attractiveness.

The associations emerging from the health variable are of lesser interest, due to the paucity of observed associations with study variables of interest. For example, the positive association between health and intelligence among males may potentially reflect developmental disturbances, but these effects are likely to be washed-out by the well-established effects that *immediate* illness has on test performance (Sattler, 2001). The negative associations between better health and greater use of short-term sexual strategies is less likely to be confounded in the same manner, as a consequence of having measured sexual strategies with respect to both recent and historical behaviors. Even so, it seems parsimonious to conclude that the lifestyle associated with execution of short-term mating strategies in this population (e.g., late nightlife and subsequent depressed immunological response, or exposure to communicable diseases) is not particularly conducive to salubriousness, without resorting to more complicated, evolutionarily derived explanations.

Modeling Fitness Using Latent Prospective Measures

In general, the use of multiple prospective measures in modeling fitness appears tenable, and it may offer an improvement over the use of single manifest-variable indicators. The observed measurement invariance in these data suggests that the variables identified as critical indicators of fitness are, in fact, essentially comparable between genders. In essence, it appears that although the selection pressures to which males and females may have been exposed over the course of evolutionary history may have substantially differed (Buss, 2009), the process has resulted in the adoption of different set points on corresponding factors, rather than in the emergence of overlapping but fundamentally noncongruent constructs.

Also worthy of mention is the apparent multidimensional nature of fitness. Although one would be hard-pressed to find an evolutionary theorist arguing for a unidimensional construct (at least with regard to prospective measures), the relative dearth of observed oblique relationships was somewhat surprising. Out of 28 possible (and plausible) intercorrelations among fitness-level constructs in each gender, only 8 (28.6%) emerged as significant among females and only 4 (14.3%) among males; additionally, the intercorrelations were almost exclusively medium-to-small in magnitude. This provides a strong argument against the heuristic of labeling individuals as more or less "fit" compared to others; instead, it suggests that individual fitness is based upon the existence and execution of a multitude of adaptations (and, likely, the interactive effects of these).

Interrelationships of SWL, PA, and NA

As expected, positive affect and negative affect both loaded strongly (and in the expected directions) onto life satisfaction. This was a critical, non-negotiable aspect of the current study, inasmuch as failure to replicate such previously well-established associations would have generated significant doubt regarding the construction of the study's models. Additionally, nested modeling indicated that the influences of affect measures onto satisfaction with life (SWL) were indistinguishable from one another within genders ($\Delta\chi^2_{(2, n = 213)} = .578$, $p = .4790$), which suggests that positive and negative affect make proportionally equivalent contributions to the general conceptualization of SWB.

Surprisingly, the negative covariance between PA and NA was significant among males but not females. Elsewhere (e.g., Tellegen, Watson, & Clark, 1999), the dimensionality of affect has been the subject of debate. Tests of two-factor structures specifically have demonstrated: (a) stronger correlations for females rather than males, albeit in a much older, more rural population (Kawata, 2006); as well as (b) patterns in a community sample more comparable to the findings from this study, $r_{males} = -.31$, $r_{females} = -.24$ (Crawford & Henry, 2004). In contrast, Mackinnon et al. (1999) found small, invariant intercorrelations between genders. In general, however, investigations of the factor structure of affect have thus far done an inadequate job of testing for differences in this association, and few explanations have been proffered for observed gender differences in the relationship between positive and negative affect.

Prediction of SWL, PA, and NA

Males. By and large, the structural model for the male sample identifies SI as the nearly exclusive predictor of SWL, PA, and NA (with positive, positive, and negative paths, respectively). These pathways are as expected, with SWL serving as an indicator of the fitness–via–social instrumentality construct (see Griskevicius et al., 2009; Hawley, Little, & Card, 2007). Most notable was the extremely large loading of SI onto PA ($\beta = .685$, between-groups completely standardized solution), demonstrating that level-one happiness in young males may largely devolve from perceived ability to navigate the social demands they encounter. The direct pathway between SI and SWL, demonstrating only partial mediation of the affect variables, further implies that social instrumentality's predictive usefulness of level-two happiness goes beyond its influences merely on affect. In other words, social instrumentality appears to contribute to a positive cognitive evaluation of one's life situation, above and beyond the contribution it makes to augmenting the individual's experience of positive emotion and mollifying the impact of negative emotions. This influence of social instrumentality is congruent with C. R. Snyder and colleagues' (1991) work with the construct of hope—with positive affect reflecting an individual's conceptualization of his or her facility at devising multiple routes to goals (pathways thinking) and confidence in his or her ability to executing these plans (agency thinking). Within Snyder's framework, social instrumentality likely reflects a constrained set of goal-directed pathways, while drawing heavily on the individual's self-judgments about the capacity to carry these out.

Additionally, material well-being was associated with *greater* negative affect. This finding is particularly surprising in light of the strongly stated case by many theorists (e.g., Buss & Barnes, 1986) that access to resources is a salient characteristic for males vis-à-vis their qualities as mates. Although the observed effect was not particularly strong ($\beta = .22$), if it were to be replicated, it would certainly warrant further explication. Numerous explanatory possibilities exist. For example, more affluent young men could conceivably make more attractive targets for stressful inter-male aggressive confrontation; on the other hand, there could conceivably exist differing sub-cultural norms for the expression of negative affect among males across varying socioeconomic strata. Regardless of the exact nature of the NA-MWB relationship, however, the lack of direct effects from MWB on SWL was congruent with well-published findings regarding the general lack of utility in predicting SWL from material welfare in a sample drawn from above minimal poverty thresholds (see Diener & Seligman, 2004, for a review).

Short-term mating strategies also exerted an indirect effect upon SWL and affect via their strong association with SI. However, its unique variance was not strong enough to warrant any direct paths, suggesting that, at least for this population of convenience, sexual behavior is a less powerful predictor of SWB than social resource control is. Remarkably, no fitness indicators aside from those already described emerged as significant predictors of SWL, PA, or NA.

Females. Contributors to affectivity and life satisfaction were far more numerous among females. As with males, however, social instrumentality appeared to play a strong role, with similar predictive relationships emerging. This finding reflects a robust and extensive literature linking subjective well-being to sociality variables such as social connectedness (e.g., Lee, Dean, & Jung, 2008), extraversion (e.g., Weiss, Bates, & Luciano, 2008), and social resources (e.g., Robb, Small, & Haley, 2008).

MWB, too, emerged as a significant predictor of NA—however, among females (unlike males) this effect was in the expected negative direction. Greater material well-being may put females in a position where they are protected from hardship, offering some resilience to the fortunes that otherwise could lead to negative emotions and, consequently, to dissatisfaction with one's life situation. One could argue that the same effect should occur for males. If, as previously mentioned, however, observable high-status indicators such as material wealth encourage intra-sex competition among males far more than among females (Buss, 1989), this would identify high-MWB males as prime targets for high-risk/high-gain gambles by their male competitors (Ermer, Cosmides, & Tooby, 2008). The sex-specificity of this phenomenon may then lead to reverse-signed pathways between the two genders, as observed in this study. Although support did not emerge for MWB to be considered helpful in generating positive affect or an affect-independent judgment about life satisfaction, the failure to find these relationships should not be overstated, in light of the discussion above regarding potential restriction of range.

Of the two variables in the study most likely to represent a female's physical desirability as a mating partner— attractiveness and deviation from optimal BMI—

only the former was a good direct predictor. Notably, a significant path emerged only between attractiveness and SWL, such that attractiveness positively associated with life satisfaction scores but did not appear to increase the odds of positive or negative affective experiences. Given the relatively strong correlation between attractiveness and BMI deviation, it is likely that the attractiveness variable may have suppressed any effect of the BMI deviation variable onto SWL.

Desirability as a mating partner must also be interpreted in light of the provocative paths that emerged from the STMS variable. Specifically, greater endorsement of short-term mating behaviors predicted *reduced* happiness and substantially *more* negative affect among young women, despite the positive association between short-term strategies and attractiveness described previously.

These findings appear to describe a scenario in which attractiveness affords more opportunities for PVI and also may benefit one’s satisfaction with life (possibly by boosting self-esteem; Crocker, Luhtanen, Cooper, & Bouvrette, 2003). Nevertheless, actually acting on such sexual opportunities may decrease a female's subjective well-being. Although researchers increasingly acknowledge evidence suggesting that execution of female short-term mating strategies reflects an underlying evolutionary adaptation, these tactics might be considered adaptively functional only insofar as they serve as precursors to longer-term mating (Buss & Schmitt, 1993; Shackelford, Goetz, LaMunyon, Quintus, & Weekes-Shackelford, 2004). Given the fact that the majority of such "tests" are bound to be failures with regard to this distal goal, it is unsurprising that short-term sexual interactions tend to be more poorly regarded by females than by males (Campbell, 2008), explaining the pathways emanating from the STMS variable in the present study's model for females.

The variable representing *g* performed unexpectedly. Its contribution to the structural model was relatively modest, loading only onto NA. However, this loading was positive—in the opposite direction from what would have been hypothesized—and at odds with some research on manifest variables in past research. For example, in a sample of undergraduate job applicants, Fox and Spector (2000) found insignificant relationships between either positive or negative affect and a measure of intelligence, while the non-significant associations were positive and negative, respectively. However, this study did not discriminate between males and females. To the knowledge of this researcher, no other published studies have reliably investigated the relationship between general intelligence and affect. Salovey and Mayer's (1989) conceptualization of emotional intelligence, which has been demonstrated to positively correlate mildly to moderately with general intelligence (Derksen, Kramer, & Katzko, 2002; Lam & Kirby, 2002), stipulates that the emotional regulation component of emotional intelligence—which might likely be manifested via affective displays—plays an important role in tailoring one's social response to situational demands. High levels of negative affect, therefore, would be disruptive to preparing the individual for these social demands. Because of the fact that the study population draws disproportionately from the upper reaches of the intelligence continuum, it is not unreasonable to speculate that the observed positive loading of NA onto *g* may reflect a sampling artifact, and may indicate that something about *extremely high* (rather than merely high) intelligence among females induces negative emotion regulation problems. Thus, the question becomes whether there is any reason to expect extremely high intelligence females, but not their male counterparts, to manifest these characteristics. Unfortunately, to the best knowledge of this author, no investigation of this question has yet been made.

Finally, physical health exhibited a strange relationship with the criterion variables, with better health associated with reduced life satisfaction but greater positive affect. Such a perplexing pattern does not appear amenable to coherent interpretation, and may instead reflect limitations of the manner in which health and illness were operationalized in the present study (via antibiotic use, sick days, etc.). However, it should be noted that, despite being statistically significant, the aforementioned paths were of small magnitude and unlikely to compromise the integrity of the model's overall structure.

Implications on the Fitness-Signaling Theory of SWB

Overall, subjective well-being appears to have at most a limited role as a signal of evolutionary fitness among males. Very few variables representing fitness loaded onto any of the cognitive-affective variables of interest, despite sound theoretical reasons for expecting these paths to be significant should SWB serve as a fitness signal. Furthermore, although several sizeable beta weights did emerge from the social instrumentality variable, these cannot account for more than a small proportion of fitness-level variance across the array of fitness-related predictors, given the moderate-to-low intercorrelations observed among such variables.

Nevertheless, as described above, compelling explanations for why other significant relationships did not emerge may lie in consideration of the age and education level of the study's participants, among other characteristics of the sample. It may be the case, in fact, that for 20-year-old males who have self-selected to enroll in college, differences in social instrumentality may be the key variable discriminating between individuals most and least capable of passing on their genes, with the other variables still being reflected in signaling, but not yielding their relationships in the current study, due to restrictions in range.

The model for females offers much different testimony about the applicability of SWB as a signal of fitness. Every purported variable representing some manifestation of fitness enjoyed at least one significant loading onto a cognitive-affective criterion variable, and the vast majority of these were in directions fully consistent with fitness-signaling expectations. Furthermore, these pathways persisted despite a much greater level of shared variance among the latent fitness variables than was evident in the male model.

Referring back to the initial hypotheses about the utility of SWB as an indicator of evolutionary fitness, three possibilities were articulated: (a) life satisfaction *is* an adaptive (or exaptive) cognitive mechanism and serves as a signal for one's fitness level; (b) life satisfaction *is* an adaptive cognitive mechanisms, but not for the reasons posited above; or (c) life satisfaction is *not* an adaptive cognitive mechanism. Although the present study cannot definitively discriminate among these hypotheses, the evidence among females offers compelling evidence for retaining the possibility of life satisfaction's service as a fitness-signaling mechanism. These findings in some ways tend to trump the somewhat contradictory evidence offered by the male model, given the reasonable limitations that may exist in applying the model to the latter group. Additionally, given the apparent configural and metric invariances of the SWL, PA, and NA constructs across genders, as well as the apparent congruence between these variables in many other research contexts, it would be improbable that life satisfaction could have acquired a fitness-signaling function via evolution in one gender but not in the other.

Study Limitations and Future Directions

Although the model produced through the study offers important advancements to the field’s understanding of associations between evolutionary and positive psychology constructs, several aspects of the study’s design and properties of the variables place limits on the strength of conclusions that may be drawn. Future work may succeed at further illuminating the relationships between fitness and subjective well-being should some of these complications be resolved through amended methodology, consideration of new statistical approaches, or reconceptualization of variables.

Sample size. The first of these concerns characteristics of the model and the sample. Sample size, especially with respect to statistical power, is a frequent concern in studies where strength of associations and paths are being measured. This clearly did not appear to be an issue among the female participants, but the lack of significant paths within the male model raises concerns about loss of power due to large standard errors. However, visual investigation of the standard errors for the two genders suggested that these were relatively similar between the male and female models, whereas the magnitudes of the parameters were smaller among males. Although care must be taken not to infer appropriate sample size solely on the basis of a single collected sample, these findings lend some credence to the assertion that, were similar paths truly to exist between males and females, their emergence only in one group is not easily attributed to inadequate sample size.

Sample size also is relevant with regard to factor analysis. Statisticians have offered numerous and frequently contradictory recommendations about the most appropriate sample sizes for ensuring that real factors emerge, with other guidelines, such as the ratio of cases to manifest variables, often being debated as well. The degree to which the present model fits these guidelines depends upon the guidelines adopted, as well as upon whether one is considering the model prior to the sample being subdivided into the two groups. For example, the combined (male and female) model ($N = 213$, $N/p = 7.1$) almost meets the specifications recommended by Cattell (1978; $N \geq 250$, $N/p \geq 3$ or 6), but clearly violates these same criteria when considered in individual groups (males: $n_{males} = 107$, $n/p = 3.57$; $n_{females} = 106$, $n/p = 3.53$). MacCallum and colleagues (1999), however, demonstrated that sample size past a minimal threshold (roughly $n = 60$) was important in factor analysis only insofar as other criteria failed to be met. Specifically, these researchers found that communalities and overdetermination of factors were critical elements in determining minimum sample sizes, both in terms of providing converging solutions devoid of Heywood cases and having high congruence across factors. Under the context of this work, the wide range of communalities and relatively low overdetermination would be predicted to achieve good-to-excellent convergence even for sample sizes as low as n = 100, although the proportion of non-converging, Heywood-case solutions might remain relatively high. Although this latter issue did not appear to be a problem in this study, it should be considered if replication were to be attempted. Additionally, future work should consider the potential cost-benefit ratio of overidentifying latent constructs given the advantages this offers for minimizing sample size. Due to the lack of previous research pertaining to the present study, a model aimed at maximizing fit was used to judge the feasibility of the purported relationships. Now that the model has demonstrated its adequacy, overidentified conditions can be employed in subsequent investigations in the absence of excessive concern about model fit.

Problems in the conceptualization of fitness. One of the unique challenges of measuring fitness cross-sectionally, as opposed to prospectively, is the constant uncertainty about the validity of the variables being measured. Optimally, when measuring fitness, one is hoping to capture the likelihood that an array of genes will interact with the environment in a way that maximizes their influence in some future population. Fitness thereby represents a construct with very lengthy temporal considerations, and the ability to identify variables that adequately capture this construct is heavily limited. (How does one measure something that has not yet happened?) The variables included in this study represent some well-established, theory-driven variables likely to represent aspects of fitness, but this set was far from comprehensive. Future research should maintain openness toward the inclusion of other plausible fitness-representing factors.

Considering sexual strategies in only one dimension. This study looked at only one aspect of sexual strategies, focusing on the short-term approach. Although it was initially hoped to include a long-term strategy variable as well, this was not feasible given the quality of the relevant data collected.

This leads to two potential issues. First, this limit forced the consideration of STMS in isolation. In discussing the resulting findings, this author has been careful not to paint an overgeneralized picture of the relationship between sexual behavior and subjective well-being. For example, although the data appear to suggest that females who have penile-vaginal intercourse frequently and from an early age tend to show diminished SWB, the finding is confounded by the fact that competition for variance with potentially overlapping long-term mating strategies has not been statistically considered. Furthermore, it is possible that happiness differs depending upon the execution of one's selected sexual strategy, which may be either short-term or long-term (or both). In other words, even if, on average, short-term mating strategies augur poorly for SWB, it is still feasible that females within the subset that *predominantly* uses short-term strategies, excluding those who predominantly use long-term strategies, might vary in their SWB, such that females who do a good job of executing this strategy are happier than those who are less successful in this strategy. Consequently, better data on long-term strategies would not only permit the contrast of the two variables in the model, but this also would permit investigations of sexual strategy from a person-centered, rather than a variable-centered approach.

Problems with individual variables. Finally, a few variables were complicated by issues related to range and validity. First among these was FA, whose coherence as a construct appeared compromised to the point that it was dropped from consideration in the model. One of the most troublesome findings, which has been reported elsewhere (e.g., Livshits & Smouse, 1993), is that individual FA traits tend to be very weakly correlated within an individual, a finding which has been explained as due to differences in ontogenetic trajectory based upon the timing of developmental stressors. Although body asymmetries remain as the most touted measurements of FA with regards to fitness, the aforementioned concerns merit consideration of the use of dermatoglyphs or measures of other, more highly correlated morphological characteristics connected to FA in future research (e.g., Weinstein, Diforio, Schiffman, Walker, & Bonsall, 1999).

Second, possible range restrictions of *g* may have masked effects among males and may, in fact, have reversed relationships among females, as discussed previously. In a wider sense, however, this represents a limitation of working with a convenience sample of college undergraduates. Focusing a similar methodology on a broader cross-section of the general population may yield somewhat different results. Additionally, use of a convenience sample precludes this study from investigating developmental relationships. Given that aspects of happiness are known to vary over the lifespan (Diener et al., 1999; Easterlin, 2006) and that adaptive strategies necessarily ebb and flow as a consequence of reproductive status (e.g., Peccei, 1995), consideration of the role of development will be a necessity in future studies attempting to model the relationship between SWB and evolutionary fitness.

Third, the health variable appeared to yield relatively unremarkable findings. This may be attributable to poor indicators, and it must also be pointed out that this was the only fitness variable to rely exclusively on retrospective reporting measures, thus possibly attenuating actual effects. Future research should attempt to minimize the use of retrospective variables and to consider the collection of biomedical data to develop a more objective measure of expected current health (e.g., cortisol levels, white blood cell count).

Finally, MWB must be interpreted primarily as a measure of *perceived* affluence, rather than a bona fide representation of material well-being. Although this caveat did not compromise the utility of the factor—in light of the evolutionary "arms race" that could have emerged as males developed adaptations aimed at maximizing appearance of resource control and females developed adaptations aimed at parsing apart these exaggerations—it would nevertheless have been enlightening to test the relationship between self-report and actual conditions empirically. Future work should seek to investigate differences between the self-report and objective indicators of MWB, given the relevance that both variables may have with regard to representing adaptive mechanisms.

Future investigators can shed greater light on the question of happiness's role in reflecting evolutionary fitness by capitalizing on several different factors. Developmental considerations, for example, are ripe for inclusion in this model, as these would provide very clear hypotheses and conservative tests for the paths in this model. Another enlightening line of inquiry could be made into examining these relationships under a program of person-centered, as opposed to variable-centered, approaches. This shift in tactics would better reflect the strategy-based nature of fitness, instead of the more piecemeal conceptualization employed in this study. Last, this study explicitly used a model-building approach in which only an evolutionary approach was directly being tested. An alternate technique would be attempt to model these variables based on non-evolutionary models of happiness—e.g., Klein's (2006) neurobiological theory, Seligman's (2002a) strengths-based theory—to determine if equally cogent explanations may be devised under different paradigms. Overall, this study offered an important first step in attempting to broadly describe a number of observed relationships under a single framework; further work must elaborate on many details that this study was not able to give due consideration.

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Appendix A

Health History Questionnaire

The following questions ask about the frequency and duration of respiratory infections (colds, flus, etc.) and stomach/intestinal infections (flu) that you have experienced *with the last three months*.

	How many *times* did you have this illness?	How many *days* total did you have this illness?
Cold		
Respiratory flu		
Other respiratory infection		
Stomach/intestinal flu		
Other stomach infection		
Any other infections		

How many times in the last three months were you prescribed antibiotics to treat an infection of any kind?

______

Immediately below, list any disabilities from which you suffer or have suffered in the last three months. Please include any conditions whose onset preceded the last three months but which still significantly affects your life (e.g., paralysis from a car accident years ago, suffering from Crohn's disease since childhood, etc.).

Immediately below, list all relatives (by relationship, not name) who have become ill or have acquired some disability *within the last three months.* You may include recurrent conditions (e.g., re-appearance of cancer) if the most recent episode started within the last three months. Also identify the illness or disability.

Returning to the list you just made, please place a <u>check mark</u> before each relative *if your relationship (or how you think about your relationship) with that person has changed as a result of their new illness or disability*.

Returning to the list you just made, now place"<u>B</u>"s in front of each relative you identified who is a biological (blood) relative, and an "<u>A</u>" in front of each relative who is an adoptive, step-, or otherwise non-biological relative.

On a 7-point scale (1 = much poorer health, 4 = the same quality health, 7= much better health), indicate how good your health has been over the last week compared to the two weeks immediately preceding it:

Appendix B

Sex and Relationships Questionnaire

Instructions: The following questions ask about various sexual activities in which you have engaged. Please answer them to the best of your recollection, taking note of the specific *types* or sexual behaviors being asked about as well as the *time period*.

What age were you when you first had consensual *penile-vaginal* sexual intercourse?

With how many partners *over your lifetime* have you had consensual *penile-vaginal* sexual intercourse?

What age were you when you first consensually participated in *any* sexual behaviors with a person of the opposite sex (giving or receiving), including romantic kissing, touching of erogenous zones, oral sex, or anal sex—*aside from penile-vaginal intercourse*?

With how many partners *over your lifetime* have you consensually participated in *any* sexual behaviors with a person of the opposite sex (giving or receiving), including romantic kissing, touching of erogenous zones, oral sex, or anal sex—*aside from penile-vaginal intercourse*?

Please list the durations of your last five romantic relationships (using days, weeks, months, etc.; in the event that you have had fewer than five, simply list all that qualify). *Please include any romantic encounters of single dates, one-night stands, etc., labeling them as such.*

1.
2.
3.
4.
5.

With how many partners *over the last three months* have you had consensual *penile-vaginal* sexual intercourse?

With how many partners *over the last three months* have you consensually participated in *any* sexual behaviors with a person of the opposite sex (giving or receiving), including romantic kissing, touching of erogenous zones, oral sex, or anal sex—*aside from penile-vaginal intercourse*?

Apprioximately how many times *over the last three months* have you had consensual *penile-vaginal* sexual intercourse?

Apprioximately how many times *over your lifetime* have you had consensual *penile-vaginal* sexual intercourse? (If unclear, estimate based upon per-week or per-month averages since you first became sexually active.)

Apprioximately how many times *over the last three months* have you consensually participated in *any* sexual behaviors with a person of the opposite sex (giving or receiving), including romantic kissing, touching of erogenous zones, oral sex, or anal sex —*aside from penile-vaginal intercourse*?

Apprioximately how many times *over your lifetime* have you consensually participated in *any* sexual behaviors with a person of the opposite sex (giving or receiving), including romantic kissing, touching of erogenous zones, oral sex, or anal sex—*aside from penile-vaginal intercourse*? (If unclear, estimate based upon per-week or per-month averages since you first became sexually active.)

On a 7-point scale (1 = extreme decrease, to 7 = extreme increase), to what extent has the number of times that you have had consensual *penile-vaginal intercourse* changed over the last week, compared to the 2-week period immediately preceding it?

On a 7-point scale (1 = extreme decrease, to 7 = extreme increase), to what extent has the number of times that you have consensually participated in *any* sexual behaviors with a person of the opposite sex (giving or receiving), including romantic kissing, touching of erogenous zones, oral sex, or anal sex—*aside from penile-vaginal intercourse*—changed over the last week, compared to the 2-week period immediately preceding it?

Appendix C

RCQ II

Directions: Read each item carefully. Rate how true each item is for you using the following scale:

Not at all true — Completely true

1 ——— 2 ——— 3 ——— 4

___ 1. If there's something worth knowing, I'm among the first to know it.

___ 2. I get the inside scoop.

___ 3. I get important information that I and others need or want.

___ 4. I am the center of attention when with friends.

___ 5. I get the attention of high status/important people when with others.

___ 6. I'm successful at getting a date (or sex) with whom I want.

___ 7. I'm successful at getting the material things that I and others want.

___ 8. I know how to get a job/internship/position that I and others want.

___ 9. I'm successful at getting the things that I and others value.

___10. I'm successful at getting things that are associated with status.

Appendix D

Material Resources Questionnaire

Participants' material wealth will be assessed by self-report of both personal, familial, and expected income, as well as any wealth likely to be inherited within participants' reproductive lifetimes. and the amount they expect to inherit from relatives, trust funds, or other irregular sources within the next twenty years. To obtain a single indicator, all variables with substantial variation will be transformed into *z*-scores and averaged representing the participant's overall material wealth score.

Instructions: The following questions ask about your own material well-being, as well as that of your financial support network (e.g., parents, guardians, benefactors, etc.). Please answer them to the best of your ability.

If you were to total all the money you have in your personal bank accounts (i.e., any money that you independently control, without including money owed to you or available through loans), excluding money encumbered in investments (e.g., IRAs), how much would you estimate that you would have.

Determine your total net worth. Include money in personal bank accounts, investments, and trust money that is available to you, as well as any other assets (homes, valuable property, precious metals, etc.).

What is your average yearly income (only if employed)?

What is the average yearly income of your primary financial support group (e.g., immediate family)?

Given one week's advance notice, how much money do you think that you could acquire, both from your own accounts and from your financial support network, for a dire financial need, excluding anything acquired from loans from third parties (e.g., banks, credit unions)?

What is your anticipated vocation five years after leaving college?

What is your anticipated income five years after leaving college?

Over the next twenty years, how much net worth do you expect to inherit from relatives or other benefactors, or have become available to you through the maturing of investments, that you do *not* have access to at the present time?

On a 7-point scale (1 = much worse, 4 = the same, 7 = much better), how would you say your financial well-being has changed within the last week, compared to the immediately preceding two weeks?

Notes

[i] Fredrickson does not deny that some positive affective experiences *can* induce more specific responses; instead, she allows that this happens for affective experiences that require no appraisal component (e.g., physical pleasure) and therefore do not qualify as emotions per se but instead as moods or other phenomena.

[ii] Admittedly, any argument about evolution based upon reverse-engineering principles is subject to the criticism that evolution *never* produces the truly optimal solution, due to factors such as previously existing design constraints and competition among what Dawkins (1976) has aptly described as "selfish" genes. However, given the robust literature that has emerged from the field of developmental evolutionary psychology—and, in particular, around an epigenetic framework in which genetic, structural, functional, and environmental factors all play an interactive role in driving the ontogeny of adaptations (e.g., Causey, Gardiner, & Bjorklund, 2008)—speculation about the existence of temporally specific adaptations would appear to extend beyond armchair theorization and merits recognition in this paper.

[iii] Here, too, lies a topic worthy of investigation but well beyond the scope of this paper. Not only would subjective well-being be expected to reflect developmentally appropriate goals, but sexually appropriate ones as well. Thus, any complete evolutionary theory of subjective well-being would have to consider two dimensions (age and sex) in ascertaining the adaptive goals that ought to be contributing to changes in the variable.

[iv] Indeed, others (Lee & DeVore, 1968) have noted that greater material wealth for those leading *nomadic* lifestyles would actually have been burdensome, given the extra difficultly one would have guarding and transporting such objects, especially given their low practical values in the context of the hunter-gatherer lifestyle. It is, however, worth considering that such a heightened burden may also have served as an honest signal of fitness.

[v] One other defense against the apparently incongruent findings of this hybrid approach to evaluating happiness is Veenhoven's (2005) own admission that "happy life years" still are better predicted by informatization and individualization than to urbanization and industrialization. Put another way, even using these nonstandard operationalizations, subjective well-being appears to be better predicted by the "social" aspects of wealth (ability to stay connected with others; ability to establish voluntary rather than obligatory social connections) than the "material" aspects of wealth.

[vi] Although measurement in units of inches (and later, pounds) deviated from traditional use of the metric system in scientific studies, this was done mindfully in the present study. With the expectation that future research may occur online, it was desirable to collect data that would be in the same unit of measurement that was most likely to be reported by the general population, so that overestimation could be statistically controlled while converting between metrics as little as possible. Contrast this approach to measurement of fluctuating asymmetry (impossible to measure via online studies), for which the research assistants took measurements in millimeters.

[vii] In subsequent analyses, missing values for the age at first intercourse among participants who reported never having participated in penile-vaginal intercourse were filled with the participants' current ages. Although this technique would not be recommended for a data set with wide variability in age, the narrow age range of this sample diminishes the likelihood that this approach to imputation would lead to deleterious interpretive effects.

[viii] Additionally, data for BMI Deviation were subjected to a square-root transformation in order to diminish positive skew.

[ix] The modeling of sexual strategies was initially planned to include consideration of both short-term and long-term strategies. However, data relevant for the measurement of long-term strategies ultimately appeared to be unusable due to inconsistent and contradictory reporting used by the participants. As a consequence, this latter construct was dropped from the model. Additionally, the items intended to measure frequency of sexual behavior were dropped due to statistical considerations. Foremost among these was the finding that a locally overidentified model of short-term strategies led to major instabilities in the specification of the model. After determining that age at first PVI and either of the two measures of number of PVI partners performed well in the model, alternate options of including the other measure of PVI partner number or a measure of frequency of PVI were considered. One measure of PVI frequency (lifetime) was rejected because participants frequently did not provide data in which rates of behavior could be reliably calculated; the other measure of frequency (past 3 months) was rejected due to a lack of variability.

[x] Each of these indicators was transformed using a natural-logarithm transformation in order to correct for positive skew. Additionally, prior to transformation, seven instances in which participants reported family income of less than $7000 per year were capped at this minimum. This number was used as the basement of the measure a) because it appeared to be the lowest value clearly falling within the greater distribution and b) because, based on the experience of the researcher, it accurately represented the minimum reasonable amount of annual income on which a student could live in the local community.

[xi] These figures also illustrate *significant* covariances between latent variables, although all parameter estimates for insignificant covariances were permitted in the model.

[xii] This latter metric of access to material resources may be particularly relevant in the current population, as the decision to pursue higher education effectively delays the acquisition of material resources for the short term, but with the demonstrable fact that investing in a college degree significantly influences future income and, by extension, potential wealth (e.g., Levy, 1998).

[xiii] Trivers and Willard's (1973) argument briefly is as follows. Assume a population with an approximately 1:1 sex ratio. Also, assume that the quality of offspring is significantly influenced by the condition of the mother (i.e., a mother with access to better food, being in better health, etc., than other females will imbue her offspring with advantages over the offspring of rival females) and that these advantages have more than chance likelihood of persisting into the offspring's

reproductive lifetime. Then consider the fact that a reproductive-aged male in much better condition relative to his male rivals will likely have very significant reproductive success over his competitors, while a female in an analogous position will also have reproductive success over that of female peers, although her advantage will be less than the male's due to practical constraints on the number of children that can carry on her genes. From these points it follows that the mother's fitness level will be affected by the sex of her offspring given the conditions she experiences during and before pregnancy, such that it will be more advantageous to her fitness should she produce female offspring when her condition is poor relative to her competitors at the time of reproduction, and males offspring when her condition is good relative to her competitors.

[xiv] The general of lack of consensus about the direction of the observed genders differences in affect is further complicated by a lack of well articulated, comprehensive explanations for such patterns. Vigil (2008), however, has argued that the types of social networks in which humans have historically affiliated provides some insight into why affective systems may have evolved differently in males and females. Vigil cites Wrangham and Peterson (1996) and Geary (2002), among others, in proposing that, due to the principles of male-biased philopatry (migration to the male's home following pair-bonding) and male-male coalitional competition, females' affective skills are attuned to navigating reciprocal altruism with non-kin conspecifics, whereas males have a greater need to exhibit affect that will be useful in interactions with kin-related peers. Consequently, males will develop affective sets

congruent with demonstrations of dominance and aggression, with females becoming adept at affective expression conducive to intimate relationship formation and maintenance. A corollary to Vigil's argument would be that, with the male affective set being more blatant, and the female set less observable, the level of affectivity demonstrated by females will have to be greater than that of males to accomplish the same social networking goals. It is notable that the hypothesis stemming from this argument would be that *females* ought to be reporting higher PA and NA means than males—a hypothesis that is directly contradicted by the present findings but supported by some of the previously cited studies.

[xv] Admittedly, this explanation is somewhat less tenable when one considers that the *strong* metric invariance of PA and NA was nevertheless supported by the resulting model.

[xvi] It is plausible, for example, for Vigil's (2008) hypothesis to have substantial merit with regard to actual expression of affect, but for the genders to have developed differing affect-sensing mental modules in order to best execute the concomitant behaviors, thereby leading to unexpected findings on self-report measures like the PANAS.