

LIFE HISTORY STRATEGIES, TESTOSTERONE, AND THE ANTHROPOLOGY OF  
HUMAN DEVELOPMENT

by

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## ABSTRACT

Life history theory was originally formulated in evolutionary biology to describe interspecies variation in life course development as a result of natural selection. Recently, some theorists in psychology and anthropology have tried to apply life history theory to understanding human intraspecies variation in psychology and behavior. These theorists have proposed that psychosocial stressors found in harsher social environments serve as cues of mortality risk that prime the development of particular life history strategies. The current study was an early empirical exploration of this theoretical development through examining a possible relationship between measures of the social environment and proposed components of human psychological and behavioral life history strategies, including sociosexuality, aggression, and risk taking. This proposed relationship was tested using a sample ( $n = 99$ ) that was recruited from the population of young adult male college students at the University of Alabama. Further, the current study was an effort to incorporate hormonal mechanisms as well as the influence of culture into life history strategy theorizing. Testosterone was measured both in the morning and in the late afternoon/evening through saliva samples due to its implication in sexual behavior, aggression, and risk taking. Ethnographic open ended interviews were conducted with members of the population under study ( $n = 10$ ) in order to obtain environmental factors specific to the sociocultural context. This served to add breadth and a contextually specific assessment of the social environment for the study population. Results indicated no relationship between environmental assessment measures, life history strategy measures, and testosterone. Therefore,

this suggests a need to reconsider the relevance of life history theory to variation in human psychology and behavior.

## LIST OF ABBREVIATIONS AND SYMBOLS

$n$	Frequency
$p$	The probability of obtaining a given result when the null hypothesis is true
$r$	Pearson or Spearman correlation coefficient
<	Less than
$\mu\text{L}$	Microliter
mL	Milliliter
nm	Nanometer
pg/mL	Picograms per milliliter
rpm	Revolutions per minute
SES	Socioeconomic Status
SD	Standard Deviation
SPSS	Statistical Package for the Social Sciences

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## 1. INTRODUCTION

Life history theory was developed within evolutionary biology to describe how natural selection shapes the development of various species. Each species has a resulting life history strategy, including characteristics such as the pace of growth, when to reproduce, how many offspring to have, and how much to invest in these offspring. Life history strategies are often described on a fast-slow continuum, in which a “fast” strategy refers to characteristics such as fast pace of growth, reproducing early, reproducing larger numbers of offspring, and investing little in these offspring. A slower strategy includes the opposite characteristics (Stearns 1992; Del Giudice 2014).

While life history theory has been applied to interspecies variation, it has recently been applied to intraspecies variation, specifically with reference to humans (Belsky 2012; Del Giudice 2014; Kuzawa & Bragg 2012). This has led to theorizing on the environmental influences acting on the development of a life history strategy. Using the same fast-slow continuum, some theorists have proposed that harsh psychosocial conditions serve as mortality cues, which then promote a faster life history strategy (Belsky 2012; Del Giudice 2014; Del Giudice et al. 2015). Under this theoretical framework, a faster strategy includes behaviors related to living life in the “fast lane”. Life is expected to be shorter, therefore conserving energy and investing in the long term is de-prioritized. The suite of characteristics proposed by these theorists to be included in a faster life history strategy generally include a sociosexual preference for short term and uncommitted sexual relationships, a higher number of offspring with less

investment in them, higher aggression, higher risk taking, and prioritizing the short term over the long term (Del Giudice et al. 2015).

The current study served as an early empirical exploration of this theoretical development, in which sociosexuality, aggression, and risk taking were measured in relation to variable environmental measures. Sociosexuality, aggression, and risk taking were incorporated and measured in the current study using previously developed questionnaires (Buss & Perry 1992; Jackson & Kirkpatrick 2007; Weber et al. 2002), while environmental measures were created using both previously created measures as well as one measure created specifically for the current study. These measures were applied to young adult male college students at the University of Alabama, who served as the population under study.

The current study was also an early effort to incorporate the role of culture in life history theorizing, and this was done through the creation and use of environmental quality measures. Currently, theorists incorporating life history theory into understanding human variation in psychology and behavior have ignored the role of culture. Since life history theory relates to development, and much research has been done on the role of culture in human development (Worthman 2010), an understanding of the development of life history strategies must account for the role of culture. The incorporation of culture was done through the reliance on cultural models of development.

The use of cultural models was done by heavily relying on previous research conducted by Brown et al. (2006). These researchers studied cultural models of development in the form of important developmental milestones or goals that individuals desired and worked toward achieving in later life. Brown et al. (2006) focused on youths in western North Carolina. They used methods derived from cultural model research in cognitive anthropology in order to elicit

important developmental goals individuals in the population aspired to achieve, along with socioemotional resources, material resources, and barriers they were likely to encounter that would influence the success in achieving these goals.

The current study incorporated the work of Brown et al. (2006) in order to construct additional measures of environmental quality that were culturally relevant, thereby incorporating the influence of culture into the development of life history strategies. Two measures were constructed, one for early life environmental quality and another for current life environmental quality. Select resulting items in the domains of resources and barriers from Brown et al. (2006) were used to construct an interview schedule asking participants about their early life environmental quality. For the current life environmental quality measure, an interview schedule was constructed using free listing with members of the population under study, similarly to Brown et al. (2006). Convenience sampling resulted in ten open ended interviews, in which participants were asked to list their short and long term goals. Participants were then asked to list as many resources and barriers that they thought could influence the achievement of these goals. Data obtained on contextually relevant resources and barriers were used to construct the interview schedule measuring current life environmental quality.

These two measures were included with environmental quality questions present in the questionnaire, including parental education, subjective socioeconomic status, expected life span, and rated stress, in order to assess environmental quality broadly as well as in a contextually specific manner. This resulted in two phases of the study. The first involved ten open ended interviews intended for the purpose of constructing a measuring instrument for the second phase of the study. The second phase involved an interview assessing early life and current life environmental quality, a questionnaire further assessing environmental quality along with

measures of sociosexuality, aggression, and risk taking, and finally morning and late afternoon/evening saliva sample collection for measuring testosterone.

Further empirical exploration of the recent use of life history theory in human psychology and behavior was done through incorporating testosterone measurement. Testosterone is an androgen hormone that plays a major role in the biological development of males (Mazur & Booth 1998). However, it has also been implicated in behavior. Specifically, testosterone has been associated with sexual behavior and desires (Gettler et al. 2013; van Anders 2013), as well as aggression and risk taking under certain social circumstances (Archer 2006; Booth et al. 2003; Booth et al. 2006; Ronay & Hippel 2010). Further, hormones such as testosterone have been proposed as mechanisms acting on the development of a life history strategy, as they serve as directors of the flow of resources used by organisms (Gettler et al. 2011a; Gettler et al. 2011b). The current study incorporated the measurement of testosterone through the use of saliva samples. It was expected that the faster life history strategy indicators of the current study, sociosexuality preference for short term uncommitted sexual relationships, higher aggression, and higher risk taking, would be associated with higher testosterone. Saliva samples were collected at different times of the day, in the morning and in the late afternoon/evening, in order to account for variation due to the diurnal pattern of testosterone in which concentrations are highest in the morning and decline throughout the day (Granger et al. 2004).

In total, a sample of 99 individuals was relied on for hypothesis testing during Phase II of the study. Data collected on environmental quality, life history strategy indicators, and testosterone were used to test the hypotheses that (1) worse environmental quality measures would be associated with faster life history strategy indicators, (2) faster life history strategy indicators would be associated with higher testosterone, and (3) life history strategy indicators

would mediate a relationship between worse environmental quality measures and higher testosterone. Correlations and multiple linear regressions were used to analyze the data and test the hypotheses.

### *Outline*

Chapter two traces life history theory from its original use in evolutionary biology to its current application by some theorists to understanding variation in human psychology and behavior. It describes much research focusing on pubertal development as a mechanism through which to study intraspecies variation in life history strategies in humans, particularly in females. It also alludes to possible hormonal mechanisms relevant to life history strategy variation, such as glucocorticoids and testosterone.

Chapter three serves as an introduction to testosterone. How testosterone influences biological development as well as behavior is covered. Further, the complex and causal relationship involved in associations between testosterone and certain behaviors is explained.

Chapter four covers the role of culture in human development. Early research conducted by anthropologists on human development is presented and traced through its influence up to recent anthropological research on the role of culture in human development. Cultural models are explained, and their incorporation into anthropological research on the role of culture in human development is highlighted.

Chapter five describes the methodology used in the current study. The process through which measures were constructed specifically for this study is described in detail as well as the prescribed use and interpretation of previously constructed questionnaires for sociosexuality, aggression, and risk taking. The process through which testosterone was measured is also described in detail.

Chapter six presents the results of the current study. Results from both study phases are presented in tables. Descriptive statistics, bivariate correlations, and multiple linear regression models of data obtained during Phase II are presented in tables.

Chapter seven includes a discussion and interpretation of the results. Further literature is presented in an effort to make sense of the results. The chapter concludes with a consideration of study limitations.

Chapter eight contains the concluding remarks on the current study. The results are considered in light of the proposed hypotheses, and overall assessment is made. Finally, suggestions for further theoretical use of life history theory based on the current study are made.

## 2. LIFE HISTORY THEORY APPLIED TO HUMANS: BIOLOGICAL DEVELOPMENT AND BEHAVIOR

### *Introduction*

Life history theory describes the relationship between organisms with limited resources to allocate for various biological functions, such as growth, maintenance, and reproduction, and selective pressures from the environment that shape the resource allocation decisions or trade-offs an organism must make in order to survive and reproduce. In this way, natural selection shapes the life cycle of organisms, creating a life history strategy or profile of a species that consists of resource allocation trade-offs, including when to reproduce or how quickly or slowly to develop (Kuzawa & Bragg 2012; Schwartz 2012). Life history profiles are often described on a fast-slow continuum, in which a faster life history strategy would include faster pace of development, smaller body size, reproducing earlier, producing a higher number of offspring with lower investment in those offspring, and dying earlier. Strategies on the slow end of the spectrum would include the opposite, such as developing slower with generally a larger body size, reproducing later, reproducing fewer offspring and investing more in their survival, and having an overall longer life span. An example of a selective force operating on life history strategies is mortality; increased mortality promotes a faster strategy whereas decreased mortality promotes a slower strategy (Schwartz 2012; Sibly & Brown 2007; Sibly & Brown 2009).

The life history strategy of humans is unique in two major ways. These include the mix of fast and slow characteristics in the species strategy and the relatively high variability of life history strategies among individuals within the same species. The human life history strategy

consists of slow development, later age at reproduction, shorter interbirth intervals relative to other great apes primates, high offspring investment, and a longer overall life span. This inclusion of the fast characteristic of shorter interbirth intervals and resulting higher number of offspring compared to other great apes can be explained by earlier weaning that is compensated for through alloparental care, in which other adults besides the mother provision food for these newly weaned offspring. (Hill 1993; Kuzawa & Bragg 2012; Worthman & Kuzara 2005).

Despite a general species-wide life history strategy, there appears to be high variability in this strategy among humans (Kuzawa & Bragg 2012). This developmental plasticity allows for high variability in growth rate, body size, reproductive timing, and the length of the life span. This variability could have started to appear in early *Homo*, which is dated at around 2.5 million years ago (Schwartz 2012). The environment that members of early *Homo* experienced was highly variable, which could have led to a selective pressure for adaptive plasticity (Aiello & Antón 2012). Therefore, selective pressure on plasticity as a trait could explain how human developmental plasticity contributes to variability in life history strategies. This variability is contingent on factors such as nutrition, mortality, and possibly even psychosocial stress (Chisholm 1993; Kuzawa & Bragg 2012; Schwartz 2012).

### *Applications to Human Reproductive Development*

Life history theory has been used in order to explain differences in human behavior, particularly regarding reproductive behavior (Belsky 2012). The application of life history theory to human mating strategies was originally sparked by an article written by Draper & Harpending (1982), in which they discussed the possibility that children learn from their parents how to construct their own mating strategies later in life in an adaptive manner. For example, if a child grows up in a household with parents who are not pair bonded, that child will likely devalue

having their own stable pair bond relationship, and whether they choose the path of stable pair bonded relationships in their mating strategy or less stable and shorter lasting relationships simply represents different paths to the same goal of reproductive fitness under different social conditions. Draper & Harpending (1982) presented cross-cultural as well as intracultural evidence for their claim. They noted that in cultures of strict sex segregation, men and women are often ambivalent towards each other, and women of these cultures typically do not seek out a long lasting partner to form a stable pair bond with. Instead, the women of these cultures do less “vetting” of their mates because they do not expect much paternal investment in the offspring. These women also reproduce at a younger age.

Other evidence Draper & Harpending (1982) heavily rely on comes from an earlier study that compared the behavior of three groups of young girls in how they interacted with either male or female study interviewers (Hetherington 1972). These groups consisted of girls with fathers still married to their mothers and regularly present, girls with divorced fathers, and girls with fathers who were deceased. These groups showed no differences in how they interacted with a female interviewer. However, the groups showed differences in how they interacted with a male interviewer. The group with father-present homes showed less interest, openness, and eye contact compared to the group with divorced fathers who showed more interest, eye contact, and sat closer to the male interviewer. The group with deceased fathers were the most avoidant towards a male interviewer.

Despite serving as the predecessor for the integration of life history theory into the study of human behavior, the Draper & Harpending (1982) paper did not actually integrate life history theory. Instead, later researchers incorporated life history theory as a developmental mechanism to explain the proposed facultative adaption in which early life experience shapes reproductive

strategies later in life (Belsky 2012). The observations of individual variability and high developmental plasticity in life history traits were combined with the reasoning from life history theory that the environment imposes various conditions that organisms must respond to by making resource allocation decisions. This framework has now been used to make new predictions about human development and behavior.

Most of these predictions are in regard to reproductive strategies. For example, an often cited study by Wilson & Daly (1997) suggested a relationship between life expectancy and timing of reproduction. These researchers surveyed several Chicago neighborhoods and found that the life expectancy of the various neighborhoods predicted age at first reproduction for women, in which lower life expectancy predicted earlier first reproduction.

This empirical investigation has expanded to studying the pace of maturational development in response to different environmental influences, such as levels of nutrition and exposure to psychosocial stress. For example, Gettler et al. (2015) found that increased levels of nutrition during childhood was associated with accelerated development in adolescent males in the Philippines. Better nutrition was also associated with an earlier age at beginning sexual intercourse, while psychosocial stress did not predict biological measures of accelerated maturational. However, an unstable paternal presence as well as experiencing a sibling death during childhood was associated with becoming a father sooner.

The relationships between nutrition and the pace of development as well as psychosocial stress and development have also been studied in females. For example, it has been found that nutrition is related to the timing of menarche in girls, in which undernutrition is related to later menarche and better nutrition associated with earlier menarche (Ellis 2004). Much research has also been done on the relationship between psychosocial stress and age at menarche. Ellis &

Essex (2007) tested predictions that stressors in the family context would predict accelerated pubertal timing in children, with particular emphasis on young girls in a longitudinal study that spanned from preschool to age eleven. Their measures of ecological stressors included socioeconomic status, mother's report of parental supportiveness and marital conflict, and father's reported parental supportiveness and marital conflict. The outcomes were measures of adrenarche in both girls and boys at age seven, determined by a cutoff in salivary measures of dehydroepiandrosterone or DHEA, and secondary sexual characteristics in girls at age eleven measured by mother and daughter self reports of pubic hair and breast development. They found mixed results, in which parental supportiveness reported by both parents but only paternal reported marital conflict predicted adrenarche status. While only socioeconomic status and maternal reported parental supportiveness predicted secondary sexual development pace in the group of eleven-year-old girls.

Belsky et al. (2007) examined family conditions as predictors of puberty timing in both boys and girls. This was a longitudinal study following children from birth up to eighth grade. Pubertal timing was measured with a combination of self-reported menarche and physical examinations of both boys and girls by nurse practitioners in order to evaluate the physical development of puberty in both sexes. Using a variety of rearing predictors, such as observing parenting styles and having parents self-report their parenting styles, they found that parental reported harsh control style of parenting predicted earlier menarche and pubertal development in girls, but did not predict pubertal development in boys. Worthy of note is that maternal age of menarche was a stronger predictor of daughter's age at menarche and pubertal development than the rearing predictors, in which mothers reporting earlier age at menarche had daughters with

earlier age at menarche and earlier pubertal development. Maternal age at menarche did not predict pubertal development in sons.

The life history theory derived predictions about the relationship between rearing or family conditions and reproductive strategies appears to be equivocal. In a large review of the literature regarding predictors of reproductive development and strategies, Ellis (2004) made a conclusion in line with the two studies previously highlighted; that there is partial empirical support to what is referred to as psychosocial acceleration theory (Belsky et al. 1991), a theory that draws from life history theory and asserts children regulate the development of their reproductive strategies based on cues from their familial context. In this family context, psychosocial stressors supposedly serve as mortality cues, and therefore speed up development. Previous research has indicated that some parental behavior can predict reproductive development in girls but not boys.

However, Ellis (2004) has highlighted a problem with the psychosocial acceleration theory; pubertal development appears not to be related to the expected suite of mating strategy characteristics that would be expected by incorporating life history theory into reproductive development of children. It is more an assumption than empirical fact that earlier puberty leads to a reproductive strategy characterized by risky sociosexual preference with a higher number of sexual partners, lack of interest and ability to form stable pair bonds, and lower investment in offspring (2004). While women who experienced earlier pubertal development appear to have more offspring over their life course, this might just be the result of having a longer reproductive window rather than utilizing a qualitatively different mating strategy (Sheppard et al. 2015). In order to overcome this empirical pitfall, Ellis (2004) has proposed the child development theory, in which puberty timing is actually related to shortening childhood and having an earlier entrance

into later life stages that are characterized by more independence, higher peer engagement, and initiating sexual relationships. This theory is less ambitious, since it does not expect children to be calibrating a reproductive strategy they will be utilizing in fifteen to twenty years in response to parental cues. However, the fact that pubertal and family conditions appear to only be related in girls and not boys remains a limitation of these theories.

### *Hormonal Mechanisms Involved in Life History Trade-offs*

The application of life history theory to humans has gone beyond pubertal development to other potential trade-offs, such as whether to invest in mating versus parenting as well as whether to invest in quality over quantity of offspring. Again, the focus has been on the role of developmental plasticity in the relationship between environmental stimulus and individual variability in life history strategies (Del Giudice et al. 2015). This broadening focus has led to interest in hormones and the endocrine system.

The endocrine system has been identified as the necessary unit of analysis because hormones direct how energy is utilized, and are therefore crucial for making energy trade-offs (Del Giudice et al. 2015; Stearns et al. 2008; Worthman & Kuzara 2005). For example, in a study of adult males in the Philippines, Gettler et al. (2011a) found that higher waking testosterone in single males with no children predicted a higher likelihood of being partnered fathers at a follow up 4.5 years later. The men who became partnered fathers at the follow up had a larger decrease in testosterone levels than the men who were not partnered fathers. Time spent in childcare also predicted testosterone levels, in which testosterone was lower in the fathers who reported more time spent in childcare.

The same group of researchers also studied the relationship between the mating-parenting trade-off and co-regulation of testosterone and cortisol using the same sample in the Philippines

(Gettler et al. 2011b). They grouped mating oriented individuals as those who were not pair bonded or fathers, while parenting oriented individuals were grouped as those who were either pair bonded, fathers, or both. These groups were compared on two salivary measures of testosterone and cortisol, one upon waking (AM) and the other prior to bed (PM). Their results mostly supported the prediction that co-elevated testosterone and cortisol served as mediators in the life history trade-off of mating versus parenting effort. The parenting oriented men were more likely to have the lowest testosterone and cortisol levels in both the AM and PM samples. However, the mating oriented men were more likely to have the highest testosterone and cortisol levels in only the PM samples.

The hypothalamus-pituitary-adrenal axis (HPA) and its end product in humans, cortisol, has also been proposed as a likely hormone involved in life history strategies (Del Giudice et al. 2015). For example, Worthman & Kuzara (2005) propose that viewing cortisol as the “stress hormone” is too narrow of a conceptualization of the hormone. They note that cortisol plays a large role in regulating how energy is used, specifically during a stressor. Therefore, they propose viewing cortisol as the “traffic cop of resource partitioning” (2005:99).

However, a review of the role the HPA axis plays in life history strategies across several vertebrate species by Crespi et al. (2013) revealed that the empirical data does not show a simple and direct relationship between the functioning of the HPA axis and life history strategies, contrary to what theoretical intuition assumed. For example, while the HPA axis can serve to speed up the life cycle in some species, this is not the case in others. Crespi et al. (2013) assert that much more empirical work needs to be done on the way the HPA axis has evolved along with particular life history strategies in different species before it will be possible to discover simple and general relationships between the HPA axis and life history strategies. They are also

cautious in their expectations of eventually finding this, noting it conceivable that if general patterns are discovered then they will have several exceptions.

*Life History Theory Applied to Human Psychology and Behavior*

The HPA axis is not simply an endocrine system, it is a neuroendocrine system, and Worthman & Kuzara (2005) speculate about the relationship between environmental stimulus, life history strategies, and the brain in terms of cognitive trade-offs. They assert that in humans, stressful early environments induce cognitive trade-offs related to various brain functions, such as attention regulation, learning and memory, emotion regulation, and social tendencies related to exploration, risk taking, and aggression.

These cognitive trade-offs relate to the composite life history strategies proposed by Del Giudice (2014), in which individuals who experience stressful early life conditions are expected to exhibit a suite of characteristics that include higher aggression, risk taking, prioritizing the short term, less emphasis on stable pair bonds, earlier reproduction, and reproducing higher numbers of offspring with relatively less investment in them. In other words, stressful early life experiences promote a faster life history strategy. Del Giudice (2014) has applied life history theory beyond only biological development in order to predict general psychological and behavioral predispositions. Therefore, this adaptive calibration ability would have been selected for because it promoted survival and reproduction under variable possible environmental circumstances. This theoretical view is an attempt to merge evolutionary biology with evolutionary psychology.

Exactly how early life environments have been conceptualized and measured has mostly included socioeconomic status (Del Giudice et al. 2015; Ellis & Del Giudice 2014; Sheppard et al. 2015). Some empirical work using measures related to socioeconomic status and early

childhood environments has supported predictions made from this theoretical perspective. For example, Brown et al. (2009) studied multiple predictors of life course priority goals of youths in the Appalachia region of western North Carolina and found that poverty and exposure to traumatic stressors predicted certain life course priorities. Poverty was associated with a higher priority placed on family formation, while exposure to traumatic stressors was associated with placing less priority on long term economic establishment items such as a career, house, and financial security. These researchers pointed out that their data was in line with the prediction that stress exposure would be associated with discounting the future.

Discounting the future in response to stress exposure has been viewed as an adaptive response (Ellis et al. 2009). In order to emphasize this point, Ellis & Del Giudice (2014) have asserted that the labels of “toxic” and “undesirable” in the societal determination that chronic stress is toxic and leads to undesirable psychobiological and behavioral outcomes needs to be separated from the analysis of stress and development. They claim that this is necessary in order to see the potential underlying adaptive logic. Therefore, individuals can have adaptive responses that can have long term deleterious impacts on health and longevity in the future, but nevertheless enhance survival and reproduction in the immediate or short term environmental circumstances.

### *Current Study*

The broader application of life history theory to understanding and predicting human psychology and behavior has been almost exclusively a theoretical endeavor, with little empirical exploration at present. This study empirically explored some of the predictions derived from theorizing on how life history theory explains and predicts human psychology and behavior (Del Giudice 2014). Previously designed questionnaires measuring sociosexuality, aggression, and

risk taking were administered to study participants in order to examine components of a life history strategy (Buss & Perry 1992; Jackson & Kirkpatrick 2007; Weber et al. 2002).

Along with these questionnaires, participants were asked to fill out information related to their socioeconomic status in order to provide measurement indicators of the quality of their environmental circumstances. This included both maternal and paternal education as well as subjective socioeconomic status. Also included was an assessment of participants' expected life span in decades in order to provide a mortality cue score. Finally, a five point scale of perceived stress was included. These measurements all served as predictors of aggression, risk taking, and sociosexuality in order to test whether harsher environments promoted a faster life history strategy.

Testosterone was also measured using saliva samples due to its relevance to life history strategies (Gettler et al. 2011a). This specific hormonal measure was included also because of its implication in sexual behavior, aggression, and risk taking (Booth et al. 2006). Further, harsher environments in the form of low SES have been observed to be associated with higher testosterone in the United States, which served as the geographic setting for this study (Alvarado 2013).

### 3. TESTOSTERONE, BIOLOGICAL DEVELOPMENT, AND BEHAVIOR

#### *Introduction*

Testosterone is an androgen steroid hormone, and plays a primary role in the development of male physical characteristics during development. Testosterone in males is produced primarily by the testes. Production of testosterone is elevated during gestation and through the first few months of life, supporting the development of male genitalia in early life. This is followed by declines until another period of elevation during the onset of puberty (Winter et al. 1976). This elevation during puberty serves the purpose of developing male adult sexual characteristics, such as growth of the penis, larynx, muscles, body hair, and sex interest (Mazur & Booth 1998). During the pubertal transition, testosterone begins to have a diurnal pattern, in which levels are highest in the morning and decline throughout the day (Booth et al. 2006). Since testosterone plays a major role in growth and development through somatic investment, levels are sensitive to energy availability, in other words nutrition. For example, Kuzawa et al. (2010a) studied the role of nutrition in early life growth patterns and developmental outcomes for young adults in Cebu, Philippines. Individuals who were born into wealthier households, an indicator of nutritional status in this resource poor setting, grew more rapidly from birth to six months of age. These individuals then reached puberty sooner, had higher testosterone, and were taller and more muscular.

#### *Sexual Relationships and Fatherhood*

Along with research interest on how testosterone relates to biological development, there has been extensive interest and exploration on the relationship between testosterone and certain

behaviors, such as sexual behaviors, aggression, and risk taking. Several studies have examined how testosterone relates to marriage and fatherhood. Booth & Dabbs (1993) examined a sample of over four thousand United States Armed Forces veterans relating testosterone to marriage status and quality. They found that men with higher testosterone were less likely to get married and more likely to get divorced, more likely to leave home as a result of marriage troubles as well as engage in extramarital sex, hit or throw things at their spouse, and report a lower quality of interactions with their spouses.

Burnham et al. (2003) found that adult men involved in committed romantic relationships had lower testosterone levels, and this did not matter whether they were married to their partners or not. Examining both adult men and women, Edelstein et al. (2014) found that relationship satisfaction and commitment was negatively related to testosterone levels in both sexes. Gray et al. (2002) examined whether testosterone was related to both marriage and parenting in adult males. Echoing other findings, married men had lower testosterone than unmarried men. However, there were no differences comparing men with and without children. This might be due to the small sample size, since the group of men married with children consisted of only fifteen individuals, while the group of married men without children consisted of only fourteen.

In contrast, Gettler et al. (2011a) used longitudinal data on 624 young adult men in the Philippines in order to examine how testosterone related to partnering and fatherhood. As briefly mentioned in chapter two, they relied on testosterone measures along with partnered and parenting status at two time points 4.5 years apart. Using this data, they found that among single nonfathers at the first time point, those with higher waking testosterone were more likely to become partnered fathers at the follow up. Since testosterone declines with age, they then examined whether partnered fathers experienced a sharper decline than single nonfathers, which

turned out to be the case. Among the group of only fathers, those reporting three or more hours of daily childcare had lower testosterone as well. Using the same data set, Gettler et al. (2013) then examined whether the decline in testosterone observed among married fathers was related to sexual behavior. The declines associated with becoming partnered as well as becoming fathers were smaller for those who reported more frequent intercourse with their partners.

Van Anders (2013) has placed these types of observations into a theoretical perspective of competition versus nurturance. This perspective critiques viewing high testosterone as related to masculinity and low testosterone with femininity. Instead, it is intended to explain testosterone in both sexes, in which competition is related to high testosterone and nurturance with low testosterone. This helps explain why fathers in the Gettler et al. (2013) study had lower testosterone if they reported more time spent in childcare. It also helps explain testosterone and behavior in women along with men. For example, Kuzawa et al. (2010b) found that among a sample of women in the Philippines, pairbonded mothers had lower waking testosterone than non-pairbonded non-mothers. This relationship was also dependent on the age of the child for pairbonded mothers, in which mothers with children under two years of age had lower testosterone than mothers with older children. Gettler et al. (2013) have described these testosterone relationships as a trade-off of mating versus parenting, while van Anders (2013) prefers the competition versus nurturance trade-offs. The mating-parenting perspective is more narrow in scope, and based on life history theory, in which limited resources must be diverted into different energy-requiring biological functions. The competition-nurturance perspective is broader in scope, attempting to explain a range of behaviors, including sexual behaviors, aggression, and risk taking.

### *Testosterone and Pubertal Development*

There has also been much interest in how testosterone relates to male pubertal development and adolescent behaviors. For example, Halpern et al. (1998) conducted a three year longitudinal study of testosterone and sexual initiation in adolescent males ranging in age from twelve to fourteen in the United States. They found that higher testosterone was related to earlier sexual initiation and more frequent sexual activity. Research on testosterone and behavior in adolescent males has also highlighted the complex relationships between testosterone, behavior, and social context. For example, Booth et al. (2003) found that testosterone was only related to risk taking in adolescents if they had poor relationships with their parents.

Further research on adolescents has revealed how testosterone, pubertal development, and sexual behavior are interactive. Smith et al. (1985) studied sexual behavior in the United States for both adolescent boys and girls in relation to the combined influences of pubertal development and the sexual behaviors of friends. They found that in girls, the sexual involvement of friends positively associated with their own sexual involvement, and that this relationship was moderated by pubertal development. The influence of friends' sexual involvement on their own sexual involvement increased with pubertal development. In boys, a slightly different relationship was found. Both pubertal development and friends' sexual involvement were positively associated with their own sexual involvement. While the social influence had a stronger association with sexual behavior than pubertal development, it did not moderate the relationship between pubertal development and sexual behavior.

In a similar study, Udry (1990) added testosterone measurements to social and pubertal developmental influences on initiating sexual behavior. Similarly to Smith et al. (1985), Udry (1990) found social influences to be important in predicting the start of sexual behavior in girls.

However, this was not the case in boys. Also similarly to Smith et al. (1985), Udry (1990) found pubertal development to be related to initiating sexual behavior in both girls and boys.

Testosterone was also measured in the boys of the sample, and was associated positively with pubertal development and negatively with time of initiating sexual behavior. Further, after controlling for testosterone, the relationship between pubertal development and time of initiating sexual behavior disappeared, suggesting a spurious relationship.

### *Aggression, Competition, and the Social Context*

The increase in testosterone in adolescent boys has led to much interest in how testosterone relates to other behaviors besides sexual activity that increase in prevalence during this time period, such as aggression and antisocial behavior. Rowe et al. (2004) studied 789 boys aged nine to fifteen in the Smokey Mountain region of North Carolina as part of a large longitudinal study on the development of emotional and conduct disorders in order to determine the relationship between testosterone and aggression and antisocial behavior. Similarly to the studies previously highlighted, this study showed that the social context is important in studying the relationship between testosterone and behavior. Rowe et al. (2004) found that while testosterone was not associated with physical aggression, it was related to non-aggressive conduct disorder behaviors, such as lying, stealing, damaging property, and truancy if an individual had deviant peers. These behaviors were not related to testosterone if individuals did not have deviant friends. Instead, testosterone was related to leadership if the individual did not have deviant friends. Leadership was measured by reports of how often individuals were chosen by peers to be the leader. Rowe et al. (2004) concluded that overall, testosterone was related to social dominance. However, social dominance involved different behaviors depending on the social context.

The study by Rowe et al. (2004) echoed earlier findings by Dabbs & Morris (1990) with regard to the social contextual influence on the relationship between testosterone and behavior. Using the same United States military veteran dataset as Booth & Dabbs (1993), consisting of over four thousand adult male military veterans, Dabbs & Morris (1990) examined how socioeconomic status interacted with testosterone and sensation seeking behavior. They noted that sensation seeking behavior in a low SES context more often involves illegal activity compared to sensation seeking behavior in a high SES context. For example, sensation seeking behavior in a low SES context might involve stealing a fast car versus buying one in a high SES context, or playing college football in a high SES context versus committing assault in a low SES context.

Dabbs & Morris (1990) focused on individuals they classified as “high testosterone” individuals, meaning their measures were in the upper ten percent. This high testosterone group reported that they displayed aggression towards others more often, were more likely to use alcohol and marijuana, had more sexual partners, more conflict with parents, and reported an overall tendency for excessive behavior. This group also had more members from low SES contexts. Comparing SES groups within the high testosterone group, adult delinquency and hard drug use was twice as high in the low SES group. Dabbs & Morris (1990) concluded that the low SES group had higher testosterone levels, and that testosterone was more strongly related to overall antisocial behavior in the low SES context.

### *The Challenge Hypothesis*

While research has shed light on the relevance of the social context in moderating the relationship between testosterone and behavior, it is still unclear why lower SES would be associated with higher testosterone in the United States. One explanation comes from Alvarado

(2013), who draws from the challenge hypothesis, in which testosterone levels increase in response to competition, which ties in aggression. Alvarado (2013) was interested in the influence of life time testosterone exposure on prostate cancer risk in order to understand social inequalities in prostate cancer risk, in which lower SES men as well as African Americans compared to white men suffer higher rates of prostate cancer. He focused on young adult men, a demographic for which testosterone is highest and most variable in. For example, Alvarado (2013) highlighted that testosterone levels in young adult men in the United States are among the highest in the world. However, the magnitude of difference between populations diminishes with age, as do testosterone levels in all populations.

Within the United States, testosterone levels in young adult males differ based on socioeconomic status and racial group, with testosterone being higher for individuals in a lower socioeconomic status as well as higher for African Americans compared to whites. However, the racial differences disappear with both increased education and age, and the SES differences disappear with age. Alvarado (2013) suggested that the high energy or nutritional environment of the United States allows for unusually high testosterone levels, and elevations in testosterone levels are further driven by harsh and competitive environments in lower SES contexts as well as contexts of institutional racism. These harsher contexts, involving higher prevalence of aggression and violence related to male-male competition, possibly trigger testosterone rises, therefore increasing prostate cancer risk. This reasoning is based on the challenge hypothesis.

The challenge hypothesis expands the relationship between testosterone and sexual behavior, and includes competition between males that can involve aggressive encounters (Archer 2006). However, it is important to keep in mind that the challenge hypothesis is still related to mating effort, whether testosterone is related directly through mate access or indirectly

through competition over resources or status. Exploration of the challenge hypothesis has revealed further complexity in the relationship between testosterone and behavior. While studies have found increases in testosterone related to sexual and competitive encounters, the observation that increases in testosterone during puberty are not associated with corresponding increases in aggression discounts a simple relationship (Archer 2006; Booth et al. 2006).

Studies that measure testosterone in the context of the behaviors being studied rather than relying on self reports of behavior have been productive. For example, Trumble et al. (2012) studied testosterone levels before and after a competitive soccer match among Tsimane adult men. In contrast to most testosterone studies that focus on men in the United States, who inhabit a context of high food availability that requires little effort to obtain along with a low pathogen exposure, this study focused on the Tsimane, who are a forager-horticulturalist population inhabiting the Bolivian amazon. The Tsimane are exposed to much more pathogens than populations in Western industrialized countries. This drains energy away from growth and maintenance, meaning that testosterone levels observed in the United States cannot be maintained in this context. Trumble et al. (2012) noted that at baseline, the Tsimane testosterone levels were lower than age-matched males in the United States. Utilizing the challenge hypothesis, 88 adult men in total were studied for potential rises in testosterone related to competing against other males in a soccer match. Immediately following the competition, testosterone levels were significantly higher. Levels had dropped after one hour, but were still higher than baseline. Interestingly, Trumble et al. (2012) did not find larger increases in testosterone among winners, though larger increases were positively associated with perceived performance during the match.

### *Testosterone and Risk Taking*

There has also been research interest in the relationship between testosterone and risk taking. For example, Ronay & von Hippel (2010) examined how the presence of a female observer influenced cognitive performance, risk taking, and testosterone among male skateboarders. This was done by conducting a study in which participants either had a male or female experimenter in order to observe differences in risk taking and testosterone in response to a potential mate. The experiment involved approaching male skateboarders at a public skateboarding park and asking them to perform a mildly challenging cognitive learning task, then perform their best skateboarding tricks, and finally providing a saliva sample for testosterone measurement. The cognitive task provided a proxy measure of the ventral medial prefrontal cortex (VMPFC). The VMPFC is involved in assessing reward and punishment, and therefore has relevance to risk taking. The cognitive task involved a sequence of decisions regarding varying magnitudes of rewards and punishments that shift throughout the task in order to measure how responsive individuals are to cues about rewards and punishments. The participants in the presence of the female experimenter performed worse on this learning task than those in the presence of the male experimenter, suggesting that female presence decreased sensitivity to cues of rewards and punishments. Next, participants were asked to perform their best skateboarding tricks. The three possible results were succeeding, crash landing, and aborting the trick. The skateboarders in the presence of the female experimenter aborted tricks less often, resulting in increased successful tricks as well as crash landings. Afterward, saliva samples were collected for testosterone comparisons. They found that skateboarders who were in the presence of the female experimenter had higher testosterone.

Research has also shown a relationship between testosterone and financial risk taking. Stanton et al. (2011) examined risk taking during a gambling game and testosterone in 154 United States college students (78 male). This gambling game consisted of 100 trials, in which individuals picked from four decks of cards in order to earn money. Each deck provides one monetary reward and one punishment. Two of the decks offer large rewards and large punishments, while the other two provide both modest rewards and punishment. However, overall, the modest reward and punishment decks end up yielding more money. Over the course of the 100 trials of picking decks, sensitivity to reward and punishment and therefore risk taking was measured by how quickly participants learned to choose from the overall advantageous decks with moderate rewards and punishments. The quicker the learning, the sooner participants begin preferentially choosing the advantageous decks. In both men and women, higher testosterone was associated with a lack of learning to choose the advantageous decks, indicating a smaller sensitivity to reward and punishment and therefore higher monetary risk taking.

In another study of testosterone and monetary risk taking, Apicella et al. (2008) included 98 United States male college students in a study in which individuals could risk fake money with the chance of an actual monetary gain. In this experiment, individuals were given \$250 in fake money and told they could invest as much as they wanted of it on the outcome of a coin toss. If they lost, they were left with \$250 minus how much they invested. If they won, they were awarded 2.5 times the money they invested added to the remaining money they did not invest. At the end, one participant was drawn at random to be awarded the actual monetary amount they ended up with in the game. Testosterone, measured from saliva samples, was positively associated with the amount of money risked in the game. Also, when participant groups were

formed based on whether all \$250 was risked or not, the group of individuals who risked all \$250 had higher testosterone than those who risked less.

### *Broader Relevance of Testosterone-Behavior Relationship*

Testosterone might have even broader relevance to behavior as evidenced by research on testosterone and subsistence activity. Using the same Tsimane population, Trumble et al. (2013a) found that one hour of tree chopping in order to clear land for horticultural activity was associated with a significant rise in testosterone among the adult males studied. This rise was higher than the one observed following the competitive soccer match previously mentioned (Trumble et al. 2012). Trumble et al. (2013a) reasoned that this activity should not be conflated with competitive behavior, since tree chopping is done in seclusion from other males.

Also in broadening current understandings of testosterone and behavior, Trumble et al. (2013b) conducted a focus study of 31 Tsimane hunters in order to study the changes in both testosterone and cortisol related to hunting in order to determine if hunting was related to family provisioning versus competition and mate signaling. They reasoned that if hormonal changes were associated with both the size of a kill as well as whether or not an audience was encountered when returning with a kill, then hunting would be related to competition and mate signaling. While if no hormonal changes occurred based on the kill size and audience, then hunting would be related to provisioning. They found that unsuccessful hunters experienced decreased testosterone and cortisol throughout the hunting day, though this was probably a result of the diurnal rhythm of the hormones. However, successful hunters had elevated testosterone and cortisol, and hormonal changes did not occur with the size of the kill or whether an audience was encountered upon returning with the kill. Trumble et al. (2013b) concluded that understandings of hormone-behavior interactions with regard to testosterone should be expanded

from focusing solely on immediate mating opportunity and competition to include provisioning. Though they note that provisioning and mating opportunity are not mutually exclusive, as provisioning is an important aspect of female mate choice.

### *Causal Direction Between Testosterone and Behavior*

With all of this research on associations between testosterone and behavior, the causal direction becomes important to decipher. Human and non-human animal research has revealed a bidirectional causal relationship between testosterone and behavior. The human studies previously presented demonstrate a clear causal link of behavior influencing testosterone (Gettler et al. 2011a; Gettler et al. 2013; Trumble et al. 2012; Trumble et al. 2013a; Trumble et al. 2013b). Further, a review of the non-human primate research on testosterone and behavior by Monaghan & Glickman (1992) has reinforced this assertion. However, both human and non-human animal research models have shown that testosterone also has subtle effects on behavior.

These studies have revealed that testosterone can influence behavior through exaggerating pre-existing social behavior or lowering the threshold for the initiation of behaviors already present in an animal (Booth et al. 2006; Dixon & Herbert 1977; McGinnis 2004; Monaghan & Glickman 1992). For example, McGinnis (2004) focused on rodent studies, in which rodents were injected with testosterone in order to observe its effect on aggression. Rather than increased indiscriminate aggression, the rodents responded to the social environment, and only showed heightened aggression in situations that would have already induced an aggressive response, such as having their tail pinched or introducing an unknown rodent into an enclosed space. Similar findings have been reported with primates, in which Talapoin monkeys were put into an enclosed space under experimental conditions in order to form a hierarchy. Once the hierarchy was formed, a middle ranking monkey was injected with testosterone. Aggression

increased for this monkey, but only toward lower ranking group members, a behavior that would have been present prior to testosterone injection.

Further, Wobber et al. (2010) focused on chimpanzees, measuring salivary testosterone in response to food competition experiments in a controlled lab setting. The researchers observed an anticipatory testosterone rise prior to pairs of chimpanzees competing over food. This anticipatory rise might have served the purpose of reinforcing competitive behavior that was already about to occur.

Neural mechanisms have been explored in order to understand how testosterone can exaggerate or lower the threshold for initiating behavior. Kendrick & Drewett (1979) castrated rats and then injected them with testosterone in order to see how testosterone influenced the refractory period between the amygdala and hypothalamus. Castrating the rats increased the refractory period, while injecting testosterone reduced the refractory period, suggesting testosterone influences the communication between these two parts of the brain. Human studies have focused on the amygdala and the orbitofrontal cortex (OFC). The OFC is thought to be important for self-regulation and impulse control. Therefore, enhanced connectivity between the OFC and the amygdala is thought to enhance regulatory control over the amygdala and therefore enhance self-regulation and impulse control. Lab studies on humans support the prediction that testosterone reduces connectivity between the OFC and the amygdala (van Wingen et al. 2010), and early research indicates this reduced connectivity then reduces self-regulation at least in the form of increased aggression (Mehta & Beer 2009). However, more research is required before the neural mechanisms are fully understood.

### *Current Study*

The current study measured testosterone through saliva samples due to the relationship between testosterone and sexual behavior, aggression, and risk taking previously highlighted. Drawing from theoretical work on life history strategies (Del Giudice 2014) and the challenge hypothesis (Alvarado 2013), testosterone was incorporated as a dependent variable in a mediating relationship of environmental quality and life history strategies. In this proposed relationship, life history strategy was operationalized as measures of aggression, risk taking, and sociosexuality, and served a mediating variable between environmental quality and testosterone. It was therefore predicted that a worse environmental quality would be associated with a faster life history strategy in the form of higher aggression, risk taking, and a sociosexuality trait of preferring short term and unstable romantic relationships, and that this faster life history strategy would be associated with higher testosterone.

The complex, bidirectional relationship between testosterone and life history strategy behaviors was not examined in this study. Instead, a simple associative conceptual model was relied on, in which behaviors were predictors and testosterone the outcomes. This conceptual oversimplification was made due to study design limitations that only allowed examination of associative relationships and not causal determinations.

## 4. CULTURE AND HUMAN DEVELOPMENT

### *Introduction*

Scholarly work on the influence of life history theory on human development and behavior has ignored the influence of culture. This chapter provides a background on anthropological work examining the role of culture in shaping human development and behavior. This work has been at the intersection of anthropology and psychology, as there is a recognition among these researchers that human psychology cannot be separated from culture.

### *Early Researchers*

Early approaches to human development from an anthropological perspective were done by psychological anthropologists, working at the intersection of anthropology and psychology and largely trying to decipher the relationship between culture and personality. A key component to the research that was done by these pioneers of human development included large, cross-cultural comparisons. They used methods that would allow them to make comparisons across very diverse cultures, such as recording the activity settings of children, what these activities were, and who they were doing these activities with. Arguably the two most well known of these early anthropologists of human development were John and Beatrice Whiting (Worthman 2010). Despite conducting research at the intersection of anthropology and psychology, the Whiting's work was relatively materialistic. They reasoned that belief systems held by parents were the result of their socioeconomic and ecological environment (Edwards & Bloch 2010).

In some of the earliest anthropological work on human development, Whiting & Child (1953) posited a causal chain running from what they considered "maintenance systems" to child

training practices, then to personality variables, and finally to projective systems. The maintenance systems consisted of the economic, political, and social organizations in the society. Since these orchestrated food, shelter, and other protections of basic individual needs, Whiting & Child (1953) posited that these maintenance systems likely influenced child training practices. These child training practices in turn would influence the personality of the developing members of the society. The molded personalities of these societal members would then reproduce as well as mold culture through integrating different elements of the projective, symbolic systems. This understanding of how human development is shaped, through examining the physical and social setting as well as the relationship between the individual and culture while utilizing a perspective at the intersection of anthropology and psychology, would lead to further advances in research on human development.

A similar approach to that of Whiting & Child (1953) was Edgerton (1971). Similarly materialistic, and with a focus on how personality was influenced by culture, Edgerton (1971) compared four African tribes, in which some were agriculturalists while others were pastoralists. Edgerton (1971) was interested in what factors influenced personality traits that he had identified in these tribes. The main factors of interest were the subsistence strategies and “cultures”, which were identified simply as what tribe an individual belonged to. Edgerton (1971) found several differences in personality traits based on comparing the agricultural tribes and the pastoralist tribes. These differences were all lumped into two main personality differences; closed versus open emotionality and direct versus indirect action. After identifying these as personality differences, in which the agriculturalists exhibited more closed emotionality and indirect action, Edgerton (1971) elaborated on the functional aspects of these. For example, the agriculturalists lived in closer quarters and were immobile compared to the pastoralists. Therefore, more

controlled emotions and indirect methods for sorting out squabbles and disagreements would be preferred, since the opposite would promote social instability and major tensions since everyone was enclosed in close quarters with each other. However, having found a relationship between subsistence strategies and supposed personality traits, Edgerton (1971) noted that an even better predictor of personality was culture, identified by tribal affiliation.

One of the key strengths of early approaches was the focus on the activities and activity settings of children. This was one of the major contributions the Whittings had on the study of human development that would stand the test of time (Edwards & Bloch 2010). For example, Whiting & Edwards (1988) asserted that individual behavior was developed in the settings frequented by children. They also asserted that in these settings, the most important factors were the people who occupied the setting, and that specific research attention must therefore be paid to the age, sex, and kinship relation of these people to the children under study. How these people were organized in this space would then relate to the activities performed in that setting, and these activities would be culturally determined. Whiting & Edwards (1988) noted that these settings and activities under study included the daily occurrences or routines, and through observing these, researchers could discover the salient predictors of behavior.

Therefore, the approach to studying human development that the Whittings helped shape involved prioritizing the daily activities of children, including where they were doing these activities and who they were doing them with. This led to observations of children performing work and adults assigning tasks to children. In their massive study of human development in six cultures, Whiting & Whiting (1975) observed that children often enjoyed the economic tasks and domestic chores they were assigned that contributed to the functioning of the family, such as building fires, cooking meals, or taking care of the family cattle. The intrinsic reward, they

reasoned, came from the children identifying with adult roles, due to their envy of the privileges that came with adult status. Whiting & Whiting (1975) noticed on the whole that the behaviors of children, shaped through their activities and the settings they occurred in as well as the actors they occurred with, was in line with adult role requirements.

This molding of child behavior in order to be compatible with adult requirements and expectations highlighted gender development, a focus of Whiting & Edwards (1988). They took the same approach of examining activities, the settings they occurred in, and the actors they occurred with. Their study focused on boys and girls aged two through ten. Whiting & Edwards (1988) uncovered notable information about the cultural infusion of gender into activities that shaped the interpersonal behaviors of developing individuals. For example, culturally determined sequences of behavior provided information on the work expected of boys and girls and whom they should be spending time with, among other things. At around the age of four or five, children began to establish their gender roles through forming gender segregated groups, in which only boys spent time together and the same for girls. With regard to work, in cultures with marked gender inequality, boys spent the years of four through ten especially trying to distance themselves from their mothers and the task or work assignment related to their mother's work.

Interestingly, Whiting & Edwards (1988) also found no difference in the nurturance ability toward infants between boys and girls. This became observable through their focus on the activities, settings, and companions or related actors to the children they were studying. After controlling for the amount of time spent with infants and the responsibility the children assumed over the infants, there was no difference in nurturing behavior between genders. Therefore, this difference supposedly thought to be purely innate was shown to be dependent on the activities, settings, and individuals children engaged with, which was culturally determined.

Having developed lasting impacts on future research of human development, the major weakness of the Whittings' work was how they engaged with and utilized culture on both a theoretical and methodological level. For example, Whiting & Whiting (1975) acknowledged the problem of assuming cultural uniformity. However, they still struggled to incorporate intracultural variability into their approach. Also, as Edwards & Bloch (2010) highlighted, the Whittings took a materialist stance to understanding the cultural beliefs of parents. They thought that material conditions determined belief systems and parental practices, and they thought that the introduction of new ideas was secondary in determining these beliefs. Later researchers moved away from this heavily materialist stance and gave primacy to culture. These later researchers also engaged with culture in a more sophisticated manner following the development and incorporation of the concept of cultural models.

### *Cultural Models*

The concept of cultural models relies on a definition of culture as the knowledge an individual must know in order to function in their particular society (Goodenough 1996). Taking culture to be socially distributed knowledge, such knowledge is studied through empirically observing its sharing and distribution. Cultural models are abstract formulations for understanding how culture influences the way individuals interpret and understand their world. In an abstract sense, cultural models serve as data processors (D'Andrade 1992). Therefore, cultural models form a connected set of interpretations that together help individuals organize and understand their sensory input, and these interpretations are acquired through social interaction, since cultural knowledge is socially distributed (Dressler & Oths 1997).

The methods utilized to study cultural models include both ethnographic methods as well as statistical methods. The first step involves ethnographic interviews in order to elicit the

elements of a particular cultural domain. For example, the cultural domain of social support was studied by Dressler et al. (1997) in Brazil. A domain of social support was suspected to exist because (as is the case with suspecting all cultural domains) it was something the researchers noticed Brazilians talked about. After suspecting a cultural domain, they conducted a series of interviews in order to elicit the elements of the domain of social support. This included asking participants who they turned to for various problems. Once the ethnographic work uncovered the contents of the cultural model, in which the researchers identified which types of people are sought out under particular circumstances, statistical methods were then performed based on the cultural consensus method that was developed by Romney et al. (1986). This last step determines statistically and empirically whether the knowledge elicited in the ethnographic work is sufficiently shared among research participants in order to consider it a cultural model. This is done by comparing participant responses with each other and determining if individuals are drawing from the same body of knowledge in generating their responses to interview questions about the cultural domain. However, this last statistical step in the method is usually not performed by human development researchers utilizing cultural models.

### *The Developmental Niche*

Super and Harkness were two of the early Whiting students who had theorized another approach to studying human development that incorporated cultural models. In their theoretical construction of human development, they identified what they considered to be the developmental niche of the child, borrowing the niche construction idea from evolutionary biology (Harkness & Super 1994). The developmental niche places focus on the household and has three main components. These include, (1) the physical and social settings of the child's daily life, (2) culturally regulated customs of child care and child rearing, and (3) the psychology

of the caretakers. The household, then, is considered the developmental niche that mediates the relationship between the child and the larger society and culture. Also, in line with the concept of niche construction borrowed from evolutionary biology, the child is acknowledged as an active agent in co-constructing their own developmental trajectory.

Part of the psychology of the caretakers includes parental ethnotheories, which have been described as cultural models (Edwards & Bloch 2010). These ethnotheories or cultural models are held and used by parents as they interact with their child. These models provide directive force through influencing how parents perceive and respond in their interactions with their child (Harkness et al. 1992). These models have great utility in understanding cross-cultural comparison of parenting. For example, in the United States, there is a cultural model parents hold that establishing a regular sleeping schedule in which children sleep completely through the night is essential for adequate child development. Therefore, infants and young children who do not regularly sleep through the night are often perceived as difficult, and this likely influences how the parents then respond to their child not regularly sleeping through the night. In contrast, Harkness & Super (1994) highlighted research in Italy, where parents focused more on eating rather than sleeping. The Italian mothers perceived children who did not eat regularly and were picky eaters as difficult. In order to accommodate for difficult eaters, many Italian mothers in the study reported breast feeding well into the second year of life, and in some instances, when the child was perceived to be an exceptionally difficult eater, they utilized nutritional injections.

### *Ecocultural and Bioecocultural Theories*

Another approach following the Whitings that incorporated cultural models was ecocultural theory developed by Weisner (1997). This approach places further, and in fact primary, emphasis on culture and relies heavily on cultural models in studying human

development. Similarly to the Whittings as well as Super and Harkness, this approach focuses on the activities that children engage in. Weisner (2002) stressed the importance of activities, since according to him they are how culture is experienced. Some examples of activities that Weisner (2002) considered relevant to ecocultural research included bedtime, homework, watching television, playing video games, cooking dinner, soccer practice, visiting grandma, babysitting, and algebra class.

According to Weisner (2002), culture consists of connected cultural models, and these connected cultural models provide pathways, through activities, toward cultural well being. These everyday routines and activities are how parents and children live out cultural models. Weisner (1997) identified five features of these everyday routines and activities, including goals and values, motives and emotions, tasks to be performed in the given activity, a script for what to do in that activity, and the people who should be involved. According to Weisner (1997), participating in these activities is the most important influence on child development. Through participating in these routines and activities, children are living out the connected cultural models, and in doing this, they are using culture to adapt to their local context (Weisner 2002). The sustainable engagement of children with culturally prescribed activities and routines is key for understanding child well being throughout development according to Weisner (2002).

In a biological extension of ecocultural theory, Worthman (2010) has developed the bioecocultural theory of human development. This approach keeps with ecocultural theory in the reliance on cultural models and the focus on activity settings and routines children engage in. However, it places an added emphasis on biological developmental plasticity and physiological responses to the developmental settings infused with cultural models. This approach has

generated notable empirical findings. For example, DeCaro & Worthman (2008) examined mother-child dyads in the United States during child school entry.

They focused on eliciting a cultural model of middle class parenting, and discovered that these mothers had somewhat conflicting beliefs. On the one hand, they believed that busyness was an important and desired component of living a middle class life. On the other hand, they also believed they should protect their children from being overscheduled. DeCaro & Worthman (2008) then examined the scheduling and busyness of both the mothers and children, and they studied this in relation to child parasympathetic nervous system (PNS) activation. They found that child busyness had no relation to PNS activity. However, maternal busyness predicted child PNS activation. They found that busier married mothers and less busy single mothers had children with more context-appropriate PNS activation, while children with busy single mothers and less busy married mothers did not. This study therefore tied together Super and Harkness' developmental niche theory through eliciting parental ethnotheories, Weisner's ecocultural theory through examining single and married mothers in relation to family routine sustainability, and Worthman's bioecocultural theory through incorporating a physiological marker that indicated how the children were responding to their developmental context, with implications for later life physiological functioning of these children.

#### *Cultural Models of Life Span Development and Health*

Brown et al. (2006) utilized cultural models in order to better understand variation in youth mental health. They did this through studying a cultural model of life-course achievement goals held by youths in western North Carolina. Their methods were aimed at eliciting elements of this cultural model, such as the milestones these individuals were attempting to achieve, the

resources (both material and socioemotional) that would help them achieve the milestones, and the barriers that could interfere with the achievement of the milestones.

They developed a measurement instrument based on the model they had studied in this population called The Life Trajectory Interview for Youth. This scale was created in order to understand the mediating role of cultural models in the relationship between larger structural forces and mental health across the life span for this population, since it took into account shared knowledge of culturally prescribed milestones these youths were consistently working toward while also including what these youths identified as larger structural forces that could help or interfere with the achievement of these milestones.

Similar work on human development and cultural models was done by Dressler et al. (2017), in which they examined cultural models of life goals in Brazil. This work built on previous work on cultural consonance and depression. Cultural consonance is a measure of how well individuals approximate in their beliefs and behaviors the cultural model in a particular domain. The purpose of this study was to determine whether several cultural models were linked through a single, nearly all-encompassing cultural model, which evidence suggested to be the case. This cultural model, referred to as goals in life, consisted of smaller models including family life, lifestyle, social support, and occupational and educational aspirations.

This model of goals in life was then used in order to examine variation in depressive symptoms, and indeed there was a negative relationship between consonance in goals in life and depressive symptoms. This study utilized both the concept of cultural models and the method of cultural consensus analysis in order to study goals in life, or what could be alternatively understood as developmental goals. Similarly to the research conducted by Brown et al. (2006), this research suggests that individuals use socially distributed knowledge to construct shared

cultural models of development, in this case how their life should play out, and the interaction between these models and the realities for every individual have implications for health and well being.

### *Current Study*

The current study incorporated an anthropological understanding of culturally regulated development and behavior. Theoretically, this study relied on bioecocultural theory in order to link predictions of human development and behavior derived from recent applications of life history theory to human psychology and behavior with the cultural context that serves to shape development and motivate behavior through cultural models. The necessarily flexible biodesign Worthman (2010) highlighted served as life history strategy calibration mechanisms that must also interact with the sociocultural context filled with cultural models of development.

Methodologically, both results and methods from Brown et al. (2006) were used. This was done in order to provide, along with conventional socioeconomic indicators, a culturally relevant measure of environmental quality in order to test whether this would also be predictive of a life history strategy. Results from Brown et al. (2006) regarding resources and barriers were used in a retrospective interview schedule in which participants were asked to identify resources and barriers present in their lives prior to age twelve. Along with this early life measurement tool, ethnographic interviews were conducted in the form of open ended interviews with randomly selected members of the population under study ( $n = 10$ ) in order to decipher culturally relevant resources and barriers this population faces as they strive to achieve culturally prescribed developmental goals. Results from these interviews were used to create a second interview schedule that was used to assess current environmental quality in order to complement the early life measure and to see their interaction.

## 5. METHODOLOGY

### *Introduction*

The population under study was University of Alabama male students. The current study included two phases of data collection- Phase I and Phase II. During Phase I, open ended interviews were conducted with male students at the Ferguson Student Center on the campus of the University of Alabama ( $n=10$ ). This was done in order to assess relevant life goals in the population as well as resources and barriers influencing the achievement of these goals. This was used to construct one of the measurements of environmental quality. This method was borrowed from Brown et al. (2006), along with results from their study in order have a second environmental quality measurement tool. These two measurement tools made up the interview schedule during Phase II.

Along with the interview, participants were asked to fill out a questionnaire that included demographic information, more environmental quality measures including parental education, subjective SES, rated stress, and life expectancy, as well as questionnaires previously constructed that measure self-reported aggression, risk taking, and sociosexuality preferences (Buss & Perry 1992; Jackson & Kirkpatrick 2007; Weber et al. 2002). Finally, saliva samples were collected in order to perform testosterone assays for each participant. The information from these data collection methods were used to test the hypotheses that (1) lower environmental quality measures would be associated with a faster life history strategy, (2) a faster life history strategy would be associated with higher testosterone, and (3) that life history strategies would mediate a relationship between worse environmental quality measures and higher testosterone.

### *Population Under Study*

This study focused on male University of Alabama students. The University of Alabama is the flagship university of the state of Alabama, and is located in Tuscaloosa, Alabama. The total student body consists of over 37,000 students. Of these students, 43% come from Alabama, 53% from elsewhere in the United States, and 4% are international students. The gender make up is 56% women and 44% men. Most of the students are white, with the next two most prevalent racial groups being African American and Asian American, making up 12% and 2% of the student population respectively. The total calculated cost of attendance for undergraduates for one year is estimated at \$29,702 for in-state students and \$47,322 for out-of-state (The University of Alabama 2017).

This last piece of information is particularly important, since the high cost of attendance indicates that students in general at this university are of higher SES. Further, while the amount of scholarships awarded have increased in recent years, the overall recruitment strategy of the university has been to focus on out-of-state students who tend to come from wealthier households and do not rely on financial assistance (Pappano 2016). Therefore, variance in SES in this population was expected to be limited. However, since life history strategy theorists generally rely on comparisons between SES contexts, this study provided a unique opportunity to examine a potential relationship between environmental quality and life history strategies within a similar SES context.

This study focused on males due to practical considerations related to study design. Research funds permitted assaying approximately two hundred saliva samples. Since two daily samples were taken, this allowed approximately one hundred participants. Due to the sexual dimorphism in testosterone, separating samples by sex is a necessity in study designs involving

testosterone measurement (Granger et al. 2004). This meant that if both men and women were included, then they would have to be split into two smaller groups based on sex and analyzed separately. This would have greatly limited statistical power. Therefore, either men or women had to be chosen in order to include all samples in the same analyses. Men were chosen because testosterone is easier to measure in men due to their generally higher levels compared to women (Granger et al. 2004) among other factors soon to be elaborated.

### *Phase I Recruitment and Method*

Phase I involved open ended interviews with members of the population under study in order to assess relevant goals as well as resources and barriers influencing goal achievement ( $n=10$ ). The researcher approached male students on the second floor of the Ferguson Student Center on the University of Alabama campus and asked if they would like to take part in an interview about their life goals in exchange for five dollars. The interview schedule is shown in Appendix A. It included asking participants what their short and long term goals were. Participants were asked to list as many as they could until they could not think of any more. Following this, participants were asked to list as many resources, both material and socioemotional, that they could think of that would help them achieve the goals they just listed. Participants were also asked to list as many barriers as they could that could interfere with the achievement of their goals. The interview schedule for current life environmental quality shown in Appendix B was constructed based on responses participants gave in these interviews regarding relevant resources and barriers they potentially face as they strive to achieve their developmental goals. All interviews for Phase I were conducted during June of 2016.

This method was partially derived from the research conducted by Brown et al. (2006) on developmental goals of youths in the Appalachian region of Western North Carolina. The work

conducted by Brown et al. (2006) was designed to elicit cultural models of life course goals and sought after achievements, along with various factors that influence success or failure in these. This work was done in order to create an interview tool that could predict mental health outcomes throughout development. Part of the methods used to create the measurement tool included ethnographic interviews with members of the population, in which they were asked about their life goals and desired achievements along with desirable material items to own, desirable socioemotional resources, and finally barriers that could negatively influence life course goals and achievements.

This ethnographic interview method was used in order to construct the current environmental quality interview schedule used during Phase II. The interview schedule consisted of questions related to social and material resources as well as barriers participants listed as relevant to the success or failure in the achievement of their short and long term goals. Questions were chosen based on items listed in multiple interviews.

### *Phase II Recruitment and Method*

Participants for Phase II were recruited during the Fall semester of 2016 through two primary ways. The first was through anthropology classes, in which the professor offered extra credit in the course for participation. The second was through the Psychology Subjects Pool, in which students of introductory psychology courses must sign up for psychology studies to participate in for course credit, or write papers for the same course credit instead. Most of the participants during Phase II were recruited using the Psychology Subject Pool. Following very limited successful recruitment through anthropology courses, recruitment efforts were shifted toward using the pool. This study was accepted into the pool website, and psychology students were allowed to participate in order to gain course credit. Recruitment through anthropology

courses lasted from August through October of 2016, while recruitment through the Psychology Subject Pool lasted from October through December. Participants were met at various public campus locations in order to conduct the study, including the Ferguson Student Center, Gordon Palmer Hall, ten Hoor Hall, North Lawn Hall, and the Developmental Ecology and Human Biology laboratory inside the Science and Engineering Complex. In total, there were 99 participants in this study for Phase II.

Once individuals agreed to participate, they were informed that full participation involved two meetings. The first meeting served to gain written consent and provide equipment and instruction to the participants in order for them to collect a morning saliva sample the day of the second meeting. This second meeting consisted of an interview schedule assessing early and current life environmental quality measures, a questionnaire containing demographic information, more environmental quality measures, already created aggression, risk taking, and sociosexuality questionnaires (Buss & Perry 1992; Jackson & Kirkpatrick 2007; Weber et al. 2002), and finally a second saliva sample. Participants were instructed to collect the morning saliva sample immediately upon waking the day of the second meeting, and to bring the sample with them to give to the researcher at the second meeting. Along with instructions on how to collect the saliva sample, participants were given collection swabs and tubes commercially available from Salimetrics (State College, PA).

All meetings occurred on a weekday, and second meetings occurred between 4 p.m. and 6 p.m. This was done in order to account for the diurnal rhythm of testosterone, in which testosterone levels are highest in the morning and decline throughout the day. The time slot of two hours in the evening was chosen in order to minimize the variation in testosterone measurements between participants due to diurnal rhythm variation.

The total time to complete the second meetings ranged from ten to thirty minutes depending on how quickly the participant completed the questionnaire. The structure of the second meeting was not consistent, and this was a result of the necessity to ensure that all evening saliva samples were collected between 4 p.m. and 6 p.m. This meant that for some participants, saliva sample collection was the last part of the second meeting, while for others it was the first part. The method for saliva sample collection was the same between the morning and evening samples. Both involved the participant rolling a swab around their mouth for 60 seconds and then spitting the swab into a storage tube.

Eating food within a short time period prior to collecting saliva can interfere with collecting usable samples. This was not a problem for the morning samples since participants were collecting them immediately upon waking. However, in order to ensure that usable samples were collected at the late afternoon/evening meetings, participants were asked not to eat or drink in the twenty minutes leading up to the second meeting. Following the completion of the second meeting, both the morning and evening samples were immediately stored in a -29° Celsius freezer in the Developmental Ecology and Human Biology laboratory on campus, operated by Dr. Jason DeCaro of the anthropology department.

### *Environmental Quality Measures*

Along with the current life environmental quality measure, the creation of which was previously described during Phase I, an early life environmental quality measure was included to create the two part interview schedule. The early life environmental quality interview schedule was constructed using results derived from Brown et al. (2006) in the socioemotional resources, material resources, and barriers domains. From these items, some were excluded either because they were not relevant to the current time period (such as whether individuals had internet or cell

phones) or because they overlapped with elements of a life history strategy (such as prioritizing short term gratification over long term considerations). This resulted in fifteen interview questions, the contents of which are shown in Appendix B.

Other environmental quality predictors were included in the questionnaire. The questionnaire is shown in Appendix C. It begins with demographic information, followed by environmental quality predictors, including parental education levels, a subjective SES ladder, perceived stress on a five point scale, and expected lifespan in decades. The remainder of the contents of the questionnaire consisted of life history strategy indicators.

### *Life History Strategy Measures*

The first indicator was a sociosexuality questionnaire created by Jackson & Kirkpatrick (2007). Sociosexuality is a measure of an individual's willingness to engage in uncommitted sexual relations. Jackson & Kirkpatrick (2007) critique previous understandings of sociosexuality as existing on a single continuum, and they highlight their empirical research showing that interest in short term and uncommitted sexual relations and long term committed ones are not mutually exclusive. Instead, individuals can have an interest in both. This understanding is reflected in how they instruct their questionnaire to be used. In total, the questionnaire contains 25 questions. Questions one through twenty-one are answered using a Likert scale, ranging from one to seven, in which a seven indicates the participant strongly agrees with the sociosexual related statement and one indicates they strongly disagree with the statement. Questions twenty-two through twenty-five are answered by indicating any whole number that is not negative, as it relates to numerical partner interest and experience.

Overall, while short and long term mating orientations did not correlate when they tested their questionnaire, men and women differed. Men scored higher on both short and long term

mating orientation, though the magnitude of difference was larger for short term compared to long term. This further strengthens the decision to conduct this study using only one sex, since the sample would have needed to be split in order to account for variation attributed to sex, which would have created two smaller sample sizes and therefore reduced statistical power.

Jackson & Kirkpatrick (2007) state that their questionnaire elicits three measures, including short term mating orientation, long term mating orientation, and previous sexual behavior. For creating the short term mating orientation measure, responses to questions one through ten are averaged. For long term mating orientation, responses to questions eleven through sixteen as well as eighteen are averaged. Previous sexual behavior is determined from adding together responses for twenty-two through twenty-four. All three measures, short term mating orientation, long term mating orientation, and previous sexual behavior were used as outcome variables being predicted by environmental quality indicators. These three measures were also used as predictors of testosterone levels.

The second life history strategy indicator was aggression. A questionnaire created by Buss & Perry (1992) was used for this. 29 questions in total make up this questionnaire, broken into categories of physical aggression, verbal aggression, anger, and hostility. Some of the items are reverse coded, and all are summed to elicit an aggression score in which a higher number indicates higher reported aggression. For each question, participants read statements that are intended to describe them. The participants then rate on a Likert scale ranging from one to five how characteristic each statement is of them, from one being extremely uncharacteristic of them to five being extremely characteristic of them. Buss & Perry (1992) note that the questionnaire can either be used as a total aggression score or with the subscales separated. In order to reduce the number of comparisons, the total aggression score was used in this study. Buss & Perry

(1992) also note that men and women tend to score differently on this questionnaire, which further strengthens the case for this study being sex specific in order to increase the possible sample size used.

The final indicator of a life history strategy included a risk taking questionnaire created by Weber et al. (2002). These researchers examined risk taking in multiple domains, including social, ethical, health and safety, recreational, and financial. They highlighted that risk taking is not unidimensional, and in the research they conducted for creating the scale they noted that individuals who report high risk taking in one domain are not necessarily high risk taking in any others. Therefore, they advise against using a single, unidimensional risk taking scale. In line with their assertion, risk taking was measured in all five domains in this study, and these domain results were not aggregated into a single risk taking score. Instead, each were used separately, resulting in five risk taking outcome variables of a life history strategy as well as five predictor variables for testosterone level outcomes. Also, Weber et al. (2002) reported sex differences in their results, in which men reported higher risk taking than women in four of the five domains. This further strengthens the reasoning for using a sex specific recruitment method for this study.

The risk taking questionnaire consisted of 40 total questions. Each of the five domains contained eight questions. For each question, participants read a statement indicating a risky behavior and were asked to indicate how likely they were to engage in that particular risky behavior. Responses were constrained to a Likert scale ranging from one to five, in which one indicated they were very unlikely to engage in the behavior, three indicated they were not sure, and five indicated they were very likely to engage in the behavior. Responses were summed with respect to each domain, resulting in a score for each of the five domains for each participant in which a higher score indicated higher risk taking in that domain.

### *Testosterone Measurement*

Testosterone concentrations were measured in saliva samples following the procedures provided by Salimetrics in using their competitive immunoassay kit (No. 1-2312). In this procedure, synthetic and sample testosterone hormones compete in binding to the antibodies coated along the plate wells. The amount of bound synthetic testosterone is then measured, providing an inverse proportional measure of the testosterone present in the sample. All lab procedures were performed in the Developmental Ecology and Human Biology Laboratory, lasting from December of 2016 to February of 2017.

Six plates in total were run with all 198 samples. The total time for running a plate ranged from five to six hours. To begin, the samples and kit materials were set out for an hour to come to room temperature. Following this, samples were each centrifuged for fifteen minutes at 1800 rpm in order to extract the saliva from the swabs. 25  $\mu$ L of the saliva samples were then pipetted into the appropriate wells of the plate along with the same amount for standards, controls, and diluent. The enzyme conjugate was diluted 1:1000 by mixing 18  $\mu$ L of the conjugate with 18 mL of the assay diluent, and 150  $\mu$ L of this mixture was added to each well using a multichannel pipette. The plate was then placed on a rotator for five minutes at 500 rpm and left to incubate at room temperature for 55 minutes. This process allowed time for the sample testosterone and synthetic testosterone to compete for the antibodies coated along the wells, and for the conjugate to bind to the synthetic testosterone that had bound to antibodies.

The plate was then washed four times using a plate washer with the wash buffer provided in the kit. The buffer, 100 mL in total, was mixed with 900 mL of deionized water to create the wash buffer. Following the wash, 200  $\mu$ L of the substrate was added to each well using a multichannel pipette. The plate was then placed on a rotator for five minutes at 500 rpm and left

to incubate in a drawer at room temperature without light for 25 minutes. This allowed for the substrate to bind to the conjugate, giving off a blue color. Next, 50  $\mu\text{L}$  of stop solution was added to each well using a multichannel pipette. This halted chemical activity in the wells, and gave off either a yellow or green color. The plate was then placed on a rotator set at 500 rpm for three minutes or until all green wells had turned yellow.

The plate was then read at 450 nm in a plate reader. In compliance with the procedure guidelines, all plates were read within ten minutes of adding stop solution. The plate reader gives a wavelength measurement, which is converted through computer software into proportional measurements of the synthetic testosterone bound to the antibodies on the well, which is then converted into concentration measurements of the testosterone from the sample bound to the antibodies in pg/mL using the known concentrations of the standards. Coefficients of variance (CV's), a measure of distance between the duplicates for each sample, were used to assess quality control. Only four of the 198 samples had a CV above 10%, all four between 10% and 11%, and these were included in the analysis since they were above 10% by a very small magnitude.

The assay procedure produced data that were organized into three variables. These included an AM testosterone concentration measure, a PM concentration measure, and a diurnal rhythm measure. This last measure was created by subtracting the PM measure from the AM measure, and was referred to as AM-PM testosterone concentration.

### *Statistical Analysis*

All statistical analyses were performed using SPSS (IBM v. 22). Statistical analyses were restricted to Part II only. Descriptive statistics, correlations, and multiple linear regressions were performed on the data collected during Phase II. Bivariate correlations were performed (Pearson

and Spearman) to observe relationships among the two created environmental quality measures as well as the life history strategy measures. Multiple linear regression models were performed using environmental quality predictors and life history strategy and testosterone outcome variables as well as life history strategy predictors and testosterone outcome variables. For correlations, significance was set at  $p < .05$  and  $p < .001$ . For regressions, significance was set at  $p < .05$  and  $p < .01$ . In order to perform regression models with all variables of interest, some variables were transformed to make them normally distributed. The variables for previous sexual behavior and AM testosterone concentrations were  $\log_{10}$  transformed, while long term mating orientation and the difference between AM and PM testosterone concentrations were transformed using a two step procedure described by Templeton (2011). The first step involves transforming the data of the variable into percentile ranks, followed by the second step which converts the percentile ranks into normally distributed z-scores.

#### *Protection of Human Subjects*

All study procedures were reviewed and approved by the Institutional Review Board of the University of Alabama. Approval was granted on three separate occasions. The first was for the overall study design. Next, approval a second time was required as the second environmental quality measurement instrument was created using data collected from Phase I. The third approval was granted for adding the recruitment strategy of entering the current study into the Psychology Subject Pool of the University of Alabama. Written informed consent was required for study participation in both Phase I and II. Participants were not asked for names, and data obtained was organized using case identification numbers for both phases. Participants were given a copy of the informed consent form for their own records that outlined study procedures and other important information, such as contacts for questions about the study as well as

participant rights, including the ability to terminate participation at any time or refuse to answer any questions.

## 6. RESULTS

### *Phase I Results*

Table 6.1. shows the results from the open ended interviews ( $n = 10$ ) conducted with male students regarding their goals, along with resources and barriers influencing the achievement of these goals. The goals listed were not part of the study, and were therefore not included in the table. The table shows the resources and barriers listed in the interviews as well as the number of interviews in which the participants listed the item. As described in the previous chapter, items that were brought up in multiple interviews were used to construct the current life environmental quality measure. However, the barrier regarding “change mind about career/troubles with career” was excluded from the created interview schedule, since this referenced a time period after life course goal achievement. The interview schedule constructed based on these open interviews was given to three graduate students in the anthropology department in order to troubleshoot possible confusing language. Final edits were then made and used in Phase II.

The most mentioned resources included a supportive social circle and the university library among various related school resources. The most mentioned barrier was financial difficulties. As indicated by the higher number of barriers than resources present in the table, interview responses for barriers were more variable than resources mentioned.

Table 6.1. Resources and Barriers Listed During Phase I Interviews

Resources	# Interviews Listing Resource	Barriers	# Interviews Listing Barrier
Supportive Social Circle	6	Financial Difficulty	5
University Library/Related School Resources	6	Poor Work Ethic/School Performance	4
Networking	4	Poor Time Management	4
School Organizations	3	Getting Overwhelmed/Too Many Activities	4
Family Support	3	Not Going Out/Being Secluded	3
Mentors	3	Change Mind About Career/Troubles in Career	3
Previous Experience/Preparation	3	Peer Challengers	3
Good Relationship with Professors	3	Negative/Unsupportive Social Circle Influence	2
Good Colleagues	3	Legal Trouble	2
Tutors	2	Health Problems	2
Counselors	2	Poor Relationship with Professors	2
Advisor	2	Not Adjusting to College Life	1
Work Ethic	2	Not Getting into Desired School	1
Study Groups	1	Unsupportive Relatives	1
Church Support	1	Lacking Experience	1
Luck	1	Poor Networking	1
		Difficult Coursework	1
		Moving	1

*Phase II Descriptive Statistics*

Table 6.2. shows the frequencies of ethnicities in the sample for Phase II ( $n = 99$ ). Most of the sample identified as either white or European American (76). The second most prevalent ethnicity consisted of those identifying as African American (16). Frequencies of all other listed

ethnicities were very small, and therefore grouped under “Other”, making up only six participants of the total sample. There was one missing value for the ethnicity question.

Table 6.2. Ethnicities of Sample

White/European American	African American	Other
76	16	6

Table 6.3. shows the descriptive statistics of the sample. The mean age of the sample was 19.10, with a standard deviation of 1.663. As described in the previous chapter, early and current life quality measures were sum scores, with some questions reverse scored so that a higher number indicates better environmental quality. For total aggression, some questions were reverse scored and summed to provide a total score, in which a higher score indicates higher aggression. Both short term mating orientation and long term mating orientation were average scores across questions, in which a higher score indicates a higher preference. Previous sexual behavior is a sum score over three questions related to previous sexual experiences, in which a higher score indicates more frequent sexual behavior. All of the risk taking scores are sum scores for each risk taking category, in which higher numbers indicate higher risk taking in each domain. Both AM and PM testosterone concentration values were measured in pg/mL, and higher numbers indicate higher presence of testosterone. The testosterone decline measure is the difference between the AM and PM values, which provided a diurnal rhythm measurement accounting for the decline in testosterone throughout the day.

Aggression scores were highly variable with a standard deviation of 16.51. Comparing short and long term mating orientation, the sample exhibited a higher preference score in the long term orientation (5.03) than short term (3.83). Previous sexual behavior showed high

variation, with a standard deviation of 12.14 and a minimum of zero with a maximum of 79. This is a result of outlier effects. With regard to risk taking, social risk taking showed the highest sample average (26.28), with ethical risk taking showing the lowest (13.09). As expected, AM testosterone was higher than PM (AM Mean- 205.26 vs PM Mean- 133.43). AM was also more variable (AM SD- 74.25 vs PM SD- 47.28), which was expected since in the current study the AM samples were less time constrained than evening samples.

Table 6.3. Descriptive Statistics

Variables	Mean	SD	MIN	MAX
Age	19.10	1.663	18	31
Early Life Environmental Quality	47.96	6.07	32.00	60.00
Current Life Environmental Quality	45.08	4.96	29.00	57.00
Total Aggression	71.18	16.51	41.00	123.00
Short Term Mating Orientation	3.83	1.05	1.60	5.80
Long Term Mating Orientation	5.03	0.57	2.43	6.14
Previous Sexual Behavior	7.81	12.14	0.00	79.00
Social Risk Taking	26.28	4.49	9.00	36.00
Recreational Risk Taking	23.39	6.56	8.00	37.00
Health and Safety Risk Taking	22.32	5.40	12.00	36.00
Ethical Risk Taking	13.09	4.40	8.00	26.00
Monetary Risk Taking	18.12	5.63	8.00	37.00
AM Testosterone Concentration (pg/mL)	205.26	74.25	96.69	484.98
PM Testosterone Concentration (pg/mL)	133.43	47.28	48.44	282.42
Testosterone Decline (PM subtracted from AM)	71.84	64.66	-92.11	309.65

### *Bivariate Correlations*

Table 6.4. shows bivariate correlations between the environmental quality measures, life history strategy measures, and testosterone measures. Both Pearson and Spearman correlations were used. Spearman correlations were used for correlations involving variables not normally distributed. These variables included long term mating orientation, previous sexual behavior, AM testosterone concentration, and AM-PM testosterone concentration. Significance was determined at both  $p < .05$  and  $p < .001$ . Both environmental quality measures showed a positive correlation with each other ( $r = .426, p < .001$ ). The early life environmental quality measure was also positively correlated with recreational risk taking ( $r = .207, p < .05$ ). The current life environmental quality measure was negatively correlated with ethical risk taking ( $r = -.235, p < .05$ ) and positively correlated with AM testosterone concentration ( $r = .242, p < .05$ ).

The aggression measure was positively correlated with short term mating orientation ( $r = .297, p < .05$ ), social risk taking ( $r = .388, p < .001$ ), health and safety risk taking ( $r = .421, p < .001$ ), and ethical risk taking ( $r = .340, p < .05$ ). Short term mating orientation was positively correlated with previous sexual behavior ( $r = .473, p < .001$ ) and health and safety risk taking ( $r = .461, p < .001$ ), while slightly positively correlated with ethical risk taking ( $r = .297, p < .05$ ). Previous sexual behavior was positively correlated with health and safety risk taking ( $r = .385, p < .001$ ). Social risk taking had positive correlations with health and safety risk taking ( $r = .294, p < .05$ ), ethical risk taking ( $r = .233, p < .05$ ), and monetary risk taking ( $r = .200, p < .05$ ). Recreational risk taking was positively correlated with health and safety risk taking ( $r = .249, p < .05$ ) and ethical risk taking ( $r = .202, p < .05$ ). Health and safety risk taking was positively correlated with ethical risk taking ( $r = .494, p < .001$ ) and monetary risk taking ( $r = .235, p < .05$ ).

.05). Ethical and monetary risk taking were positively correlated ( $r = .382, p < .001$ ), and AM and PM testosterone measures were positively correlated ( $r = .576, p < .001$ ).

The correlation results were mixed, but overall providing little support that all of the life history strategy variables should be used in a single construct. The results showed mostly no support that the environmental quality measures were related to these life history strategy variables, and the results also showed that testosterone had almost no relationship with either the environmental quality or life history strategy variables. However, multiple linear regression models were constructed for further hypotheses testing and are shown in the next section.

Table 6.4. Bivariate Correlations for Major Variables

All Participants (n = 99)		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	ELEQ	-													
2	CLEQ	.426**	-												
3	Aggression	.027	-.129	-											
4	STMO	.052	-.079	.297*	-										
5	LTM0	.048	.061	-.010	-.033	-									
6	PSB	.105	.006	.198	.473**	-.077	-								
7	Social Risk	-.011	-.036	.388**	.131	.068	.004	-							
8	Recreational Risk	.207*	.195	.171	-.030	.114	.074	.185	-						
9	Health and Safety Risk	.151	-.130	.421**	.461**	-.104	.385**	.294*	.249*	-					
10	Ethical Risk	-.077	-.235*	.340*	.297*	-.006	.152	.233*	.202*	.494**	-				
11	Monetary Risk	.083	.168	.135	.164	-.108	-.103	.200*	.170	.235*	.382**	-			
12	AM T	.158	.242*	-.027	.087	-.009	.081	-.103	-.097	-.112	-.124	.016	-		
13	PM T	.033	.082	-.054	.087	-.001	.024	-.127	-.009	-.063	-.097	.030	.576**	-	
14	AM-PM T	.155	.159	.022	.005	.023	.068	-.002	-.069	-.032	-.012	.085	.680**	-.137	-

ELEQ- Early Life Environmental Quality, CLEQ- Current Life Environmental Quality, STMO- Short Term Mating Orientation, LTM0- Long Term Mating Orientation, PSB- Previous Sexual Behavior.

Correlations involving Long Term Mating Orientation, Previous Sexual Behavior, AM T testosterone, and AM-PM Testosterone were done with Spearman, while all others were done with Pearson

\* Significance at  $p < .05$   
 \*\* Significance at  $p < .001$

### *Regression Models*

The remainder of the tables show a series of multiple linear regression models involving environmental quality, life history strategy, and testosterone variables. Since previous literature as well as the correlational data of the current study suggest against combining all of the life history strategy variables into a single variable, several models were used to predict each life history strategy variable. Significance for these models was used at  $p < .05$  as well as  $p < .01$ . Model diagnostics included variance of inflation measures, histograms and normal P-P plots of standardized regression residuals, and scatterplots of standardized regression residuals with standardized regression predicted values along with Koenker tests for heteroscedasticity assessment.

All models except for the one predicting ethical risk taking, which violated the assumption of homoscedasticity, met all required diagnostics for performing a multiple linear regression. Cook's distance values were measured for detecting residual outliers with leverage, using a 1.0 cutoff for assessment. No Cook's distance values exceeded 1.0 in any of the models, revealing no residual outliers with leverage in any of the models.

The first model is shown in Table 6.5., in which the two created environmental quality measures were used along with more conventional environmental quality measures, including parental education, expected life span, and rated stress, to predict aggression. Subjective SES was originally planned to be used as a predictor. However, there were a high number of missing values for this variables. It was therefore removed from analysis in order to maximize statistical power.

The model shown in Table 6.5. as a whole was not significant. Though the expected life span measure on its own had a significant negative standardized coefficient ( $-.215, p < .05$ ),

suggesting that lower expected life span predicts higher aggression. However, to assess how robust this finding was, the model was stripped of all non-significant variables. With just expected life span as a predictor, it lost significance, suggesting no relationship (analysis not shown).

Table 6.5. Multiple Linear Regression of Demographic and Environmental Predictors of Total Aggression

Variables	Standardized Coefficients
Mother's Level of Education	.226
Father's Level of Education	-.083
Expected Life Span	-.215*
Rated Stress	-.153
Early Life Environmental Quality	.170
Current Life Environmental Quality	-.236
R	.321
R <sup>2</sup>	.103

\* Significant at  $p < .05$

\*\* Significant at  $p < .01$

Table 6.6. contains the same environmental quality predictors, but with short term mating orientation as the outcome variable. The model as a whole was not significant, and none of the individual predictors were significant. This suggests no relationship between the environmental quality predictors and short term mating orientation.

Table 6.6. Multiple Linear Regression of Demographic and Environmental Predictors of Short Term Mating Orientation

Variables	Standardized Coefficients
Mother's Level of Education	.207
Father's Level of Education	-.184
Expected Life Span	-.106
Rated Stress	-.151
Early Life Environmental Quality	.172
Current Life Environmental Quality	-.182
R	.270
R <sup>2</sup>	.073

\* Significant at  $p < .05$

\*\* Significant at  $p < .01$

Table 6.7. contains a model of the environmental quality predictors with the outcome variable as long term mating orientation. Long term mating orientation was transformed to normally distributed using the two-step procedure described in the previous chapter. This was done in order to avoid violating the model assumption of a normally distributed outcome variable. The model as a whole was not significant, and none of the individual predictors showed significance, suggesting no relationship between environmental quality predictors and long term mating orientation.

Table 6.7. Multiple Linear Regression of Demographic and Environmental Predictors of Long Term Mating Orientation (Two-Step Transformed to Normally Distributed)

Variables	Standardized Coefficients
Mother's Level of Education	.056
Father's Level of Education	-.249
Expected Life Span	.013
Rated Stress	.167
Early Life Environmental Quality	.024
Current Life Environmental Quality	.157
R	.255
R <sup>2</sup>	.065

\* Significant at  $p < .05$

\*\* Significant at  $p < .01$

Table 6.8. contains a model of the environmental quality predictors with the outcome variable being previous sexual behavior. Previous sexual behavior was  $\log_{10}$  transformed so that the model assumption of a normally distributed outcome variable was not violated. The model as a whole was not significant, though rated stress showed a significant negative coefficient on its own ( $-.246, p < .05$ ), suggesting lower stress predicted higher previous sexual behavior. However, in order to assess how robust this finding was, rated stress was used as a predictor on its own in a separate model. In this simple linear regression model, rated stress fell out of significance (analysis not shown).

Table 6.8. Multiple Linear Regression of Demographic and Environmental Predictors of Previous Sexual Behavior (Log<sub>10</sub> Transformed to Normally Distributed)

Variables	Standardized Coefficients
Mother's Level of Education	.094
Father's Level of Education	-.177
Expected Life Span	.077
Rated Stress	-.246*
Early Life Environmental Quality	.177
Current Life Environmental Quality	-.211
R	.316
R <sup>2</sup>	.100

\* Significant at  $p < .05$

\*\* Significant at  $p < .01$

Table 6.9. contains a model of environmental quality predictors and social risk taking as the outcome variable. The model as a whole was not significant. None of the individual predictors showed significant coefficients, suggesting no relationship between environmental quality predictors and social risk taking.

Table 6.9. Multiple Linear Regression of Demographic and Environmental Predictors of Social Risk Taking

Variables	Standardized Coefficients
Mother's Level of Education	-.081
Father's Level of Education	.012
Expected Life Span	-.041
Rated Stress	-.178
Early Life Environmental Quality	.060
Current Life Environmental Quality	-.111
R	.212
R <sup>2</sup>	.045

\* Significant at  $p < .05$

\*\* Significant at  $p < .01$

Table 6.10. contains a model of environmental quality predictors with recreational risk taking as the outcome variable. The model as a whole was not significant. None of the individual predictors showed a significant coefficient, suggesting no relationship between environmental quality predictors and recreational risk taking.

Table 6.10. Multiple Linear Regression of Demographic and Environmental Predictors of Recreational Risk Taking

Variables	Standardized Coefficients
Mother's Level of Education	.071
Father's Level of Education	.075
Expected Life Span	.020
Rated Stress	-.102
Early Life Environmental Quality	.122
Current Life Environmental Quality	.088
R	.273
R <sup>2</sup>	.075

\* Significant at  $p < .05$

\*\* Significant at  $p < .01$

Table 6.11. contains a model of environmental quality predictors with health and safety risk taking as the outcome variable. The model as a whole was significant ( $R = .385, p < .05$ ). In terms of individual predictor variables, both early life and current life environmental quality measures showed significant coefficients, though in opposite directions. Early life environmental quality showed a positive coefficient ( $.355, p < .01$ ), suggesting that higher early life environmental quality predicts higher health and safety risk taking. While the current life environmental quality variable had a negative coefficient ( $-.318, p < .01$ ), suggesting that higher current life environmental quality predicts lower health and safety risk taking. Another model was created using only early life and current life environmental quality measures as predictors of health and safety risk taking. Both predictors remained significant at the  $p < .05$  level, suggesting

a mixed relationship between environmental quality predictors and health and safety risk taking (analysis not shown).

Table 6.11. Multiple Linear Regression of Demographic and Environmental Predictors of Health and Safety Risk Taking

Variables	Standardized Coefficients
Mother's Level of Education	.122
Father's Level of Education	-.109
Expected Life Span	-.199
Rated Stress	-.197
Early Life Environmental Quality	.355**
Current Life Environmental Quality	-.318**
R	.385*
R <sup>2</sup>	.148

\* Significant at  $p < .05$

\*\* Significant at  $p < .01$

Table 6.12. shows a regression model of environmental predictors with ethical risk taking as the outcome variable. The model overall was not significant, while independently current life environmental quality had a significant negative coefficient ( $-.310, p < .05$ ). However, model diagnostics indicated a violation of the homoscedasticity assumption. Therefore, this model was actually uninterpretable.

Table 6.12. Multiple Linear Regression of Demographic and Environmental Predictors of Ethical Risk Taking

Variables	Standardized Coefficients
Mother's Level of Education	.016
Father's Level of Education	.213
Expected Life Span	.033
Rated Stress	-.152
Early Life Environmental Quality	-.028
Current Life Environmental Quality	-.310*
R	.328
R <sup>2</sup>	.107

\* Significant at  $p < .05$

\*\* Significant at  $p < .01$

Table 6.13. contains a regression model of environmental quality predictors with monetary risk taking as the outcome variable. The model as a whole was significant ( $R = .382, p < .05$ ), while the only predictor with a significant coefficient was father's level of education (.359,  $p < .01$ ), suggesting that increasing father's level of education predicts increases in monetary risk taking. Taking out all insignificant predictors did not influence the significance of father's level of education, which remained significant at the  $p < .01$  level (analysis not shown).

Table 6.13. Multiple Linear Regression of Demographic and Environmental Predictors of Monetary Risk Taking

Variables	Standardized Coefficients
Mother's Level of Education	-.090
Father's Level of Education	.359**
Expected Life Span	-.182
Rated Stress	-.038
Early Life Environmental Quality	-.007
Current Life Environmental Quality	.139
R	.382*
R <sup>2</sup>	.146

\* Significant at  $p < .05$

\*\* Significant at  $p < .01$

Table 6.14. contains a regression model of environmental quality predictors with AM testosterone as the outcome variable. AM testosterone was  $\log_{10}$  transformed to normally distributed in order to avoid violating the model assumption of a normally distributed outcome variable. The model as a whole was not significant, and none of the individual predictors had significant coefficients, suggesting no relationship between the environmental quality predictors and AM testosterone.

Table 6.14. Multiple Linear Regression of Demographic and Environmental Predictors of AM Testosterone Concentration ( $\log_{10}$  Transformed to Normally Distributed)

Variables	Standardized Coefficients
Mother's Level of Education	.173
Father's Level of Education	-.078
Expected Life Span	-.089
Rated Stress	.032
Early Life Environmental Quality	.057
Current Life Environmental Quality	.185
R	.253
R <sup>2</sup>	.064

\* Significant at  $p < .05$

\*\* Significant at  $p < .01$

Table 6.15. contains a regression model of environmental quality predictors with PM testosterone as the outcome variable. The model as a whole was not significant. Though mother's level of education had a significant positive coefficient (.336,  $p < .01$ ), suggesting that increasing mother's level of education predicts higher PM testosterone. Another model was performed using only mother's level of education as a predictor, and it remained significant at the  $p < .05$  level (analysis not shown).

Table 6.15. Multiple Linear Regression of Demographic and Environmental Predictors of PM Testosterone Concentration

Variables	Standardized Coefficients
Mother's Level of Education	.336**
Father's Level of Education	-.131
Expected Life Span	-.138
Rated Stress	-.015
Early Life Environmental Quality	.009
Current Life Environmental Quality	.079
R	.299
R <sup>2</sup>	.090

\* Significant at  $p < .05$

\*\* Significant at  $p < .01$

Table 6.16. contains a regression of environmental quality predictors with AM-PM testosterone levels as the outcome variables. The model as a whole was not significant, and none of the individual predictors had significant coefficients. This suggests no relationship between the environmental quality predictors and AM-PM testosterone levels.

Table 6.16. Multiple Linear Regression of Demographic and Environmental Predictors of AM-PM Testosterone Concentration (Two-Step Transformed to Normally Distributed)

Variables	Standardized Coefficients
Mother's Level of Education	-.076
Father's Level of Education	.007
Expected Life Span	.023
Rated Stress	.052
Early Life Environmental Quality	.078
Current Life Environmental Quality	.145
R	.188
R <sup>2</sup>	.035

\* Significant at  $p < .05$

\*\* Significant at  $p < .01$

Table 6.17. contains the results of a regression model with life history strategy variables as the predictors and AM testosterone  $\log_{10}$  transformed as the outcome variable. The life history strategy variables in the model include total aggression, short term mating orientation, long term mating orientation, previous sexual behavior, social risk taking, recreational risk taking, health and safety risk taking, ethical risk taking, and monetary risk taking. The model overall was not significant, and no individual predictor had a significant coefficient. This suggests no relationship between these life history strategy variables and AM testosterone values.

Table 6.17. Multiple Linear Regression of Life History Strategy Predictors of AM Testosterone Concentration ( $\log_{10}$  Transformed to Normally Distributed)

Variables	Standardized Coefficients
Total Aggression	.124
Short Term Mating Orientation	.195
Long Term Mating Orientation	.045
Previous Sexual Behavior	.051
Social Risk Taking	-.194
Recreational Risk Taking	.050
Health and Safety Risk Taking	-.255
Ethical Risk Taking	-.072
Monetary Risk Taking	.098
R	.324
R <sup>2</sup>	.105

\* Significant at  $p < .05$

\*\* Significant at  $p < .01$

Table 6.18. contains the results of a regression model with the same life history strategy variables as predictors and PM testosterone as the outcome variable. The model overall was not significant. None of the predictors showed significant coefficients either, suggesting no relationship between these life history strategy variables and PM testosterone values.

Table 6.18. Multiple Linear Regression of Life History Strategy Predictors of PM Testosterone Concentration

Variables	Standardized Coefficients
Total Aggression	.021
Short Term Mating Orientation	.195
Long Term Mating Orientation	.050
Previous Sexual Behavior	-.054
Social Risk Taking	-.183
Recreational Risk Taking	.077
Health and Safety Risk Taking	-.056
Ethical Risk Taking	-.112
Monetary Risk Taking	.047
R	.250
R <sup>2</sup>	.062

\* Significant at  $p < .05$

\*\* Significant at  $p < .01$

The final regression model is shown in Table 6.19. This model contains the same life history strategy variables as predictors and AM-PM testosterone as the outcome variable. The model overall was not significant. None of the individual predictors showed a significant coefficient, suggesting no relationship between these life history strategy variables and AM-PM testosterone values.

Table 6.19. Multiple Linear Regression of Life History Strategy Predictors of AM-PM Testosterone Concentration (Two-Step Transformed to Normally Distributed)

Variables	Standardized Coefficients
Total Aggression	.158
Short Term Mating Orientation	-.010
Long Term Mating Orientation	.039
Previous Sexual Behavior	.098
Social Risk Taking	-.072
Recreational Risk Taking	-.035
Health and Safety Risk Taking	-.167
Ethical Risk Taking	-.008
Monetary Risk Taking	.092
R	.198
R <sup>2</sup>	.039

\* Significant at  $p < .05$

\*\* Significant at  $p < .01$

Overall, these regression models reject the hypotheses that (1) lower environmental quality is associated with a faster life history strategy, and (2) faster life history strategies are associated with higher testosterone. Since on the whole, neither environmental quality measures or life history strategy measures were related to testosterone measures, the mediating hypothesis was not tested, as it would be impossible to detect an effect with unrelated variables to begin with.

## 7. DISCUSSION

### *Introduction*

This project was an early empirical exploration of the recent theoretical development of applying life history theory from evolutionary biology to understanding variation in human psychology and behavior. The results of this project indicated several problems with this recent theoretical development, as they overall did not support the application of life history theory to human psychology and behavior. This assertion is based on the rejection of the study hypotheses that were derived from this recent theoretical development. The hypotheses of the current study were (1) worse environmental quality measures would be associated with a faster life history strategy, (2) a faster life history strategy would be associated with higher testosterone, and (3) that life history strategies would mediate the relationship between worse environmental quality and higher testosterone. The first two hypotheses were rejected based on the results of the multiple linear regression models, while the mediating hypothesis was not tested since no relationship was found to begin with between environmental quality, life history strategies, and testosterone.

### *Correlations*

The bivariate correlation results provided valuable information regarding the relationships between the main variables. While the early life environmental quality measure was taken from the results of Brown et al. (2006), and the current life environmental quality measure was created with the specific population under study here, they still had a moderate positive correlation, suggesting they are capturing similar information regarding the sociocultural

environment of the participants. The AM and PM testosterone measures were also positively correlated, and the correlation was slightly stronger in magnitude than with the environmental quality measures, suggesting stable individual differences across the day for the participants of this study. However, the life history strategy indicators were less related than the environmental quality and testosterone measures.

If the current theoretical use of a life history strategy construct for individual variation in human psychology and behavior were an accurate representation of reality, then the correlation results should have shown all the risk taking measures, aggression, short term mating orientation, and previous sexual behavior to be positively correlated with each other and negatively correlated with long term mating orientation. The results provided mixed support of this expectation, though when taking into consideration multiple comparison issues, the evidence supporting this becomes weak.

The correlations significant at  $p < .05$  between life history strategy indicators included aggression and short term mating orientation ( $r = .297$ ), aggression and ethical risk taking ( $r = .340$ ), ethical risk taking and short term mating orientation ( $r = .297$ ), social risk and health and safety risk ( $r = .294$ ), social risk and ethical risk ( $r = .233$ ), social risk and monetary risk ( $r = .200$ ), recreational risk and health and safety risk ( $r = .249$ ), recreational risk taking and ethical risk taking ( $r = .202$ ), and health and safety risk taking and monetary risk taking ( $r = .235$ ).

However, these correlations should be treated heavily with caution, as a significance threshold of  $p < .001$  is more appropriate based on the number of comparisons performed. This leaves aggression and social risk taking ( $r = .388$ ), aggression and health and safety risk taking ( $r = .421$ ), short term mating orientation and previous sexual behavior ( $r = .473$ ), short term mating orientation and health and safety risk taking ( $r = .461$ ), previous sexual behavior and health and

safety risk taking ( $r = .385$ ), health and safety risk taking and ethical risk taking ( $r = .494$ ), and ethical risk taking and monetary risk taking ( $r = .382$ ). Using these correlations at a stricter significance threshold suggest a mixed and overall weak overlap among the three life history strategy indicators. Therefore, this evidence suggests they should not be treated as components of a single construct.

Regarding each of the three life history strategy measures independently, total aggression was used as a total score as recommended by Buss & Perry (1992). Risk taking measures were kept domain specific as recommended by Weber et al. (2002), and the mixed correlation results between all five domains reinforced the prescribed use of the measure as domain specific. With regard to the sociosexuality measure, short and long term measures were kept separate and treated as not mutually exclusive as recommended by Jackson & Kirkpatrick (2007). The lack of a negative correlation between the measures in the correlation results further reinforce the claim that these are not mutually exclusive, and that human sociosexuality should not be treated as unidimensional.

Worthy of note is the observed positive correlation between short term mating orientation and previous sexual behavior. It is certainly conceivable that individuals might express a certain sociosexual preference but not act in accordance with that preference. Therefore, preference and actual behavior should not be conflated. While the positive correlation between short term preference and previous sexual behavior suggests a relationship between preference and behavior, it must also be pointed out that there was no observed correlation between previous sexual behavior and long term interest. Therefore, the interpretation of the positive correlation between previous sexual behavior and short term interest should be done with caution, and conflating preference with actual behavior should still be avoided.

## *Regressions*

Regarding the regression results, multiple significant coefficients were observed. However, in order to make sure these results were robust, the models were run again with only the significant variables in order to ensure a more informed interpretation of the regression results. This led to two significant findings later being rejected, as they did not hold significant in multiple models. These included expected life span predicting aggression ( $-.215, p < .05$ ), and rated stress predicting previous sexual behavior ( $-.246, p < .05$ ). Along with these two significant results later being rejected, the significant coefficient of current life environmental quality predicting ethical risk taking ( $-.310, p < .05$ ) was also rejected because model diagnostics indicated a violation of the homoscedasticity assumption.

Some significant coefficients remained significant in multiple models. These included early life environmental quality predicting health and safety risk taking ( $.355, p < .01$ ), current life environmental quality predicting health and safety risk taking ( $-.318, p < .01$ ), father's level of education predicting monetary risk taking ( $.359, p < .01$ ), and mother's level of education predicting PM testosterone concentration ( $.336, p < .01$ ). When all other variables were taken out of the models except these significant variables, father's level of education remained significant at  $p < .01$  in predicting monetary risk taking, while the other three significant coefficients dropped from  $p < .01$  to  $p < .05$ .

Interpreting these results overall, they did not support the hypotheses that environmental quality measures would be associated with life history strategy indicators and that life history strategy indicators would be associated with testosterone concentrations. Only four variables had significant coefficients, and only one was in the expected direction (current life environmental quality and health and safety risk), with the remaining three in the unexpected direction. Further,

three of the four significant coefficients dropped from  $p < .01$  to  $p < .05$  when other variables were removed from the original regression model. Due to the number of regression models and therefore comparisons performed, coefficients significant at  $p < .05$  should be treated heavily with caution, and could conceivably be the results of chance due to so many comparisons being performed.

The one coefficient that remained significant at  $p < .01$  across multiple models was father's level of education positively predicting monetary risk taking. This observation is in contrast to the expectation that lower environmental quality would be associated with higher risk taking. However, previous literature exists that can be viewed as in accordance with this observation. For example, Humphreys et al. (2015) compared individuals who had reported being institutionalized early in life to those who had not on a computer task designed to assess exploration-exploitation strategies. In this computer game, participants were instructed to inflate a balloon by clicking the mouse, in which each click further inflated the balloon. Monetary incentive was introduced by telling participants that they would receive increasing monetary rewards for increasing balloon sizes. However, at some point unexpectedly, the balloon would pop. If the balloon popped all rewards would be lost. Therefore, more clicks indicated a more explorative strategy, while less clicks indicated a more exploitative strategy. This could also be interpreted as willingness to take a monetary risk. Humphreys et al. (2015) found that individuals with a history of being institutionalized clicked less compared to those without a history of institutionalization, indicating a more exploitative strategy for the institutionalized group. Alternatively, this could be interpreted as individuals with worse environmental quality in early life were less likely to take a monetary risk.

Another example comes from poverty research presented in the book *Poor Economics* (Banerjee & Duflo 2012). Written by two leading economists, Abhijit Banerjee and Esther Duflo, part of the book covers the misconception of the global poor as inherently keen on taking business risk. This idea is based on the observation that so many of the global poor are entrepreneurs, generally running small businesses near or out of their homes. Banerjee & Duflo (2012) documented efforts in India aimed at helping these poor entrepreneurs by providing them funds to increase the scale of their business operations. The results were underwhelming, in which these individuals did not generally use the funds to increase the scale of their small businesses. While investigating why, it was discovered that the reason there are so many entrepreneurs among the global poor is that they are “buying a job”. These individuals simply cannot find employment, and starting a small business is their last resort for generating a sustainable income. When given the option to take more monetary risk than they are forced to, such as being given business funds as part of a poverty research study, they were risk averse and did not seek to expand their businesses. Therefore, it appears that at least some contexts exist in which indicators of a worse environmental quality is associated with being averse to monetary risk taking.

Since the current study provided evidence against the hypotheses, it must then be explained why this would be the case. It is conceivable that life history theory is not applicable to human psychology and behavior, in contrast to recent theoretical endeavors (Del Giudice 2014; Del Giudice et al. 2015; Ellis & Del Giudice 2014). For example, under this theoretical orientation, risk taking and sociosexuality are placed on a unidimensional scale as indicators of a life history strategy. However, this is problematic. As highlighted both in previous literature (Weber et al. 2002) and the current study, there is no single concept of risk taking. In reality, risk

taking is complex and domain specific, in which individuals might be high risk taking in one domain but not others, and individuals are generally not high or low risk across all domains.

Sociosexuality is also multidimensional. Theorists applying life history theory to human psychology and behavior have assumed that sociosexuality is unidimensional, in which an individual either has a more short term preference as part of a faster strategy or a more long term preference as part of a slower strategy. However, again, as previous literature suggests (Jackson & Kirkpatrick 2007) and the current study reinforces, sociosexuality is not unidimensional and short and long term preferences are not mutually exclusive. Further, there is an implicit assumption that sexual strategies equate to mating strategies. However, it is far from inconceivable that human sexual behavior is not exclusively driven by reproduction. Therefore, to describe human sexual behavior as a mating strategy and relating it to a life history strategy is problematic.

Another problem with the current application of life history theory to human psychology and behavior is that it ignores culture as having any relevance. While difficult to entangle, culture clearly has some influence on behavior (D'Andrade 1992). As mentioned in chapter five, there was overlap between the results of the Brown et al. (2006) study and life history strategy indicators. One of the socioemotional results of that study was having long term goals, an indication of thinking in the long term over the short term, while one of the barriers was a preference for thrill seeking behavior. Both of these were removed when the Brown et al. (2006) results were used as the early life environmental quality measure since they could overlap with life history strategy measurement. These excluded results, while arguably life history strategy indicators, were clearly wrapped up into the cultural models of development Brown et al. (2006)

were studying, and therefore highlight the relevance of culture that has been ignored by theorists applying life history theory to human psychology and behavior.

Theorists applying life history theory to human psychology and behavior have also ignored unique political economic motivations of behavior. For example, another topic of the book *Poor Economics* (Banerjee & Duflo 2012) was why individuals in poor countries have more children than those in rich ones. The life history strategy framework would explain this as higher mortality in poor countries driving a faster strategy in which a reproductive strategy develops that prioritizes higher numbers of children with less investment in them. However, when asking these individuals why they had so many children, it was discovered that it related to the unique political economic system they existed in. Under their current circumstances, the state did not provide an adequate social safety net for those too old to work or take care of themselves. Therefore, when asked why they had so many children, they responded that having more children acted as an insurance plan for them in their old age, noting that the more children they had, the higher likelihood at least one child would support and take care of them when they were too old to do so. This alternative explanation for why they have the number of children they do reflects long term thinking that is flexible in responding to unique and highly variable political economic circumstances. This is in contrast to a life history strategy framework that expects these individuals to discount their future and have many children to maximize reproductive fitness.

Arguably, the contrast between study observations and expectations derived from applying life history theory to human psychology and behavior have been present since the beginning. As noted in chapter two, Belsky (2012) traces the origin of this theoretical development to Draper & Harpending (1982), in which they proposed that individuals learn from

their sociocultural context early in life, and calibrate a reproductive strategy accordingly. Also noted in chapter two was one of the major inspirations Draper & Harpending (1982) acknowledge for their paper, a study on father experiences and behavior toward men among young girls conducted by Hetherington (1972). This study found that young girls with divorced fathers who were not always present in their lives expressed more attention and interest toward a male interviewer compared to girls with still married fathers who were consistently present in their lives. However, the girls with deceased fathers were very avoidant of a male interviewer. This last observation contrasts starkly with an expectation from life history theory. The reasoning behind worse environments leading to a faster strategy is based on the worse environment serving as a mortality cue. Therefore, the young girls who experienced a direct mortality cue would be expected to show the greatest interest in a male interviewer. However, the opposite was observed. This observation throws into question specifically whether reproductive strategies are calibrated in early life based on mortality cues, and more generally the application of life history theory to human psychology and behavior.

### *Testosterone*

It was unexpected that previous sexual behavior was unrelated to testosterone, since sexual behavior appears to be positively associated with testosterone (Gettler et al. 2013; Halpern et al. 1998). This might be due to low variation in the previous sexual behavior variable, as it had a large positive skew. It also could be the result of differences in study design. While Gettler et al. (2013) and Halpern et al. (1998) measured participant reported frequency of sexual activity, the sexual behavior measure in the current study measured only partner count while leaving out frequencies of sexual behavior with these reported partners. Testosterone was also unrelated to sociosexuality. It has been suggested that testosterone relates to sexual preferences rather than

the actualization of these preferences (van Anders 2013). However, the current study provided evidence to the contrary of this.

Testosterone was also unrelated to aggression and risk taking measures. This was unexpected based on previous literature suggesting a link between testosterone and risk taking and aggression (Dabbs & Morris 1990). However, this might be the result of testosterone being very context specific, and therefore testosterone-aggression and testosterone-risk taking links must be studied right around the time of observing related behaviors. This particular design has been used in a number of studies, in which testosterone is measured immediately after the behavior of interest has occurred (Apicella et al. 2008; Ronay & von Hippel 2010; Stanton et al. 2010; Trumble et al. 2012). Another contributor to this observation could be the social contextual nature of testosterone (Booth et al. 2006; Rowe et al. 2004), which was not explored in the current study, and instead decontextualized measures of aggression and risk taking were used.

Testosterone overall was unrelated to environmental quality measures, which was unexpected based on previous literature (Alvarado 2013; Dabbs & Morris 1990). Though this might be due to the lack of variation in socioeconomic status as a result of sampling college students. The link between high testosterone and worse environments largely stems from the study of over four thousand United States armed forces veterans by Dabbs & Morris (1990), in which they found low socioeconomic status to be associated with higher testosterone. The socioeconomic status variation was likely much higher in that study compared to the current study. However, it must also be recognized that environmental quality and testosterone do not have a simple relationship. As in the case observed in the Philippines (Kuzawa et al. 2010a), lower socioeconomic status is expected to be associated with lower testosterone in contexts

where low socioeconomic status is also associated with inadequate nutrition, since testosterone is sensitive to nutrition (Alvarado 2013).

### *Limitations*

Several limitations must be noted with the current study. The first is in the construction of the environmental quality measures. The early life environmental quality measure was constructed from the results of Brown et al. (2006). Therefore, while their results were from studying young adults, the research was done around fifteen years ago and in a different part of the United States than the current study in western North Carolina. Therefore, it could be argued that taking results from that study and using it in the current one ignores unique sociocultural contexts. Another problem with the construction of this measure was that results were “cherry picked” in order to make them as applicable to the aims and population of the current study; measuring early life environmental quality in young adult male college students at the University of Alabama. Therefore, the validity of this measure could be debated.

Further, the current life environmental quality measure was constructed by only using the first step of the methods outlined by Brown et al. (2006) in constructing a measure of culturally relevant resources and barriers. The current study relied only on free list data. However, general cultural model research, and the study by Brown et al. (2006) in particular, use free listing as simply the first step. Therefore, the validity of the current life environmental quality measure could also be debated.

Other limitations include the sample size and specificity of the study population. The specific population under study was young adult male college students at the University of Alabama. Therefore, generalizability should be done with caution. These results should not be generalized to women or males of different age groups or those outside of the United States.

More research on both men and women and in various contexts with regard to environmental quality indicators, life history strategy indicators, and life history strategy-relevant hormones should be done before a concise conclusion regarding their relationship can be made.

In addition, the size of the sample might have limited the possibility of detecting significant testosterone findings. This is because testosterone findings can be small in magnitude, therefore requiring a larger sample size to detect them. For example, had the sample size been larger, it is possible that the insignificant positive correlations between AM-PM testosterone and early life environmental quality ( $r = .155, p > .05$ ) as well as current life environmental quality ( $r = .159, p > .05$ ) would have had significant probability values.

Finally, the number of comparisons performed in the current study caused problems for interpreting the data. Significance values at  $p < .05$  in the current study are probably not robust findings, as they could have been the result of the multiple comparisons problem. Due to this problem, results are difficult to interpret and easily lend to misleading interpretation.

## 8. CONCLUSION

This project served as an early empirical exploration of the recent theoretical development in which life history theory has been applied to understanding variation in human psychology and behavior. Under this theoretical development, indicators of a harsh environment are supposed to serve as mortality cues which leads to an adaptive response in the form of a suite of characteristics considered to be part of a faster life history strategy, including a preference for short term and uncommitted sexual relationships, higher aggression, and higher risk taking among other components. The current study tested these theoretically derived predictions, and went further by measuring testosterone in order to examine whether this hormone played a role in the proposed process of life history strategy development. The tested hypotheses included, (1) worse environmental quality would be associated with a faster life history strategy, (2) faster life history strategies would be associated with higher testosterone, and (3) life history strategies would mediate a relationship between worse environmental quality and higher testosterone.

The current study focused on young adult male college students at the University of Alabama, who were recruited through anthropology and psychology classes. Ethnographic research was conducted in the form of open ended interviews with members of the study population through convenience sampling at the Ferguson Student Center in order to examine developmental goals in this unique sociocultural context along with resources and barriers that influence developmental goal achievement. The information gathered from these interviews were used to construct an environmental quality measure. Along with this, another environmental quality measure was created using results from Brown et al. (2006), in which ethnographic

research revealed resources and barriers related to developmental goals held by youths in western North Carolina. These two created measures were combined with demographic measures, including parental education and subjective socioeconomic status, as well as stress related measures including a rated stress scale and an expected life span scale in order to capture the full extent of environmental quality.

These measures were used to predict proposed components of a life history strategy, including sociosexuality, aggression, and risk taking, which were all measured using pre-existing questionnaires (Buss & Perry 1992; Jackson & Kirkpatrick 2007; Weber et al. 2002). Both environmental quality measures and life history strategy measures were then used to predict testosterone measures. Statistical analyses included correlations and multiple linear regressions.

The results did not support the first two hypotheses and the mediating hypothesis was not tested because, overall, no relationship was found between environmental quality, life history strategies, and testosterone. Therefore, the hypotheses that worse environmental quality measures would be associated with faster life history strategy measures and that faster life history strategy measures would be associated with higher testosterone measures were rejected in the current study. While multiple linear regression models were used to analyze the data and test the hypotheses, correlations served to further explore how the main variables related.

Bivariate correlations were performed with the main variables, including both constructed environmental quality measures, the total aggression measure, sociosexuality and sexual behavior measures, and domain specific risk taking measures. There were five domain measures of risk taking, including social, recreational, health and safety, ethical, and monetary. The correlation results revealed complex relationships between these variables, as well as mixed and weak evidence for the single life history strategy construct proposed by theorists applying

life history theory to variation in human psychology and behavior (Del Giudice 2014). While the environmental quality and testosterone measures were correlated, the results for the life history strategy measures were mixed.

The current study revealed several problems with the current theoretical endeavor of applying life history theory to variation in human psychology and behavior. Contrary to theoretical expectation, environmental quality measures were not associated with the proposed components of a life history strategy, including sociosexuality, aggression, and risk taking. Further, the current study highlighted that the proposed life history strategy components are not unidimensional measures that necessarily associate with each other. The results of this study cast doubt and suggest reconsideration of the current life history theorizing examined here.

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## APPENDIX A – Phase I Interview Schedule

### **Open-Ended Interview Questions**

1. What are some of your long-term goals?
2. What do you see as barriers or potential problems in achieving these goals?
3. What do you see as resources, both material and social, helping you to achieve these goals?
4. What are some of your short term goals?
5. What do you see as barriers or potential problems in achieving these goals?
6. What do you see as resources, both material and social, helping you to achieve these goals?

## APPENDIX B – Phase II Interview Schedule

### **Life Course Trajectory Interview**

#### **Early life Questions (4-point scale) (Prior to age 12)**

For these fifteen questions, please reflect back prior to age twelve in your life, and provide an answer to each question from four options, including “strongly agree”, “slightly agree”, “slightly disagree”, and “strongly disagree”.

1. I had bad experiences in school, such as with teachers, students, and counselors.
2. I had fights, conflicts, or tensions with family members and friends.
3. I suffered major loss in the form of a serious illness, accident, or death of a family member or friend.
4. I had close friends.
5. I felt like my family had community connections and support.
6. I felt healthy and fit.
7. I felt like my family had adequate money and finances.
8. I felt like I experienced strong family support and family time.
9. I was able to partake in expensive sports or hobbies, such as athletics, music, or hunting.
10. My family had a nice home entertainment system, such as a big screen TV or surround sound.
11. I felt like I wore nice clothes, such as name brand items.
12. My family would go on vacations and travel.
13. In the area I grew up in, there was a lack of jobs and lack of educational opportunities and resources.

14. My family had recreational vehicles, such as four-wheelers, boats, or jet-skis.
15. My family had a nice house, for example having a large yard, a large deck, or a pool.

### **Current life Questions (4-point scale)**

For these fifteen questions, please reflect on your present circumstances, and provide an answer to each question from four options, including “strongly agree”, “slightly agree”, “slightly disagree”, and “strongly disagree”.

1. My friends are supportive of me.
2. I feel that there are obstacles in the way of me completing my schoolwork.
3. I'm stressed about everything I have to do right now.
4. I engage in behavior that has the potential to jeopardize what I want to accomplish in life.
5. My priorities are where they should be.
6. I worry about having enough money.
7. My family and relatives are supportive of me.
8. I worry about being competitive in the current job market.
9. I have the necessary knowledge and experience to have a solid start on my career path.
10. I am satisfied with my current level of career networking.
11. I have a good relationship with my professors.
12. I use school resources such as tutors and counselors as much as I need to.
13. I have good advisors and mentors.
14. I feel good about my health currently and for the foreseeable future.
15. I am happy with my current school performance.
16. I currently struggle to go out and meet people.

## APPENDIX C – Phase II Questionnaire

### Life History Strategy Questionnaire

I will now give you this questionnaire to complete on your own.

#### Section 1 (Demographic and Other General Questions)

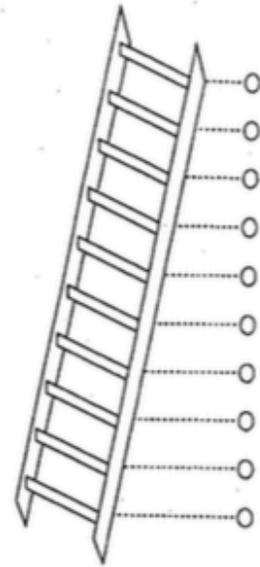
1. Please indicate your age \_\_\_\_\_
2. Please indicate which ethnic group or groups you identify with (such as European-American, African-American, Chinese-American, etc.) \_\_\_\_\_
3. What is your relationship status? (Please circle one)
  - Single
  - Married
  - Partnered (not cohabiting)
  - Living with partner
  - Other
4. What is your parenthood status? (Please circle one)
  - No children
  - Expecting a child
  - One child
  - More than one child
5. What is your mother's level of education? (Please circle one)
  - Less than high school completed
  - High school completed or GED or other equivalent
  - Some college
  - Two year college degree or associates
  - Four year college degree or bachelors
  - Post graduate degree
6. What is your father's level of education? (Please circle one)
  - Less than high school completed

- High school completed or GED or other equivalent
- Some college
- Two year college degree or associates
- Four year college degree or bachelors
- Post graduate degree

1a. Imagine that this ladder pictures how American society is set up.

- ◆ At the top of the ladder are the people who are the best off--they have the most money, the highest amount of schooling, and the jobs that bring the most respect.
- ◆ At the bottom are people who are the worst off--they have the least money, little or no education, no job or jobs that no one wants or respects.

Now think about your family. Please tell us where you think your family would be on this ladder. **Fill in the circle that best represents where your family would be on this ladder.**



7. Please indicate your expected lifespan from the options provided (circle one)

30      40      50      60      70      80      90      100      Over-100

8. Please rate your sleep quality from the previous night on a scale from 1-5, where 1=*very poor* and 5=*very good* \_\_\_\_\_

9. Please rate your stress level today on a scale from 1-5, where 1=*not stressful* and 5=*very stressful* \_\_\_\_\_

**Section 2 (For questions 1-20, please indicate on a scale of one to seven how much you agree with each statement, where 1=*strongly disagree*, 4=*not sure*, and 7=*strongly agree*)**

1. I can easily imagine myself being comfortable and enjoying “casual” sex with different partners.
2. I can imagine myself enjoying a brief sexual encounter with someone I find very attractive.
3. I could easily imagine myself enjoying one night of sex with someone I would never see again.
4. Sex without love is OK.
5. I could enjoy sex with someone I find highly desirable even if that person does not have long-term potential.
6. I would consider having sex with a stranger if I could be assured that it was safe and he/she was attractive to me.
7. I would never consider having a brief sexual relationship with someone.
8. Sometimes I would rather have sex with someone I did not care about.
9. I believe in taking sexual opportunities when I find them.
10. I would have to be closely attached to someone (both emotionally and psychologically) before I could feel comfortable and fully enjoy having sex with him or her.
11. I am interested in maintaining a long-term romantic relationship with someone special.
12. I hope to have a romantic relationship that lasts the rest of my life.
13. I would like to have a romantic relationship that lasts forever.
14. Long-term romantic relationships are not for me.
15. Finding a long-term romantic partner is not important to me.
16. I can easily see myself engaging in a long-term romantic relationship with someone special.
17. I cannot imagine spending the rest of my life with one sex partner.

18. I can see myself settling down romantically with one special person.
19. If I never settled down with one romantic partner, that would be OK.
20. I would like to have at least one long-term committed relationship during my lifetime.
21. How often do you fantasize about having sex with someone other than your current dating partner? (scale of 1-7, where 1=never, 4=not sure or not applicable, 7=a lot)
22. During your entire life, with how many partners of the opposite sex have you had sexual intercourse?
23. With how many partners of the opposite sex have you had sexual intercourse within the past year?
24. With how many partners of the opposite sex have you had sex on one and only one occasion?
25. With how many partners of the opposite sex do you foresee having sexual intercourse during the next 5 years?

**Section 3 (Please rate on a scale of 1-5 how characteristic these items are of you, where 1=*extremely uncharacteristic of me*, and 5=*extremely characteristic of me*)**

1. Once in a while I can't control the urge to strike another person.
2. Given enough provocation, I may hit another person.
3. If somebody hits me, I hit back.
4. I get into fights a little more than the average person.
5. If I have to resort to violence to protect my rights, I will.
6. There are people who pushed me so far that we came to blows.
7. I can think of no good reason for ever hitting a person.
8. I have threatened people I know.
9. I have become so mad that I have broken things.
10. I tell my friends openly when I disagree with them.
11. I often find myself disagreeing with people.

12. When people annoy me, I may tell them what I think of them.
13. I can't help getting into arguments when people disagree with me.
14. My friends say that I'm somewhat argumentative.
15. I flare up quickly but get over it quickly.
16. When frustrated, I let my irritation show.
17. I sometimes feel like a powder keg ready to explode.
18. I am an even-tempered person.
19. Some of my friends think I'm a hothead.
20. Sometimes I fly off the handle for no good reason.
21. I have trouble controlling my temper.
22. I am sometimes eaten up with jealousy.
23. At times I feel I have gotten a raw deal out of life.
24. Other people always seem to get the breaks.
25. I wonder why sometimes I feel so bitter about things.
26. I know that "friends" talk about me behind my back.
27. I am suspicious of overly friendly strangers.
28. I sometimes feel that people are laughing at me behind my back.
29. When people are especially nice, I wonder what they want.

**Section 4 (For each of the following statements, please indicate your likelihood of engaging in each activity or behavior on a scale of 1-5, where 1=*very unlikely*, 3=*not sure*, 5=*very likely*)**

1. Admitting that your tastes are different from those of your friends.
2. Going camping in the wilderness, beyond the civilization of a campground.
3. Betting a day's income at the horse races.
4. Buying an illegal drug for your own use.

5. Cheating on an exam.
6. Chasing a tornado or hurricane by car to take dramatic photos.
7. Investing 10% of your annual income in a moderate growth mutual fund.
8. Consuming five or more servings of alcohol in a single evening.
9. Cheating by a significant amount on your income tax return.
10. Disagreeing with your father on a major issue.
11. Betting a day's income at a high stake poker game.
12. Having an affair with a married man or woman.
13. Forging somebody's signature.
14. Passing off somebody else's work as your own.
15. Going on a vacation in a third-world country without prearranged travel and hotel accommodations.
16. Arguing with a friend about an issue on which he or she has a very different opinion.
17. Going down a ski run that is beyond your ability or closed.
18. Investing 5% of your annual income in a very speculative stock.
19. Approaching your boss to ask for a raise.
20. Illegally copying a piece of software.
21. Going whitewater rafting during rapid water flows in the spring.
22. Betting a day's income on the outcome of a sporting event (e.g. baseball, soccer, or football).
23. Telling a friend if his or her significant other has made a pass at you.
24. Investing 5% of your annual income in a conservative stock.
25. Shoplifting a small item (e.g. a lipstick or a pen).
26. Wearing provocative or unconventional clothes on occasion.
27. Engaging in unprotected sex.

28. Stealing an additional TV cable connection off the one you pay for.
29. Not wearing a seatbelt when being a passenger in the front seat.
30. Investing 10% of your annual income in government bonds (treasury bills).
31. Periodically engaging in a dangerous sport (e.g. mountain climbing or sky diving).
32. Not wearing a helmet when riding a motorcycle.
33. Gambling a week's income at a casino.
34. Taking a job that you enjoy over one that is prestigious but less enjoyable.
35. Defending an unpopular issue that you believe in at a social occasion.
36. Exposing yourself to the sun without using sunscreen.
37. Trying out bungee jumping at least once.
38. Piloting your own small plane, if you could.
39. Walking home alone at night in a somewhat unsafe area of town.
40. Regularly eating high cholesterol foods.

## APPENDIX D – IRB Approval Letters

See next three pages for original IRB approval, IRB approval for the interview schedule created based on Phase I results, and IRB approval for recruitment from the Psychology Subject Pool.

May 31, 2016

Jacob Aronoff  
Department of Anthropology  
The University of Alabama  
Box 870210

Re: IRB # 16-OR-207-ME: "The Influence of Sociocultural Environmental Quality on Life History Strategies, Testosterone, and Cortisol"

Dear Mr. Aronoff,

The University of Alabama Institutional Review Board has granted approval for your proposed research. Your application has been given expedited approval according to 45 CFR part 46. Approval has been given under expedited review categories 3 and 7 as outlined below:

- (3) Prospective collection of biological specimens for research purposes by noninvasive means; and*
- (7) Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.*

**Your approval will expire on May 30, 2017.** If the study continues beyond that date, you must complete and submit the Renewal Form within e-Protocol. If you modify the application, please submit the Revision Form. Changes in this study cannot be initiated without IRB approval, except when necessary to eliminate apparent immediate hazards to participants. When the study closes, please complete the Final Report Form. Please use the IRB-approved (stamped) consent forms.

Should you need to submit any further correspondence regarding this application, please include the assigned IRB approval number.

Good luck with your research.

Sincerely,

Carpaneto J. Myies, MSW, CIM, CIP  
Director & Research Compliance Officer  
Office for Research Compliance

cc: Dr. Jason DeCaro

ALABAMA

Research  
Institutional Review Board for the Protection of Human Subjects

June 27, 2016

Jacob Aronoff  
Department of Anthropology  
College of Arts & Sciences  
The University of Alabama  
Box 870210

Re: IRB # 16-OR-207-ME (Revision) "The Influence of Sociocultural Environmental Quality on Life History Strategies, Testosterone, and Cortisol"

Dear Mr. Aronoff:

The University of Alabama Institutional Review Board has reviewed the revision to your previously approved expedited protocol. The board has approved the change in your protocol.

Please remember that your approval period expires one year from the date of your original approval, May 31, 2016, not the date of this revision approval.

Should you need to submit any further correspondence regarding this proposal, please include the assigned IRB application number. Changes in this study cannot be initiated without IRB approval, except when necessary to eliminate apparent immediate hazards to participants.

Good luck with your research.

Sincerely,

Carpantato T. Myles, MSM, CIM, CIP  
Director & Research Compliance Officer  
Office for Research Compliance

UNIVERSITY OF ALABAMA INSTITUTIONAL REVIEW BOARD  
205-886-6300 | 100-205-1000000



Office of the Vice President for  
**Research & Economic Development**  
Office for Research Compliance

October 26, 2016

Jacob Aronoff  
Department of Anthropology  
College of Arts & Sciences  
The University of Alabama  
Box 870210

Re: IRB # 16-OR-207-ME (Revision # 2) "The Influence of Sociocultural Environmental Quality on Life History Strategies, Testosterone, and Cortisol"

Dear Mr. Aronoff:

The University of Alabama Institutional Review Board has reviewed the revision to your previously approved expedited protocol. The board has approved the change in your protocol.

Please remember that your approval period expires one year from the date of your original approval, May 31, 2016, not the date of this revision approval.

Should you need to submit any further correspondence regarding this proposal, please include the assigned IRB application number. Changes in this study cannot be initiated without IRB approval, except when necessary to eliminate apparent immediate hazards to participants.

Good luck with your research.

Sincerely,

Carpantano I. Myies, MSW, CHM, CIP  
Director & Research Compliance Officer  
Office for Research Compliance

358 Rose Administration Building | Box 870127 | Tuscaloosa, AL 35487-0127  
205-348-8461 | Fax 205-348-7189 | Toll Free 1-877-820-3066