Evolutionary Psychology

www.epjournal.net – 2014. 12(1): 200-222

Original Article

Psychometrics and Life History Strategy: The Structure and Validity of the High K Strategy Scale

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Abstract: In this paper, we critically review the conceptualization and implementation of psychological measures of life history strategy associated with Differential K theory. The High K Strategy Scale (HKSS: Giosan, 2006) was distributed to a large British sample (n = 809) with the aim of assessing its factor structure and construct validity in relation to theoretically relevant life history variables: age of puberty, age of first sexual encounter, and number of sexual partners. Exploratory and confirmatory factor analyses indicated that the HKSS in its current form did not show an adequate statistical fit to the data. Modifications to improve fit indicated four correlated factors (personal capital, environmental stability, environmental security, and social capital). Later puberty in women was positively associated with measures of the environment and personal capital. Among men, contrary to Differential K predictions but in line with female mate preferences, earlier sexual debut and more sexual partners were positively associated with more favorable environments and higher personal and social capital. We raise concerns about the use of psychometric indicators of lifestyle and personality as proxies for life history strategy when they have not been validated against objective measures derived from contemporary life history theory and when their status as causes, mediators, or correlates has not been investigated.

Keywords: K-Strategy, life history, puberty, sex differences, psychometric analysis

Introduction

Life history theory (LHT) is an explanatory framework grounded in the evolutionary sciences, describing how and why variation in phenotypes emerges between

species and how phenotypic variation translates into variation in fitness (Stearns, 1992). Phenotypic variation, however, is constrained, principally by trade-offs between traits (Roff, 1992). Organisms within an ecological niche invest finite resources in various traits to optimize fitness returns (thus promoting genetic survival in future generations). Investment in one trait can entail costs for another trait. There are many trade-offs during the developmental lifespan of an organism, the most important arguably being the developmental switch from growth to reproduction (Charnov, 1993; Stearns, 1992), which Schaffer (1983) calls the General Life History problem. Organisms can invest in somatic effort and delay reproduction (favoring growth and health at the expense of a shorter reproductive career) or the reverse (favoring early, rapid reproduction at the expense of offspring health and quality).

Life history theory and evolutionary psychology

Although LHT originally examined variation across species, it has been applied to variation within species by behavioral ecologists and to variation within human traits by human behavioral ecologists and evolutionary psychologists. Rushton (1985), inspired by earlier work by Pianka (1970), attempted to map key human life history traits across what was originally termed the r/K continuum, which posits that species exist along a continuum of fast to slow development. A species towards the r side of the spectrum develops very quickly, matures early, reproduces quickly, and produces as many offspring as possible due to low levels of competition for resources. In species where population density is high and resources are limited, development slows and investment moves toward ensuring a small number of offspring survive to reproduce. More resources are invested in fewer offspring to increase their competitive advantage in securing resources for future survival. *Homo sapiens*, under this classification, are considered to be a K-selected species, with slow development, long gestation periods, and relatively small numbers of offspring.

The r/K continuum initially received a great deal of interest, but contemporary life history theorists now reject this concept (Stearns, 1992). Initial theory was based on density-dependent habitats that, when modeled, failed to predict life history strategies in almost 50% of species. More recent research highlights instead the importance of local age-specific mortality rates in relation to density in ecological conditions (Charlesworth, 1980; Charnov and Berrigan, 1990; Promislow and Harvey, 1990; Stearns, 1992), with age specific models being generally more accurate in mapping strategies in artificial selection experiments (Barclay and Gregor, 1981; Luckinbill, 1979; Taylor and Condra, 1980).

Although the r/K dimension is no longer accepted in its entirety, the existence of heritable clusters of morphological and behavioral traits persists in evolutionary psychology. This idea has been prominently expressed in Rushton's (1985) Differential K theory, which proposes individual (and racial) differences in psychological traits associated with an individual's position on the K spectrum. The last two decades has seen multiple attempts to examine these differences psychometrically (Bogeart and Rushton, 1989; Figueredo, Cabeza de Baca, and Woodley, 2013).

Evidence of this hypothesized behavioral clustering in humans has begun to emerge through such studies. Figueredo, Vasquez, Brumbach, and Schneider (2004) identified traits believed to be associated with life history strategy that load onto a single "K-Factor,"

including attachment (childhood and adult), mating effort, Machiavellianism, and risk propensity. In a large American sample, Figueredo, Vasquez, Brumbach, and Schneider (2007) found a similar latent construct composed of 20 measures such as family relationships, altruism, kin support, religiosity, and financial status. Furthermore, this construct loaded onto a single higher order factor together with latent variables of personality (built from measures of agreeableness, conscientiousness, openness, extraversion, and neuroticism) and general health ("covitality" measured with indicators of psychological and physical wellbeing). This higher-order factor, called the "Super-K," was taken as evidence that life history strategies represent a coordinated range of physical, cognitive, and behavioral traits that coexist throughout the lifespan. Research suggests that the K-Factor may also be heritable (Figueredo et al., 2004).

Research has continued with the development of scales that purport to measure life history traits. The two most prominent measures are the Arizona Life History Battery (ALHB: Figueredo et al., 2004) and its shorter equivalent, the Mini-K scale (Figueredo et al., 2006). These measures are reported to be related to a number of variables that are arguably associated, positively or negatively, with a K lifestyle, including aggression, anti-sociality, sociosexuality, religiosity, the Dark Triad (a clustering of three personality facets: psychopathy, narcissism and Machiavellianism), relationship satisfaction, and the use of sexual coercion (Figueredo et al., 2013; Gladden, Sisco, and Figeuredo, 2008; Gladden, Welch, Figueredo, and Jacobs, 2009; Jonason, Koenig, and Tost, 2010; McDonald, Donnellan, and Navarrete, 2012; Olderbak and Figueredo, 2010).

An alternative measure of life history strategy is the High-K Strategy Scale (HKSS: Giosan, 2006). Whereas the ALHB and Mini-K focus on behavioral and cognitive aspects of life history, the HKSS was originally intended to focus on fitness, "largely referred to as overall adaptedness" (Giosan, 2006, pp. 394): the qualities and traits that enhance reproductive potential and promote lineage continuation in an organism. This scale has received less attention in the empirical literature, with only 12 published studies to date. The present study sought to evaluate the HKSS in terms of its theoretical suitability in relation to assessing life history strategy.

The structure of the HKSS

The HKSS was designed to assess facets of social life that reflect the adoption of an underlying High-K strategy. Giosan (2006) constructed an initial 26-item scale focusing on four domains: (1) health and attractiveness, (2) upward mobility, (3) social capital and extended family, and (4) consideration of risks. These domains were selected because K strategists are expected to demonstrate a proclivity to invest in somatic effort (translating into better health and longevity), achieve greater degrees of upward mobility and access to superior opportunities (enhancing offspring competitiveness), foster strong kin networks (increasing fitness returns from their own offspring and those of relatives), and channel resources toward the avoidance of risks (positively affecting fitness). The 26 items were selected on the basis of face validity. Internal consistency of the scale appears high, with studies typically reporting alpha values between .81 and .94 (Dunkel, 2012; Dunkel and Decker, 2010).

However, there is a lack of information on the underlying factor structure. We do

not currently know whether these four domains have been accurately measured, or whether the domains are (1) related to each other and (2) load onto a single latent factor akin to a K-Factor. Dunkel, Mathes, and Harbke (2011) reported that the total scores from the HKSS and the Mini-K load onto one latent Life History factor, which accounted for 53% of the variance. However, because the HKSS was part of a larger model constructed from scale totals rather than individual items, no information regarding the internal structure of the HKSS exists.

HKSS and construct validity

Giosan (2006) reported that scores on the HKSS were significantly and positively related to higher perceived offspring quality, fewer medical problems, better education, more social support, and fewer previous marriages. Surprisingly, High-K scores correlated positively and significantly (albeit, weakly) with number of offspring, contrary to predictions from Differential K theory (K-selection should favor quality, not quantity). Giosan and Wyka (2009) also reported that High-K scores were negatively related to instances of psychopathology, anger expression, and sleep disturbance, and positively with likelihood of marriage. Research using the HKSS has also reported significant positive correlations with estimated life expectancy, future time perspective, long term mating orientation, and the general factor of personality (Dunkel and Decker, 2010; Dunkel, Kim, and Papini, 2011). Furthermore, the HKSS appears to be positively and moderately correlated (as highly as $r = .67$) with the Mini-K, another measure of life history (Abed et al., 2012; Dunkel and Decker, 2010; Dunkel et al., 2011, 2012; Gladden et al., 2009; Olderbak, Gladden, Wolf and Figueredo, 2014).

HKSS and sampling issues

Sampling in relation to HKSS research is a concern. Of the 12 published studies that use the HKSS, only one appears to have used a general population from the United States (Dunkel et al., 2011). The majority used college samples (Abed et al., 2012; Dunkel and Decker, 2010; Dunkel et al., 2012; Gladden et al., 2009; McDonald et al., 2012; Olderbak et al., 2014), whereas others used specific samples (such as disaster workers or utility company employees: Giosan, 2006; Giosan, 2013; Giosan and Wyka, 2009). The utility of this scale as a measure of life history strategy is difficult to determine without a large and representative sample of the general population. Samples used in recent works are almost exclusively from the US, and so cross cultural validity is lacking. This concern about sampling is also true of other research using psychometric indicators of life history strategy. A more general critique of psychometric indicators of strategy follows.

General issues with psychometric life history indicators

In addition to issues specific to the HKSS, there are more general concerns regarding psychometric life history measures that warrant consideration. Firstly, sex differences are rarely considered. Although Dunkel (2012) and McDonald et al. (2012) report sex differences on the HKSS, with women scoring higher than men, these effects have not been examined outside of the US. Furthermore, a considerable body of research has identified sex differences predicted by evolutionary theory and has outlined sex-

specific developmental trajectories (Bailey, Gaulin, Agyei, and Gladue, 1994; Del Giudice, 2009; Del Giudice and Belsky, 2010). Differences in behavior between the sexes are explicable in terms of differential investment in parenting versus mating activity (Bateman, 1948; Campbell, 1999; Daly and Wilson, 1983; Trivers 1972). Measures that assume a single aggregate fitness continuum common to both sexes, such as the HKSS and the Mini-K, are therefore unlikely to be useful if the often competing goals and strategies of men and women are ignored (Muncer, 2013).

LHT originally examined objective, biological events across species (e.g., growth rate, offspring number, body sizes; see Pianka, 1970 for examples). Recent examinations of K-strategies in humans use inventories focusing mainly on personality and attitudes (e.g., impulsivity, altruism, attitudes toward relationships, Machiavellianism, and planning). The General Personality Factor, for example, is a single factor derived from the Big Five traits that is argued to represent a K-adapted personality constellation (Rushton and Irwing, 2008), and the theoretical existence of such a higher order concept was one of the driving factors in Differential K research (Rushton, 1985). Inventories such as the Mini-K, ALHB, and HKSS focus on factors consistent with a hypothesized "K-oriented" lifestyle (e.g., religiosity, wellbeing, social support, and community engagement). It is difficult to establish how well these personality and lifestyle variables independently measure an individual's strategy without first validating them against objective life history events. Measures of current wellbeing, integration into the community, and perceived neighborhood safety tell us little about how they would contingently translate into fitness returns. If the HKSS, ALHB, or Mini-K are adequate reflections of an individual's strategy, high scores should correlate with critical developmental events such as a later pubertal onset, delayed sexual onset, and fewer lifetime sexual partners. Yet these crucial variables are rarely tested in relation to psychometric life history indicators. Considering that these indicators of strategy form some of the key foundations of LHT, examining their relationship to outcomes should be a research imperative for validation purposes. A recent review of psychometric measures of life history strategy (Olderbak, Gladden, Wolf, and Figueredo, 2014) indicates that measures of mating effort (an important trade off with parenting effort) do not significantly correlate with the HKSS, the ALHB, or the mini-K. If such measures are not associated with life history outcomes that potentially impact fitness, it raises questions as to how they can represent independent measures of fitness.

Furthermore, such inventories contain a blend of items assessing current and past environments, relationships with parents and offspring, personality, and lifestyle. This eclectic assortment is particularly problematic for those who approach life history research from a psychosocial acceleration position (e.g., Belsky, Steinberg, and Draper, 1991; Chisholm, 1999; Hill, Ross, and Low, 1997). This proposes that early experiences, particularly environmental stress, result in changes to cognition and affect which subsequently modulate fitness-relevant behaviors. In many inventories, factors which are proposed to canalize developmental strategy (e.g., early environment and relationships) are confounded with potential mediators of strategy (e.g., cognition, affect, personality) and with LH outcomes and correlates (e.g., relationship stability, risk taking). Important contingent relationships are thus ignored and such measures often appear to examine what the current environment is like rather than how the individuals respond to the environment

in which they developed.

Many items on these instruments, as mentioned earlier, appear to be indicators of comfort, security, community engagement, and related aspects of "lifestyle." High-K strategists are expected to score in a manner suggestive of greater security, comfort, and community cohesion. These items, however, may simply be indications of socioeconomic status as opposed to life history strategy. There is a danger in equating a middle-class lifestyle with optimal fitness, contrary to original life history proposals that "fast" and "slow" trajectories are equally adaptive to different ecological niches. Few studies using psychometric indicators of life history strategy examine social class differences. The two that do (Figueredo et al., 2004, 2007) report very small effects on the ALHB. Because these earlier studies suggested no class effects, later replications have not examined it further. No such test for social class differences has been conducted on the HKSS.

Current study

The current study aimed to examine the HKSS with a large, general sample from the United Kingdom and to (1) examine the underlying factor structure of the measure, (2) critically inspect its relationship to theoretically relevant life history variables, and (3) review findings in relation to the current evolutionary literature.

Materials and Methods

Participants

Data were obtained from a national survey conducted in England in 2011. English participants were recruited to take part in an online questionnaire by a market research company as part of a survey commissioned by a national newspaper. Participants had to be between the ages of 25 and 55 to participate. There were 1,004 responses collected, and of these, 809 answered the key life history questions of interest. The usable sample consisted of 383 women and 426 men with a mean age of 39.11 (SD = 8.83). Table 1 presents descriptive characteristics of the sample. Although the sample aimed to be as cross-sectional as possible, it must be noted that participants were, by nature of recruitment, literate newspaper readers. Social class is also weighted more heavily in the higher classes than the lower.

Measures

Life history strategy. Life history strategy was measured using the HKSS (Giosan, 2006). This measure consists of 26 five-point Likert scale items measuring fitness outcomes (see items in Table 3). A higher score indicates a greater orientation towards K strategies. Internal consistency of the scale in this study was high, α = .86.

Age of puberty. Participants were asked to indicate how old they were when they reached puberty. The response options (and their coding) were as follows: (1) Age 11 or younger; (2) age 12; (3) age 13; (4) age 14; (5) age 15; (6) age 16 or above.

Age of first sex. Participants were asked to indicate their age, in years, when they first engaged in sexual intercourse.

Table 1. Sample characteristics

		n	%			*n*	%
Gender	Males	426	52.7	Location	North	248	30.7
	Females	383	47.3		Midlands	253	31.3
Children	Has Children	459	56.7		South	303	37.5
	No Children	350	43.3		Not Specified	5	0.6
Sexual	Heterosexual	732	90.5	Social Class	A	102	12.6
Orientation	Homosexual	30	3.7		B	299	39
	Bisexual	38	4.7		C1	260	32.1
	Not Specified	9	1.1		C2	63	7.8
Marital Status	Single	134	16.6		D	25	3.1
	Relationship	223	27.7		E	33	4.1
	Married	397	50		Not Specified	27	3.3
	Divorced	50	6.2	Mean Age	Males	40.4	
	Widowed	5	0.6	(Years)	Females	37.7	

Number of sexual partners. Participants were asked to indicate the number of people with whom they had sexual intercourse in their lifetime. The response options and their coding were as follows: (1) No sexual partners; (2) one sexual partner; (3) between 2-10 sexual partners; (4) between 11-20 sexual partners; (5) between 21-50 sexual partners; (6) between 51-100 sexual partners; (7) More than 100 sexual partners. Given that older participants were likely to have had more sexual partners, it was necessary to control for age. This was done by subtracting *age of puberty* from chronological age to give an indication of reproductive lifespan in years. The reported number of sexual partners was divided by reproductive lifespan to give an indication of the rate of partners per year. As the number of sexual partners was recorded categorically, the lower bound number in each category was used for the basis of calculation.

Social class. Participant social class was indexed by the National Readership Survey System (NRS Ltd., 2011). Participants indicated which social class they belonged to from a choice of six categories based on their occupation (A, B, C1, C2, D, and E, with A representing upper middle class and E representing those at the lowest level of subsistence). A, B, and C1 are grouped as *middle class* and C2, D, and E are grouped as *working class* for the purpose of analysis. Table 1 provides a numerical breakdown of the class responses. The sample was biased towards the *middle class* in this study, with the *working class* representing only 15% of the sample.

Analyses were conducted using IBM SPSS statistics software (version 19). Confirmatory Factor Analysis (CFA) was performed using IBM SPSS Amos software (version 19). Where the HKSS had missing cases, the series mean was used for the

purposes of analysis. It was quickly apparent that the most frequently omitted questions pertained to children. Questions specific to children and marriage had response rates of less than 90%, as did items about living with a partner. Dunkel and Decker (2010) recommended that the latter items be removed from some samples (notably college samples). One further item ("I have good health insurance benefits") also had a high rate of omission. Due to the National Health Service in England, less than 16% of the population pays for private health insurance. All items with responses less than 95% complete were omitted. Of the 26 items, 19 were used for further analysis.

Results

Factor structure of the HKSS

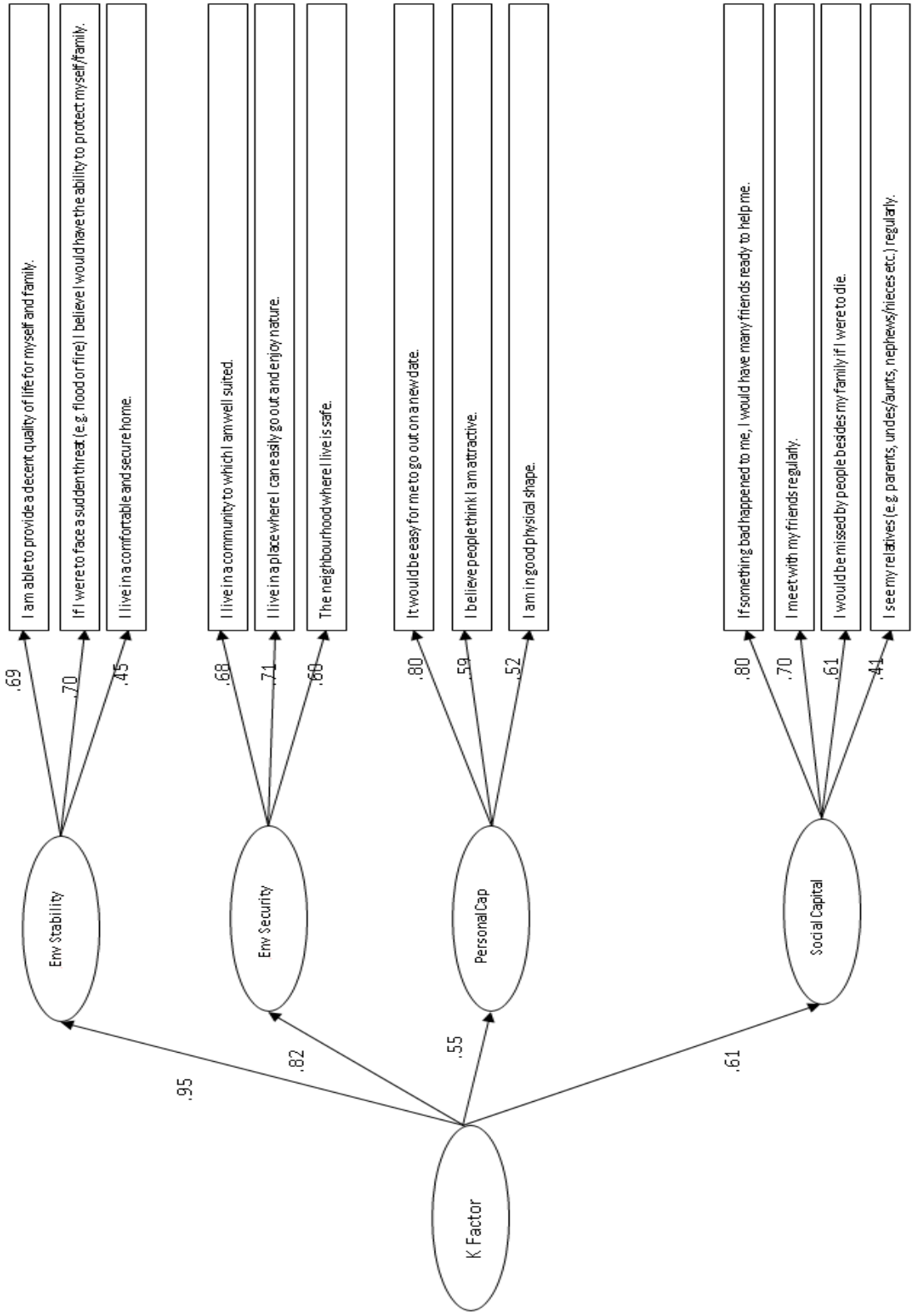
Confirmatory Factor Analysis (CFA) was conducted on the entire sample to determine if the structure hypothesized by Giosan (2006) represents an adequate statistical fit to the data set. The hypothesized, unpublished association between items and factors was supplied by Giosan (personal communication, April, 2013) and is illustrated in Figure 1. All statistics for the models tested in this section are numbered 1 to 7 and provided in Table 2 for ease of comparison.

Table 2. Model comparisons

Model	*n*	X^2	*df*	X^2/df	*p*	RMSEA	CFI
(1) HKSS (Giosan 2006)	809	1123.02	148	7.59	***	.090	.75
(2) HKSS (Giosan 2006: Four Correlated Factors)	809	1089.12	146	7.46	***	.089	.76
(3) HKSS (Giosan 2006: Unidimensional)	809	1369.23	152	9.01	***	.100	.69
(4) HKSS (PAF Based)$^{\Omega}$	404	537.31	148	3.63	***	.080	.79
(5) HKSS (PAF Based: Four Correlated Factors)	404	487.45	146	3.34	***	.076	.82
(6) HKSS (Revised)$^{\Psi}$	809	379.10	134	2.83	***	.048	.91
(7) HKSS (Revised: Four Correlated Factors)$^{\Psi}$	809	315.60	133	2.37	***	.045	.94

Notes: Ω = Negative variance; Ψ = validated across both samples; ***$p < .001$

Figure 1. Original specification (Giosan, 2006)



Model comparisons were conducted using a variety of fit statistics. Chi-square tests were used to evaluate the significance of differences between the restricted and unrestricted sample covariance matrix. The CFI (Comparative Fit Index) compares the similarities between the model's covariance matrix and the matrix observed in the data.

The Root Mean Square Error of Approximation (RMSEA) examines overall model complexity. CFI values should be greater than .90 and RMSEA values should be at least between .05 and .08 to demonstrate an adequate fit (Brown and Cudeck, 1993; Steiger, 1989). Model 1 was constructed using four latent variables (representing each of the four hypothesized subscales) loading onto one superfactor as depicted in Figure 1. Results show that this structure did not adequately fit the data set.

A second model was constructed in which the superfactor was replaced by four correlated subscales (Model 2), yielding an improved but still comparatively poor fit to the data. Finally, an attempt was made to remove the latent sub-factors and load items directly onto one latent HKSS factor to determine if the items represented a unidimensional construct (Model 3). This model had the poorest fit.

Attempts were made to re-specify the model. To determine the most parsimonious structure for the HKSS, the following procedure was conducted. The sample was split into two approximately equal halves. Principle axis factoring (PAF) with an oblique rotation was used to determine the factor structure of the HKSS on the first half of the sample (n = 405). Table 3 illustrates the component matrix from the PAF.

A four-factor solution, explaining 40% of the variance in the data, was found. As shown in Table 3, the underlying structure of the HKSS does not result in a single dimension, nor does it conform precisely to the four domains on which Giosan (2006) based the items. CFA was used on the remaining 404 participants to determine if this four-factor structure could fit parsimoniously to the data. A model was again created using the four scales from the PAF and a superfactor (Model 4). The model resulted in negative variance and was a poor fit to the data. A model without the superfactor (but leaving the four latent sub scales correlated) improved the fit significantly ($p < .001$) but was still a poor fit overall (Model 5).

Using modification indices from the CFA on the second sample, the model was re-specified (by removing items that loaded heavily onto multiple factors) in order to achieve a model that best reflected the data. The final model was constructed using 13 items on four latent sub-factors, which in turn loaded onto one latent superfactor, as depicted in Figure 2.

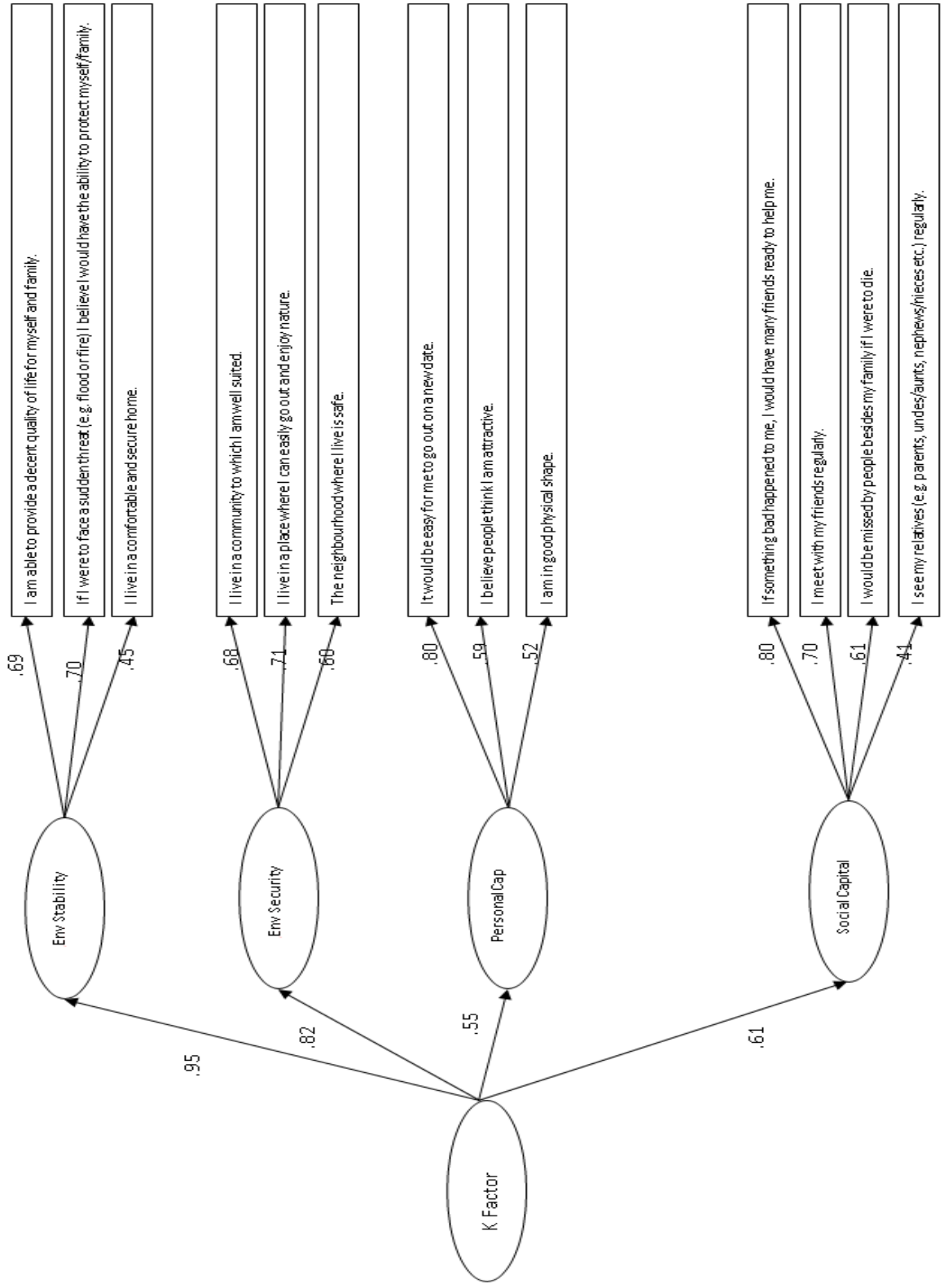
This model was validated on the original sample of 405 participants to reduce the likelihood of Type 1 error. In a further attempt to validate this model, all links were fixed from the original model and applied across both samples. The model was tested with a superfactor (Model 6) and without (Model 7). As can be seen in Table 2, although the superfactor model demonstrates an adequate fit to the data, the model can be improved significantly by removing the superfactor and using four correlated sub factors (X^2 diff = 63.50, df diff = 1, $p < .001$). These four factors were conceptually identifiable as follows: *personal capital*, *environment stability*, *environment security*, and *social capital*. Alpha values of the subscales ranged between .66 and .73. These four subscales were used for the purposes of further analyses.

Table 3. PAF factor structure of the HKSS items

Item	1	2	3	4
If I wanted to, it would be easy for me to find and go on a new date	**0.78**	-0.13	-0.07	0.06
I believe people think I am attractive	**0.72**	-0.02	-0.10	0.18
My friends look up to me	**0.52**	0.06	-0.32	-0.08
My training and experience are likely to bring me opportunities for promotion and increased income in the future	**0.42**	0.22	-0.20	-0.09
I live in a comfortable and secure home	0.05	**0.78**	0.03	0.01
The neighbourhood where I live is safe	-0.09	**0.77**	0.03	0.04
I live in a place where I can easily go outside and enjoy nature	-0.03	**0.68**	0.02	0.02
I live in a community to which I am well suited	0.08	**0.61**	-0.17	-0.01
I am able to provide a decent quality of life for myself and my family	0.42	**0.56**	0.06	0.05
The activities I engage in, both at work and elsewhere, are safe (not life threatening)	-0.25	**0.39**	-0.18	0.08
If I were to face a sudden threat (e.g., flood, fire), I believe I would have the ability to protect myself and my family	0.34	**0.35**	0.07	0.10
If something bad happened to me, I'd have many friends ready to help me	0.13	0.00	**-0.75**	0.01
I meet with my friends regularly	0.09	-0.06	**-0.73**	0.08
I would be missed by people, besides my family, if I were to die	0.05	-0.01	**-0.67**	0.10
I see my relatives (for example, parents, uncles/aunts, nephews/nieces, etc.) regularly	-0.02	-0.10	**-0.66**	-0.02
The people I work with are like me	0.03	0.24	**-0.43**	-0.13
My second-degree relatives (nephews, cousins, uncles, nieces) are generally healthy	-0.09	0.20	**-0.42**	0.16
I don't have major medical problems	-0.12	0.02	-0.06	**0.87**
I am in good physical shape	0.27	0.02	-0.02	**0.76**

Note: Bold figures represent highest factor loadings.

Figure 2. Modified HKSS model



HKSS and life history variables

One aim of this study was to examine relationships between the HKSS and other key indices of life history. Correlations among these key variables are presented in Table 4. The correlations among life history variables were broadly in line with predictions. *Age of puberty* was significantly, positively related to *age of first sex*, r =.24, $p < .01$, and negatively related to *number of sexual partners*, r = -.10, $p < .01$. *Age of first sex* and *number of sexual partners* were negatively correlated, r = -.23, $p < .01$.

Table 4. Correlations between HKSS scale scores and life history variables

Variable	Age of Puberty	Age of First Sex	Number of Sexual Partners
Personal Capital	.07	-.14**	.15**
Environmental Stability	.06	-.06	.06
Environmental Security	.03	-.04	-.01
Social Capital	-.05	-.10**	.05
Revised HKSS Total	.03	-.12**	.09*
Original HKSS Total	.03	-.09**	.06

Notes: *$p < .05$; **$p < .01$

Sex differences in many of these variables were apparent (see Table 5). As expected, men reported a significantly higher number of sexual partners and women reported significantly earlier age of puberty. As sex differences were evident, correlation analyses were repeated by sex (see Table 6). Relationships between subscales were very similar for males and females. Differences emerged, however, in relation to life history variables. In women, *age of puberty* significantly, positively correlated with *environmental stability*, *Environmental security*, and *personal capital*, suggesting that more favorable life circumstances are associated with a later sexual maturation, as predicted by LHT. However, neither of the two remaining LHT variables was associated with the four scales in women.

For men, *age of first sex* was significantly, negatively correlated with three of the four revised HKSS sub-scales (*environmental stability*, *personal capital*, and *social capital*), although *environmental security* was positively correlated. *Number of sexual partners* was also positively correlated with *environmental stability*, *personal capital*, and *social capital*. Hence, men who scored higher on these measures had sex earlier in life with more sexual partners (after age adjustment).

Table 5. Descriptive statistics for all variables (*N* = 809)

Variable	Whole sample Mean/(*SD*)	Men (*n* = 426) Mean/(*SD*)	Women (*n* = 383) Mean/(*SD*)
Age of Puberty Ω **	3.11 (1.31)	3.33 (1.25)	2.86 (1.33)
Age of First Sex	17.92 (3.20)	17.92 (3.37)	17.93 (3.0)
Number of Sexual Partners**	0.37 (0.76)	0.44 (0.84)	0.28 (0.65)
Total Original HKSS**	68.39 (10.09)	67.56 (10.26)	69.42 (9.81)
Total Revised HKSS	44.04 (7.21)	43.69 (7.57)	44.42 (6.77)
Personal Capital*	9.32 (2.66)	9.14 (2.70)	9.52 (2.59)
Environmental Stability	11.66 (2.07)	11.63 (2.17)	11.70 (1.95)
Environmental Security	11.39 (2.39)	11.29 (2.38)	11.49 (2.39)
Social Capital*	14.24 (3.32)	13.67 (3.37)	14.53 (3.24)

Notes: * Sex difference significant at $p = < .05$; ** sex difference significant at $p = < .01$; Ω = categorical variable

Table 6. Correlations between HKSS scale scores and life history variables by sex

Variable	Age of Puberty		Age of First Sex		Number of Partners	
	Male	Female	Male	Female	Male	Female
Personal Capital	.01	.15**	-.25**	-.01	.23**	.04
Environmental Stability	.02	.11*	-.16**	.09	.11**	-.03
Environmental Security	-.03	.12**	.11**	.05	.03	-.08
Social Capital	-.09	.03	-.17**	-.01	.14**	-.07
Revised HKSS Total	-.04	.13**	-.29**	.04	.18**	-.05
Original HKSS Total	-.02	.13**	-.21**	.06	.16**	-.07

Notes: * Sex difference significant at $p = < .05$; ** Sex difference significant at $p = < .01$

Social class effects

For the revised HKSS, significant class differences emerged in scores for *environment stability*, F (1,780) = 14.72, $p < .001$, and *environmental security*, F (1, 780) = 8.92, $p < .01$, with middle class individuals scoring higher than lower class individuals. However, when social class was controlled, partial correlations between the scales and life history measures did not significantly differ from zero-order correlations ($p > .05$) in all cases, for males and females (see Table 7).

Table 7. Social class correlations

	Age of Puberty		Age of First Sex		Number of Partners	
	Males	Females	Males	Females	Males	Females
Environmental Stability	.02 (.03)	.12 (.14)	-0.15 (-.18)	.08 (.07)	.12 (.12)	-.03 (-.03)
Environmental Security	-.03 (-.02)	.12 (.14)	-.10 (-.12)	.04 (.04)	.03 (.04)	-.08 (-.08)
Personal Capital	.02 (.02)	.16 (.15)	-.24 (-.25)	-.02 (-.02)	.23 (.23)	.05 (.05)
Social Capital	-.09 (-.09)	.04 (.04)	-.18 (-.18)	.01 (.01)	.14 (.14)	-.07 (-.07)

Notes: $n = 782$; partial correlations in parentheses

Discussion

It appears that the original HKSS items are best represented as four distinct but related dimensions, and do not represent a unidimensional construct. This conclusion is reinforced by relationships between HKSS total scores and life history measures: The significant correlations that were found were contrary to the predictions made by the Differential K literature (Figueredo et al., 2013; Rushton, 1985). We found that high K scores were related to earlier sexual debut and unrelated to either pubertal onset or number of sexual partners. This suggests that the HKSS does not reflect an underlying "K dimension."

The revised multidimensional solution built from the PAF analysis provided four identifiable factors that share features with (but are not identical to) Giosan's original proposal. *Social capital* items refer to access to kin, peer, and social support networks, whereas *personal capital* encompasses measures of attractiveness. The remaining two factors focus on the environment: *Environmental stability* represents items pertaining to quality, indicative of resource access, and *environmental security* contains items linked to neighborhood safety and cohesion. These factors depart from Giosan's idea of "risk consideration," but contain items relevant to environmental threat. These four factors are correlated and represent the most parsimonious fit to the data. Although the revised solution does allow some evolutionarily driven interpretations to be made (discussed shortly), it must be stressed that we do not claim that this represents an underlying fitness continuum.

Previous research suggests that the switching point from growth to reproduction is a key indicator of future strategy-related behavior. Belsky et al. (1991) postulated that environments that induce stress on parenting should foster earlier reproductive maturity and behavior in offspring (e.g., earlier sexual onset and proclivity for multiple partners). Such individuals would be expected to develop strategies that are less K orientated. The HKSS is a measure of *current* conditions and fitness. As such, we should expect that those who retrospectively report a later age of puberty would currently report a higher score on measures that purport to assess K selection (presumably because this earlier biological

event acts as a signal to adopt K-strategy related behavior). This was not the case, however. When sex-specific correlations are examined, a positive relationship exists for women (but not men) between the revised HKSS and pubertal onset, specifically in relation to the *personal capital* and both environment subscales. Females living in safe, stable ecological conditions and who have high mate value are therefore more likely to delay sexual maturity. This is consistent with evolutionary and developmental literature (Belsky et al., 1991; Chisholm, 1999; Ellis, 2004). Furthermore, it may be that pubertal onset is less critical for strategy development for males than for females. Research suggests that whereas female reproductive strategy is sensitive to ecological and familial environments, male strategies are often more dependent on peer networks (Del Giudice, Ellis, and Shirtcliff, 2011; James, Ellis, Schlomer, and Garber, 2012). It must be stressed, however, that the retrospective nature of this scale and the remaining measures makes it impossible to establish causal links, and so such conclusions must remain speculative.

Contrary to Differential K predictions, the revised HKSS total had a significant, positive relationship with *number of sexual partners* and a negative relationship with *age of first sex*. However, when sex-specific correlations were examined, these relationships held for men only, in relation to both the total score and the subscales. To the extent that these scales are measuring attractiveness and upward mobility, it is unsurprising that these correlations emerged. Research has consistently concluded that measures indicative of high status are positively correlated with female mate preferences (Borgerhoff Mulder, 1990, 1992; Buss and Schmitt, 1993; Draper, 1989; Kanazawa, 2003; Perusse, 1993). It would be advantageous for high status males not only to reproduce with more partners, but to lengthen the window in which they have the capacity to do so. These results are therefore consistent with current evolutionary thinking, although contrary to predictions from Differential K theory.

Several other findings are in line with expectations from life history theory. *Age of puberty* was significantly, positively related to *age of first sex* and negatively related to the *number of sexual partners*. Those who have invested more in growth, therefore, appear to postpone reproduction and have fewer sexual partners. Furthermore, the significantly negative relationship between *age of first sex* and *number of sexual partners* suggests that those postponing reproductive behavior have fewer sexual partners across the lifespan. Relationships between key life history variables are therefore broadly consistent with the current theoretical and empirical literature (Belsky et al., 1991; Chisholm, 1999; Ellis, Figueredo, Brumbach, and Schlomer, 2009; Negriff, Susman, and Trickett, 2011). The sex differences that emerged in the life history variables also support previous findings (Carroll, Volk, and Hyde, 1985; Tanner, 1990). Men had a significantly greater number of partners, whereas women reached reproductive maturity significantly earlier. In short, the results of this study corroborate previous findings regarding relationships between reproductive onset and reproductive behavior, but do not provide strong evidence to suggest that these relationships are part of a general "K-dimension" as predicted by Differential K theory.

Issues with psychometric life history theory research

The need to make clear distinctions between what is being measured in life history

research is crucial. In its original incarnation and in current evolutionary behavioral sciences, life history theory focuses on a suite of objective biological life events (e.g., growth rate, offspring number, life expectancy) that are strongly correlated, giving rise to a slow (K) to fast (r) continuum across species (Pianka, 1970; Rushton, 1985). In evolutionary psychology, recent psychometric measures (Figueredo et al., 2004; Figueredo et al., 2006) purport to measure individual differences in "slow," or "K," human life strategies by assessing personality and attitudes (such as impulsivity, altruism, attitudes to relationships, Machiavellianism, and planning), as well as current community and environmental variables such as religiosity and social cohesion. Although personality and lifestyle may be *associated* with fast or slow life history strategies, they cannot stand as proxies for them. It is important for research to establish the relationship between early objective life events (e.g., stress) and later life history outcomes (e.g., reproductive timing, mating strategies). Personality and lifestyle may represent (1) correlates of life history strategies or (2) mediators between early life events and subsequent life trajectories. These alternatives can best be examined through longitudinal studies (see Belsky, Schlomer and Ellis, 2012; Simpson, Griskevicius, and Kuo, 2012, for recent examples as to how this may be achieved). Our point is that we should not confuse psychological or sociological variables associated with a K or slow life history strategy with the behavioral strategy itself. This point can be highlighted particularly in relation to the HKSS.

What is the HKSS measuring? Given its inconsistent relationships with key life history variables, it is difficult to conclude that it accurately captures an adaptive "K strategy." Early validation studies (e.g., Giosan, 2006) correlated the HKSS scores with other self-reported lifestyle measures of education, health, and social support. Because the HKSS scale assesses these variables, it is not surprising that significant correlations were found: HKSS (a self-report instrument) simply validated other self-reported data. Criterion contamination (Messick, 1989) may therefore be an issue in the HKSS, raising serious questions regarding its construct validity. This same criticism can be extended to other psychometric works of life history strategy (see Olderbak, et al., 2014 for an example). Are these lifestyle variables correlates of a K-adapted strategy? Since none of the items address objective life history events, it is hard to know. Life history strategies represent an individual's developmental response to the environment in which they inhabit. It is not clear whether (and how) items such as "The neighborhood where I live is safe" and "I live in a comfortable and secure home" relate to objective measures of life history strategy as either correlates or mediators. Items such as "I live in an environment where I can easily go outside and enjoy nature" are also difficult to reconcile with life history strategy. Not only can this be interpreted in many different ways by the respondent, it is also difficult to see precisely how and why this affects adaptive behavioral responses. Such items measure the present environment, not how the individual's strategic trajectory was affected by the developmental environment. Therefore, it is important to recognize the distinction between environmental factors and individual personality and behavioral traits that are potentially affected by environmental factors. Current psychometric measures do not effectively demonstrate this distinction, and how (and by what mechanisms) the environment translates into fitness related behaviors is unclear.

We found significant social class differences on some sub-scales, with those in

upper bands scoring higher on the HKSS than those in low-paying jobs or unemployment. It appears that the HKSS may, to some extent, be measuring the respondents' current "middle class lifestyle," with high scorers reporting greater comfort and security. However, it would be fallacious to assume that a "middle-class lifestyle" represents optimal fitness. Should we take quality of life as an indicator of life history strategy, rather than a measure of achieved (or inherited) economic wellbeing that may or may not be correlated with the adoption of a K life history strategy? This may be especially true with respect to items purporting to measure local environmental conditions in the original HKSS. It should be noted, however, that significant and non-significant relationships remain unchanged when social class is controlled. Nevertheless, we recommend that class be scrutinized in future research using psychometric indicators of strategy, and the implicit assumption that class is independent of these measures should be treated with caution.

Very little research with psychometric indicators of Differential K disaggregates data by sex to examine potential differences in trajectories and outcomes. This study identifies marked sex differences in the relationships between variables that are masked when sex is not considered. Muncer (2013) highlights that, in relation to the general factor of personality proposed by Rushton (based on the rationale of the K dimension), the competing needs of the sexes mean that personality traits that enhance success for males do not necessarily enhance success in females (Campbell, 1999; Daly and Wilson, 1983) due to differences in parental investment strategies (Trivers, 1972). The same argument applies to psychometric measures of strategy. In relation to the multitude of factors that are incorporated into measures such as the HKSS, the ALHB, and the Mini-K, is it likely that a single aggregate "K-dimension" encompassing personality, health, behavior, and environment is sex-neutral? Our analysis tentatively suggests not, and that future work with such scales should consider sex differences when examining relationships with life history traits.

Although this paper focuses on fitness-related life history events as key criteria for validation, it should be noted that modern human behavioral ecology studies do not assume modern humans to be "fitness maximizers." Research clearly concludes that the adoption of fast and slow strategies in certain imposed modern conditions do not necessarily confer the anticipated fitness consequences that would be expected in ancestral environments (Clark, 2007; Clark and Cummins, 2009; Goodman, Koupil, and Lawson, 2012). The modern mismatch between biological fitness and socioeconomic circumstances is well documented. However, consistent with research in behavioral ecology, key shifts in life history that can be objectively measured are still expected to be contingent on ecological conditions, to some degree, and should show correlations with personality and lifestyle measures indicative of high or low K strategies (if these hypothesized relationships are accurate). If K-related psychological and lifestyle traits bear no relationship to key life history events and indices of fitness, it raises questions about the relevance of such constructs in general. We recommend that the best way to examine life history strategy is to employ well-designed, longitudinal studies with clearly defined measures, controls for confounding variables, and consideration of the developmental environment, in a manner consistent with studies in human behavioral ecology (Nettle, Gibson, Lawson, and Sear, 2013). If psychometric studies of life history are not validated against known indicators of fitness,

we cannot conclude that emergent K-strategy clusters indeed represent functional psychological adaptations.

Study limitations and conclusion

There are methodological limitations in the present study. Firstly, despite attempts to gather as wide a sample as possible, the individuals studied were predominantly literate and middle class. Although this is a much broader sample than has been used previously with the HKSS and similar measures, a more comprehensive range of social class would be desirable. Broadening the age range to incorporate developing individuals would also be of interest in future studies. In our sample, the first 10 years of the reproductive lifespan (ages 15-25) are omitted.

Perhaps the largest methodological issue is the use of retrospective assessments of pubertal onset, as these can be unreliable (particularly in males, for whom signs are often less memorable). This is a difficult obstacle to remedy and is precisely why longitudinal research is badly needed in this field to allow temporal ordering to be explored in greater detail. Questions regarding sexual behavior and social class are sensitive (Tourangeau and Yan, 2007) and could be subject to social desirability biases. Although the study was conducted online and participants were assured of anonymity, no other controls were in place, and this may have affected responses.

In summary, we conclude that the HKSS is best conceptualized as four related scales rather than a unidimensional or higher order fitness factor. These scales assess aspects of current lifestyle, and our preliminary analysis does not suggest that they are related to life history milestones as predicted by Differential K theory. We recommend that psychometric indicators of fitness that do not map onto measurable fitness outcomes be treated with caution and that the field of human life history research would be better advanced through the use of longitudinal studies that examine developmental environments and actual fitness or fitness-related outcomes.

Received 30 July 2013; Revision submitted 23 January 2014; Accepted 14 February 2014

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