Intelligence 57 (2016) 41–47

Contents lists available at ScienceDirect

Intelligence

Old-for-grade girls reproduce but do not mature early: Simply a mechanistic link between educational progress and pace of life?

Peeter Hõrak [a,*], Markus Valge [b]

[a] Department of Zoology, Institute of Ecology and Earth Sciences, Tartu University, Vanemuise 46, 51014, Tartu, Estonia
[b] Institute of Psychology, Tartu University, Näituse 2, 50409, Tartu, Estonia

ARTICLE INFO

Article history:
Received 16 October 2015
Received in revised form 25 February 2016
Accepted 13 April 2016
Available online 23 April 2016

Keywords:
Age at first birth
Cognitive ability
Completed fertility
Pubertal maturation
School progress

ABSTRACT

Human life-history theory predicts that low cognitive abilities have coevolved with the fast pace-of-life. Old-for-grade pupils proceed slowly at school, which is usually caused by grade repetition due to low cognitive abilities. We assessed the causes and consequences of slow school progress by comparing life-history traits and measures of growth and performance between old-for-grade and appropriate-for-grade Estonian adolescent girls born between 1938 and 1953 ($n = 1673$). We found no evidence for covariation between early pubertal maturation and school progress; girls who were more than 1.5 years old for their grade did not show signs of faster development of breasts and axillary hair. However, their first birth occurred one year earlier than for girls who had passed school at an appropriate rate. Among a subset of girls from Tallinn, a higher grade point average predicted a later age at first birth. Completed fertility and parity did not relate to the rate of school progress. Old-for-grade girls were generally shorter, weaker, and had smaller heads than appropriate-for-grade girls, which suggests that they experienced developmental constraints. The most parsimonious explanation for the observed patterns is that old-for-grade girls were devoid of capabilities required for obtaining tertiary education under the highly competitive environment prevalent in the study period. Our findings emphasize the role of (tertiary) education as a proximate constraint on reproductive rates.

1. Introduction

Education is typically positively correlated with the age at first birth (Raymo et al., 2015; Rodgers et al., 2008; Skirbekk, 2008) and negatively associates with the fertility of women (Alvergne & Lummaa, 2014; Barthold, Myrskylä, & Jones, 2012; Lawson, Alvergne, & Gibson, 2012; Lynn, 1996; Meisenberg, 2010; Wood, Neels, & Kil, 2014). The mechanistic explanation is that childbearing and child care are not compatible with schooling because of the resource and time constraints and/or opportunity costs imposed by the postponement or withdrawal of higher education (e.g., Kreyenfeld, 2006). In addition, women of low education appear to have lower family planning abilities (Klijzing, 2000), consistent with the idea that low intelligence leads to inefficient birth control (Herrnstein & Murray, 1994; Kanazawa, 2005; Shearer et al., 2002). Technically, the mechanisms described above would suffice for explaining why low educational attainment co-occurs with early reproduction and high fertility. Such proximate-level explanations, however, do not rule out the possibility that covariation between reproductive rates and education reflects individual differences in life-history strategies.

There are good evolutionary reasons to predict that both across and within-species, high cognitive abilities evolve under conditions favouring a slow pace of life. According to life-history theory, rates of maturation and reproduction of organisms evolve to track variation in mortality rates (Stearns, 1992). As applied to humans, the theory predicts that the traits characteristic for slow life-histories – late maturation and reproduction, intensive parental care, low birth rates and long life-span – have coevolved with high intelligence and personality traits favouring altruistic, law-abiding, and restrained behaviour (Figueredo, Vasquez, Brumbach, & Schneider, 2004; Figueredo et al., 2006; Rushton, 1985; Rushton, 2004; Thornhill & Palmer, 2004). This coevolution is expected to result in a situation where individual differences in intelligence covary with individual differences in pace of life (e.g., Woodley, 2011).

Persistence of heritable covariation in the life-history and behavioural traits within populations is most easily explained by balancing selection. The main underlying mechanisms include antagonistic pleiotropy (when different components of fitness are negatively correlated) and spatial or temporal fluctuations in direction of selection (see Penke, Denissen, & Miller, 2007; Penke & Jokela, 2016; Sherman, Figueredo, & Funder, 2013). In humans, (co)variation in cognitive and

* Corresponding author.
E-mail address: horak@ut.ee (P. Hõrak).

http://dx.doi.org/10.1016/j.intell.2016.04.004
0160-2896/

life-history traits is maintained by educational and residential segregation, in mutual feedback with assortative mating with respect to intelligence, and wealth (Herrnstein & Murray, 1994; Plomin & Deary, 2015). Consistent with predictions of life-history theory, a recent twin study showed that positive covariation (although small) between intelligence and life span in humans is almost entirely genetic (Arden et al., 2015). Other studies have demonstrated positive genetic correlations between intelligence and personality traits including openness, conscientiousness, agreeableness, and low hyperactivity (reviewed in Arden et al., 2015). On the other hand, criminal behaviour (that is linked to low intelligence; see Schwartz et al. (2015)) can associate with higher reproductive success on a nation-wide scale (Yao, Långström, Temrin, & Walum, 2014).

Yet the direct evidence in favour of coevolution of intelligence and life-history is still ambiguous. For instance, attempts to measure the covariation between general intelligence (g) and life-history speed, assessed on the basis of multi-item questionnaires, have usually not found substantial correlations between the two (reviewed by Figueredo et al., 2014; Woodley, 2011; Woodley of Menie & Madison, 2015). Historically, a series of studies with mainly white middle-class groups in the US at the time of the baby boom reported a negligible or slightly positive relationship between IQ and number of children (reviewed by Higgins, Reed, & Reed, 1962; Meisenberg, 2010). On the other hand, a recent extensive study of a nationally representative US database (Reeve, Lyerly, & Peach, 2013) showed that high IQ was associated with delay of reproduction and fewer offspring (particularly in women) and that these effects were strongly mediated by educational attainment (see also Meisenberg, 2010; Peach, Lyerly, & Reeve, 2014; Woodley & Meisenberg, 2013 and references therein). Yet another extensive study in the UK found that childhood general intelligence, independently of education predicted the probability of remaining childless; one standard deviation increase in childhood general intelligence decreased women's odds of parenthood by 21–25% (Kanazawa, 2014).

The association of early childbearing and low cognitive ability is particularly well documented (Fergusson & Woodward, 2000; Shearer et al., 2002). The proximate mechanism here is not necessarily subsumed under the inefficient use of artificial means of birth control by women of low cognitive ability. For instance, higher intelligence may be associated with the postponement of the initiation of the full range of sexual activities, including first intercourse (Halpern, Joyner, Udry, & Suchindran, 2000). Behavioural genetic studies in the US and Denmark have shown that the environmental differences between families contributed to an underlying factor that combined cognitive ability, education, and age at first birth (Neiss, Rowe, & Rodgers, 2002; Rodgers et al., 2008). Another study on a nationally representative US dataset found a similar effect of family environment on the link between intelligence and age at first intercourse (Harden & Mendle, 2011). However, the association between academic achievement and age at first sex could be attributable entirely to genetic factors. Testing whether low cognitive abilities have coevolved with precocious life-histories is further complicated by the issue that the rate of pubertal maturation does not usually associate with the age at first birth in populations where reproduction begins many years after reaching maturity (e.g. Boothroyd, Craig, Crossman, & Perrett, 2013; Kirk et al., 2001; Riley, Weinstein, Ridley, Mormino, & Gorrindo, 2001; Waynforth, 2012).

A complementary approach to study the associations between g and pace of life would involve the investigation of individual-level covariation between the rate of sexual maturation and cognitive ability. The occurrence of such covariation can be predicted on the basis of life-history theory, positing that early maturation uses up resources (time and nutrients) that could be invested for accumulation of somatic and cognitive capital (see Ellis, 2004; Nettle, Dickins, Coall, & de Mornay Davies, 2013). Cognitive abilities are expected to be particularly sensitive to such resource allocation trade-offs because of the high energetic cost of human brain function (which is 10 times higher than would be expected from its weight alone (e.g., Raichle & Gusnard, 2002)). In line with this, it has been shown that the early onset of puberty in girls can be associated with increased risk of psychopathology (Graber, Seeley, Brooks-Gunn, & Lewinsohn, 2004; Kaltiala-Heino, Marttunen, Rantanen, & Rimpelä, 2003) and disrupts frontal white matter development (Klauser et al., 2015). Yet early studies aiming to assess the relationship between rate of maturation and cognitive abilities have yielded contradictory results (reviewed by Daniel et al., 1982; Dubas, Graber, & Petersen, 1991; Geary & Gilger, 1989; Mendle, Turkheimer, & Emery, 2007). More recently, data from a nationally representative sample of US girls from an Adolescent Health and Academic Achievement study showed that early pubertal timing was associated with low grade point average, course failure, and dropping out of high school (Cavanagh, Riegle-Crumb, & Crosnoe, 2007). However, a similar study in Finland found no associations between pubertal timing and educational progress (Koivusilta & Rimpelä, 2004).

The aim of the current study is to investigate associations between growth, pubertal maturation, educational progress, and reproductive rates in a sample of Estonian adolescent girls born between 1938 and 1953. This dataset, collected by Prof. Juhan Aul (1897–1994), contains a unique set of multiple measures of body dimensions and sexual maturation (stages of development for breasts and axillary hair), as well as indices of performance (including cranial volume), recorded along with data on family size, place of residence, and parental occupation for 1673 girls measured around the age of 17. We assessed the causes and consequences of variation in educational progress on the basis of comparison of old-for-grade girls with those progressing in school at an appropriate rate for their age. The main reasons for being old-for-grade are delayed school progress (which results in repeating an educational course that has previously been failed) and delayed school entry. Slow progress at school may be partly caused by low cognitive abilities as old-for-grade children have lower literacy and lower numeracy performance than appropriate-for-grade children (Martin, 2009). However, educational achievement additionally depends on personality traits and prevailing socioeconomic conditions (e.g., Krapohl & Plomin, 2015). We thus consider slow school progress as a potential correlate but not as a proxy for low intelligence. For two different subsets of the data, we had additional quantifiable information about school performance (scholastic proficiency compared to class average and grade point average (GPA)). This enabled us to verify whether being old-for-grade associates with poor school performance.

We predicted that (1) in the case if slow progression at school is characteristic to individuals with a fast pace of life, we will detect faster rates of sexual maturation and age at first birth among old-for-grade girls than among appropriate-for-grade girls. On the same grounds, we predicted that school performance associates negatively with rates of maturation and positively with age at first birth. (Note, however, that the prediction about age at first birth would also hold under the hypothesis that education per se delays reproduction). Given that fast reproductive strategies are expected to associate with high offspring number (Hochberg & Belsky, 2013; Rushton, 1985), we also predicted that (2) old-for-grade girls have higher rates of completed fertility and parity than appropriate-for-grade girls. Additionally, we aimed at elucidating the causes of low school progress by comparing the rates of somatic growth and measures of performance, parental socioeconomic status (SES), and number of siblings between old-for-grade and appropriate-for-grade girls. Previous studies have shown that low cognitive abilities in children associate with short stature (Skuse, Gilmour, Tian, & Hindmarsh, 1994; von Hinke Kessler Scholder, Davey Smith, Lawlor, Propper, & Windmeijer, 2013), low parental SES (Lawlor et al., 2005; Rahu, Rahu, Pullmann, & Allik, 2010; Tork, 1940), and higher number of siblings (Lawson, Makoli, & Goodman, 2013; Tork, 1940). However, it is not known whether similar associations also hold with respect to grade repetition. We thus tested the prediction that (3) being old-for-grade associates with poorer growth and performance and harsher growth conditions.