Life History and Race Differences in Puberty Length: A Test of Differential-K Theory

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Life history speed has been argued to differ across the three main races, with Sub-Saharan Africans adopting the fastest (most *r*) strategy, Northeast Asians adopting the slowest (most *K*) strategy and Caucasians being intermediate, but closer to Northeast Asians (Rushton, 1995). Differential-*K* theory would predict that puberty begins earlier in the more *r*-strategy groups. Here, we extend this hypothesis to the length of puberty rather than its onset. Examining previously published data, we find that puberty is shortest amongst Caucasians and longest amongst Sub-Saharan Africans, and argue that this pattern is consistent with Differential-*K* theory.

Key Words: Puberty, Race, Group Differences, Differential K Theory

Life history (LH) theory is a mid-level evolutionary account of differences in evolved reproductive strategies (Wilson, 1975). LH theory categorizes species along a continuum ranging from fast (*r*) to slow (*K*). A "fast" LH strategy is characterized by having large numbers of offspring, but providing relatively little parental care. It tends to be observed in unstable ecologies in which it is beneficial to produce many offspring in order to ensure that at least some survive the unpredictable dangers, such as pathogens and predators, which lead to high mortality rates. Fast LH organisms live life quickly and die young (Ellis et al., 2009). "Slow" LH strategists have smaller numbers of offspring, but provide relatively high levels of parental care. They also tend to mature more slowly and live longer than fast LH strategists. A slow LH strategy tends to be observed in more stable ecologies. Due to this stability, the environment's maximum carrying capacity for the species is reached and its members begin to compete with each other. They do this by investing less bio-energetic resources into reproduction and more of these resources into the competitive advantage of their offspring.

Although LH theory was initially developed to account for differences in reproductive "strategies" between species, there is a body of evidence that indicates differences *within* species (Figueredo et al., 2006). Rushton (1995) proposed Differential *K* theory as a theoretical framework to organize and explain a large number of empirical findings, and tested it with data from the three largest human races, for which sufficient data were available at that time. Race refers to human sub-populations evolved to different ecologies, distinguished in physical appearance and hence also in terms of gene frequencies (for a more detailed discussion, see Lynn, 2006). He found that Northeast Asians were the most *K*-evolved and Sub-Saharan Africans were the least *K*-evolved on numerous markers including twinning, length of gestation, motor development, dental development and age of puberty. Rushton also argued that intelligence and personality differed in tandem with speed of development, as environments that were both harsher and more predictable selected for higher intelligence and greater group cooperation, the latter reducing testosterone levels among males and making them less violently competitive in behavior and less masculine in appearance. A summary of Rushton's findings can be seen in Table 1.

Table 1. Relative ranking on a set of life history variables across three major races: Northeast Asians ("Asian"), Caucasians ("European"), and Sub-Saharan African ("African"). Adapted from Rushton, 1995, Table 1.1.

	Asian	European	African
Brain size			
Autopsy data (cm^3)	1,351	1,356	1,223
Endocrinal volume (cm^3)	1,415	1,362	1,268
External head measures (cm^3)	1,356	1,329	1,294
Cortical neurons (billions)	13.767	13.665	13.185
Intelligence			
IQ test scores	106	100	85 (USA)
Decision times	Faster	Intermediate	Slower
Cultural achievements	Higher	Higher	Lower
Maturation Rate			
Gestation time	?	Intermediate	Shorter
Skeletal development	Later	Intermediate	Earlier
Motor development	Later	Intermediate	Earlier
Dental development	Later	Intermediate	Earlier
Age of first intercourse	Later	Intermediate	Earlier
Age of first pregnancy	Later	Intermediate	Earlier
Life span	Longer	Intermediate	Shorter
Personality			
Activity level	Lower	Intermediate	Higher
Aggressiveness	Lower	Intermediate	Higher
Cautiousness	Higher	Intermediate	Lower
Dominance	Lower	Intermediate	Higher
Impulsivity	Lower	Intermediate	Higher
Self-Concept	Lower	Intermediate	Higher
Sociability	Lower	Intermediate	Higher
Social Organization			
Marital Stability	Higher	Intermediate	Lower
Law abidingness	Higher	Intermediate	Lower
Mental health	Higher	Intermediate	Lower
Administrative capacity	Higher	Higher	Lower
Reproductive Effort			
2 egg twinning (per 1000 births)	4	8	16
Hormone levels	Lower	Intermediate	Higher
Size of genitalia	Smaller	Intermediate	Larger
Secondary sexual characteristics	Smaller	Intermediate	Larger
Intercourse frequency	Lower	Intermediate	Higher
Permissive attitudes	Lower	Intermediate	Higher
Sexually transmitted diseases	Lower	Intermediate	Higher

Many studies have replicated or extended Rushton's findings by looking into a larger number of races (e.g. Lynn, 2013), while others have examined African-Caucasian-East Asian differences on *K* measures which Rushton did not employ. For example, Meisenberg and Woodley (2013) compared races based on assorted national proxies for *K*-strategy and replicated the ordering discovered by Rushton. Minkov and Bond (2015) compared race differences in genetic polymorphisms associated with *K*-strategy behavior and their findings were, likewise, as Rushton's model would predict. Although, as can be seen from Table 1, Rushton looked at race differences in

age of puberty commencement, one area of life history which Rushton did not examine was *length* of puberty. In the present study, we will therefore attempt to examine race differences in the length of puberty, drawing upon the three races that Rushton employed: Sub-Saharan African, Caucasian and Northeast Asian.

1. Method

Testing this hypothesis requires representative data on puberty length for each race. To this end, the method section contains the definition of puberty and a description of the review process and inclusion criteria.

1.1. Definition of Puberty

Puberty is a period of the life span marked by significant psychological, endocrine, and physical changes. These contribute to the metamorphosis of children into adolescents, able to reproduce. This process follows a relatively consistent order. Tanner's five stages of puberty are the accepted model by which the process of puberty is measured. These stages are distinguished for breast, genital and pubic hair development. They can be summarised as follows:

Genitals (male)

Tanner I
Prepubertal (testicular volume less than 1.5 ml; small penis of 3 cm or less).

Tanner II
Testicular volume between 1.6 and 6 ml; skin on scrotum thins, reddens and enlarges; penis length unchanged.

Tanner III
Testicular volume between 6 and 12 ml; scrotum enlarges further; penis begins to lengthen to about 6 cm.

Tanner IV
Testicular volume between 12 and 20 ml; scrotum enlarges further and darkens; penis increases in length and circumference.

Tanner V
Testicular volume greater than 20 ml; adult scrotum and fully grown penis.

Breasts (female)

Tanner I
No glandular tissue: areola follows the skin contours of the chest (prepubertal).

Tanner II
Breast bud forms, with small area of surrounding glandular tissue; areola begins to widen.

Tanner III
Breast begins to become more elevated, and extends beyond the borders of the areola, which continues to widen but remains in contour with surrounding breast.

Tanner IV
Increased breast size and elevation; areola and papilla form a secondary mound projecting from the contour of the surrounding breast.

Tanner V
Breast reaches final adult size; areola returns to contour of the surrounding breast, with a projecting central papilla.

Pubic hair (both male and female)

Tanner I
No pubic hair at all (prepubertal state).

Tanner II
Small amount of long, downy hair with slight pigmentation at the base of the penis and scrotum (males) or on the labia majora (females).

Tanner III
Hair becomes more coarse and curly, and begins to extend laterally.

Tanner IV
Adult-like hair quality, extending across pubis but sparing medial thighs. (Menstruation occurs at Tanner stage IV.)

Tanner V
Hair extends to medial surface of the thighs (Marshall and Tanner, 1969, 1970).

The age at which the process of puberty begins differs systematically between races. It can also be affected by environment, with a highly stressful childhood leading to earlier onset of puberty (Penke, 2009). Childhood father absence has been shown to lead to an earlier onset of menarche in girls (Webster et al., 2014) as has 'early maternal harshness' (Belsky et al., 2010), and disordered parental behaviour (Tither & Ellis, 2008). However, age of pubertal milestones is highly heritable among individuals. For example, a twin study in India (54 identical pairs, 68 non-identical pairs) found that age of menarche was 0.66 heritable (Jahanfar et al., 2013). A Finnish study of 1891 twin pairs also found that genetics explained over half the variation in age at pubertal development (Mustanski et al., 2004). Also, a genomic study has found a strong genetic basis for age at menarche (Perry et al., 2014). Rushton (1995) found, drawing upon USA data controlling for SES, that on average, Northeast Asian boys are 14 years old when they experience rapid external genital development and start to become sexually interested, while the corresponding figures for Caucasian and African American boys are 12.5 and 11.0. Rushton also noted that African American boys are sexually active (a proxy for development) at 14.4, Caucasians at 15, and Northeast Asians at 16.4, and that all these differences were statistically significant. However, these data do not allow us to compare the speed with which different races move through the Tanner stages.

1.2. Literature Review

We conducted a systematic literature review, using PubMed, Google Scholar and Google Book. We employed keywords: 'menarche,' 'Tanner,' 'Tanner stage (s),' 'puberty,' 'pubic,' 'breasts,' 'pubic hair,' 'race,' 'ethnicity,' 'ethnic,' 'testic(le/ular),' 'menses,' 'menstruation,' 'African American,' 'Asian,' 'East Asian,' 'Chinese,' 'Japanese,' 'white,' 'black,' 'Caucasian,' 'adrenarche,' 'thelarche,' 'pubarche' and 'penis growth.' We augmented this by following up seemingly relevant literature in literature reviews and cited in papers that were found through this method. Our inclusion criteria was that the study compared at least two of the races (out of Sub-Saharan African, European and East Asian) within one country and that it provided information allowing us to compare ages for at least two Tanner stages. As we found the assorted studies, we could then only draw upon those which allowed us to compare exactly the same stages on exactly the same measure of a stage (e.g. pubic hair development). Unfortunately, there were no such studies — controlling for country and comparing different races — available for Northeast Asians. The nature of the available studies meant that we had to examine the length of stages II to IV in girls and II to V in boys. Thus, the female studies measure the period from the beginning of puberty (either start of breast development or pubic hair) up to menstruation.

2. Results

A meta-analysis of our results can be seen in Tables 2 and 3.

Table 2. Race differences in male puberty length. N, sample size; g, genital; p, pubic hair.

Study	*Race*	*N*	*Stage II Age*	*Stage V Age*	*Length of Puberty*
Herman-Giddens et al. (2012)	African American	*1062*	9.14 g 10.25 p	15.51 g 15.72 p	6.37 g 5.47 p
Herman-Giddens et al. (2001)	African American	*797*	9.5 g 11.2 p	14.9 g 15.8 p	5.4 g 3.5 p
Susman et al. (2012)	African American	*63*	9.6 g 10.5 p	14.3 g 14.5 p	4.7 g 4.0 p
Unweighted average	**African American**	***1922***	**9.4 g 10.65 p**	**14.9 g 15.34 p**	**5.5 g 4.69 p**
Weighted average	**African American**	***1922***	**9.29 g 10.26 p**	**15.09 g 15.58 p**	**5.8 g 5.32 p**
Herman-Giddens et al. (2012)	European American	*2070*	10.14 g 11.47 p	15.57 g 15.83 p	5.43 g 4.36 p
Herman-Giddens et al. (2001)	European American	*536*	10.1 g 12.0 p	15.9 g 15.7 p	5.8 g 3.7 p
Susman et al. (2010)	European American	*364*	10.4 g 11.5 p	14.9 g 15.1 p	4.5 g 3.6 p
Unweighted average	**European American**	***2970***	**10.21 g 11.65 p**	**15.45 g 15.54 p**	**5.24 g 3.89 p**
Weighted average	**European American**	***2970***	**10.16 g 11.55 p**	**15.53 g 15.70 p**	**5.37 g 4.15 p**

Table 3. Race differences in female puberty length. N, sample size; b, breast; p, pubic hair; m, menstruation.

Study	*Race*	*N*	*Stage II Age*	*Stage IV Age*	*Stage V Age*	*Length of Puberty*
Herman-Giddens et al. (1997)	African American	*1639*	8.87 b 8.78 p	12.16 m		3.29 b 3.38 p
Wu et al. (2002)	African American	*419*	9.5 b 9.5 p	12.1 m		2.6 b 2.6 p
Susman et al. (2010)	African American	*59*	9.1 b 9.5 p	12.0 b 11.9 p	13.5 b 13.5 p	2.9 b 2.4 p
Unweighted average	**African American**	***2117***	**9.15 b 9.26 p**	**12.3 b 12.2 p**		**2.93 b 2.94 p**
Weighted average	**African American**	***2117***	**8.97 b 8.94 p**	**12.11 b 12.12 p**		**3.14 b 3.18 p**
Herman-Giddens et al. (1997)	European American	*15,438*	9.96 b 10.51 p	12.88 m		2.92 b 2.37 p
Wu et al. (2002)	European American	*330*	10.3 b 10.5 p	12.7 m		2.4 b 2.2 p
Susman et al. (2010)	European American	*373*	9.9 b 10.3 p	12.8 b 12.8 p		2.90 b 2.5 p
Unweighted average	**European**	***16,141***	**10.12 b**	**12.79 b**		**2.67 b**

	American		**10.4 p**			**2.39 p**
Weighted average	**European** **American**	***16,141***	**9.95 b** **10.49 p**	**12.85 b**		**2.90 b** **2.36 p**

One problem with these female data is that one of the studies (Susman et al., 2010) does not provide us with an age of first menses, but only with a level of pubic hair and breast development which is likely to approximately correspond with this. It can be seen that using this measure, there is no statistically significant difference between the two races. However, there is such a difference in the other two studies where the comparison is exactly the same. Employing only those studies leads to an African American average puberty length of 2.95 years and a European American one of 2.66 years (unweighted). As weighted values these are 3.152 (African American) and 2.91 (European). Susman et al. (2010) and Herman-Giddens et al. (2001, 2012) obtained their results by longitudinal clinical assessment of patients whereas Wu et al. (2002) is survey based, and so less reliable. However, as can be seen, its results are in the same direction as the more reliable study. African Americans are, on average, around 75-90% genetically Sub-Saharan African (Levin, 2005, p.20). Therefore it is reasonable to assess them as Sub-Saharan African.

We also found a study comparing Caucasian British and Bangladeshi British girls on age of adrenarche (release of adrenal androgens), thelarche (Tanner II), pubarche (Tanner II) and menarche (Tanner IV) girls (Houghton et al., 2014). No significant differences were found based on a sample of 54 Caucasians and 174 Bangladeshis when controlling for environmental variables, but this might be expected from the fact that Bangladeshis and Europeans are both 'Caucasian', and are therefore predicted to exhibit only small differences that are unlikely to show up in such a small sample. In addition, this was based on interviews and so is less reliable than a longitudinal clinical assessment. Nevertheless, the average length from thelarche to menarche for British Bangladeshis was 2.9 years, whereas it was 3.9 years for British Caucasian girls

3. Discussion

It can be seen that African Americans have a shorter puberty than European Americans. These data also confirm Rushton's finding that African Americans experience both the beginning and end of puberty earlier than do European Americans, implying that African Americans follow a faster life history strategy. As discussed, Rushton (1995) applied life history theory to racial differences and found a host of support for the prediction that Sub-Saharan Africans follow a fast, *r*-strategy life history, while Northeast Asians follow a slow *K*-strategy, with Europeans intermediate. Given that Rushton's analysis found that Europeans followed a slower life history strategy than Sub-Saharan Africans, it may seem odd that Europeans should have a shorter puberty length than African Americans. We might expect all the stages of life to be slowest in Northeast Asians.

This raises the question of why Europeans should have evolved a shorter puberty length than did Sub-Saharan Africans. Puberty involves key psychological changes on the Big 5 personality traits. Soto et al. (2011) used a sample of 1,267,218, children (10-12), adolescents (13-17), emerging adults (18-25), and early adults (26-35) to look at age variation in personality. They were 70% Caucasian and 72% of them were from the USA. From late childhood into adolescence, Conscientiousness decreases by 0.3 SD. It then strongly increases from adolescence through emerging adulthood and into early adulthood by about 0.7 SD. This increase is more rapid for females than males meaning that they end up with slightly higher Conscientiousness (impulse control). Agreeableness (altruism) decreases from late childhood into adolescence and then increases up to middle age. Male and female children score about the same on Neuroticism according to Soto et al. Female Neuroticism increases into adolescence and then remains stable in emerging adulthood, declining in early adulthood. Amongst males, by contrast, Neuroticism decreases from childhood. By mid-adolescence, females score significantly higher on Neuroticism (especially the anxiety aspect) than males. Accordingly, the process of puberty involves the pubescent becoming more impulsive and less altruistic. It has been suggested that this may have benefits in terms of helping to weaken the child's bond with his parents, inclining the child to focus on finding a mate (Alacorta et al., 2012). However, more generally, a move to lower

Conscientiousness and lower Agreeableness can be regarded as a move away from a *K*-strategy. This could potentially be more problematic in a harsher, more *K*-evolved environment because cooperation and impulse control would be so important in this context, meaning that it would be useful for the process to be relatively swift. Indeed, there can be argued to be a greater pressure for cooperativeness and impulse control in K-oriented ecologies, meaning that those with a very long puberty might find themselves cast out right at the beginning of their reproductive careers. It is also possible that sexual selection could favor those who have a shorter puberty, as they will display pro-social personalities, which are more important in a K environment, for a larger percentage of their lives.

Secondly, if Europeans have the shortest puberty but otherwise adopt the slowest life history strategy, then they will combine a short puberty with the longest childhood *and* the longest adolescence or, in Soto et al.'s terms, 'emerging adulthood.' It could be argued that this is congruous with adopting the most pronounced *K*-strategy. A long childhood would provide a competitive advantage by permitting a large and complex brain sufficient time to develop as well as the development of complex social skills through play (e.g. Bjorkland, 2007). Adolescence has been argued to be a period of high creativity, brought on by the optimum combination of high intelligence (which increases up to middle age) and relatively low Agreeableness and Conscientiousness (which increase throughout the lifespan) (Alacorta et al., 2012). This would mean that those who were older would have higher Conscientiousness, rendering them too rule-following to be creative. A highly selective environment will present large numbers and a great diversity of difficult problems to be solved, meaning that the survival of a group and individuals will be aided by high levels of creativity and thus an extended period in which the population is particularly creative. In addition, individuals who are highly creative for a longer period of time may be more likely to survive, breed, and attain higher social status. This means they are more likely to be sexually selected for, as it is widely agreed that females are inclined to sexually select on the basis of creativity and social status (e.g. Buss, 1989). Indeed, research in modern societies has found that highly creative males are found particularly attractive by females (Nettle, 200

A final possibility, relating to the issue of creativity, is that a longer emerging adulthood is more useful in a highly selective environment because alternative means of producing creativity are limited, for reasons we will now explore. It has been argued that genius is a manifestation of outlier high intelligence combined with moderately low levels of Agreeableness and Conscientiousness (e.g. Eysenck, 1995 or Feist, 1998). This is an unlikely combination that is more likely to occur in a genetically diverse population, but a *K*-oriented population would be strongly evolved to its environment and thus relatively genetically homogeneous. In this regard, the African gene pool has been shown to be far more diverse than the European gene pool (Campbell & Tishkoff, 2008). Accordingly, one way to remain highly genetically homogeneous but to concomitantly be creative would be to extend the periods of life in which people develop their intelligence on the one hand and are the most creative on the other, which is achieved by shortening the puberty phase. This raises the question of why it would be beneficial to reduce creativity in 'early adulthood.' A feasible answer is that cooperation and strong pair bonding would be more necessary for survival and breeding in a highly selective environment. Cooperation and pair bonding require high Agreeableness and high Conscientiousness, which entails conformity. Thus there would need to be a trade-off between creativity and bonding/cooperation/conformity. Moreover, reducing the length of this phase in order to extend emerging adulthood would be unhelpful because it would reduce a period of time dedicated to important pair and group bonding and investment in offspring.

However, there are difficulties with these interpretations that need to be addressed: (A) Evidence that age of puberty onset predicts speed of puberty at the individual level; (B) Early puberty onset can be caused by stress.

(A) Age of and Speed of Puberty in Individuals

Apter and Vihko (1985) found, using a sample of Caucasian girls (N = 84), that those who begin puberty earlier advance more rapidly through it. Thus, the movement from Tanner stage 2 to menarche is faster among these girls than among those who reach Tanner stage 2 later. Ellis et al.

(2011) found that a stressful environment caused puberty to occur earlier and the process to be faster among children prone to stress, but there was no effect on normal children. Moreover, at the individual level, early menarche is correlated with living a less *K*-oriented life (see Mendle et al., 2007), just as it is at the group level (Rushton, 1995). However, it can be argued that it does not follow that something true at the group level will be true at the individual level. For example, the fact that religiousness is negatively associated with intelligence among individuals does not necessarily mean that the most intelligent of three social classes will be the least religious (see Dutton, 2014). Further, it is likely that both environmental and genetic factors influence the length of puberty. If the genetic diversity of the sample is decreased – by controlling for race, for example – then this may increase the relative influence of environmental factors. The single study which found that early puberty is associated with fast puberty in girls did not control for variables such as SES in examining this association. In addition, this study is contradicted by a number of other studies. Llop-Vinolas et al. (2004) found that girls who entered puberty earlier reached menarche significantly later than other girls. Marceau et al. (2011), based on large samples (364 young male and 373 female Caucasians), found that pubertal timing and tempo (speed of the process and length of time between different Tanner stages) were negatively associated (faster progression of puberty if begun younger) in boys but not in girls, for whom there was no significant relationship. Li et al. (2009) found no association between timing and tempo in Chinese girls, their stated aim being to 'investigate the pattern of pubertal development in healthy Cantonese schoolgirls.'

(B) Speed of Puberty and Stress

It might also be argued that experiencing the process of puberty rapidly could invoke greater stress in the pubescent child than experiencing it more gradually (Mendle et al., 2007), and that this could be highly problematic in a harsh ecology. Stress can, for example, lead to physical illness and interfere with rational thought. However, this argument can be countered in two ways. Firstly, it may be objected that, at the group level, this stress may be offset by the benefits of the puberty process occurring more rapidly. These benefits would be the efficiency of a high-energy consumption phase occurring quickly and a phase of relative *r*-behaviour being as fast as possible. Secondly, the actual findings in relation to the proposition that fast puberty causes stress are inconsistent. For example, Ge et al. (2003) reported that African American boys who progressed through puberty faster showed an increase in depressive symptoms later in adolescence. Others have found that faster puberty predicted slower decreases in depressive symptoms for boys, but that this was unrelated to depressive symptoms in girls (Mendle et al., 2010). Laitinen-Krispijn et al. (1999) found that faster pubertal development protected against depressive symptoms in boys.

Future research could usefully extend these findings by establishing the extent of differences in puberty length when comparing races that are more closely related, such as Caucasians and South Asians or Northeast Asians and Southeast Asians, as well as smaller races that are distantly related such as Caucasians and Australian Aboriginals. It would, of course, be very useful to obtain data on pubertal tempo among Northeast Asian children in the USA so that these could be compared to that which we already have. In addition, it would be helpful to establish more clearly the relationship between pubertal speed and stress and pubertal speed and pubertal timing in individuals.

Acknowledgements

We would like to thank Prof. A. J. Figueredo, Dr. Gerhard Meisenberg, Prof. Helmuth Nyborg, Dr. Jan te Nijenhuis and Dr. Dimitri van der Linden for their assistance.

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