VOLUME 7 | ISSUE 2 | **APRIL 2016**

ISSN 1757-9597

Longitudinal and Life Course Studies: International Journal

Published by

SLLS Society for Longitudinal and Life Course Studies

Inside this issue

Co-sponsors:

VU university medical center

ISER Institute for Social & Economic Research

SRC Survey Research Center, University of Michigan

LLCS EDITORIAL BOARD

SUBSCRIPTIONS

For immediate access to current issue and preceding 2016 issues (Volume 7):

Annual Individual rate: **£20 (discounted rate £55 for 3 years)**.

Annual Library **rate: £200** to register any number of library readers.

Annual Society for Longitudinal and Life Course Studies (SLLS) Membership: Individual **£65,** ***Student*** **£26,** ***Corporate*** **£300**.

SLLS members have automatic free access to the journal among many other benefits. For further information about SLLS and details of how to become a member, go to http://www.slls.org.uk/#!services/ch6q

All issues are accessible free of charge 12 months after publication.

Print on demand

An attractive printed version of each Issue of the journal, including all back numbers, is available at a price of £10 (plus postage and packaging). If you would like to purchase a full set or individual copies, visit the SLLS Bookshop at http://www.slls.org.uk/#!journal-bookshop/czkc Depending on distance, you will receive the order within two weeks of submitting your order.

Please note

The reselling of personal registration subscriptions and hard copies of the journal is prohibited.

INTRODUCTION

PAPERS

COMMENT AND DEBATE

LLCS Journal can be accessed online at: www.llcsjournal.org

Published by
The Society for Longitudinal and Life Course Studies
Institute of Education, 20 Bedford Way, London, WC1H 0AL

info@slls.org.uk http://www.slls.org.uk

SLLS Society for Longitudinal and Life Course Studies

SLLS International Conference

'Education and the Life Course: Determinants and Consequences of Unequal Educational Opportunities'

Bamberg, Germany
5 - 8 October 2016

(Optional pre-conference workshops on 5 Oct 16, with main conference beginning on 6 Oct)

Registration to open in June 2016

The fee for conference registration will be discounted for SLLS members so consider joining if you have not already done so. Visit the membership page of the SLLS website for full details of how to join online:
http://www.slls.org.uk/#!services/ch6q

Further information will be posted on the SLLS website as it becomes available
http://www.slls.org.uk/#!conf/c1tsl

Hosted by LIfBi LEIBNIZ INSTITUTE FOR EDUCATIONAL TRAJECTORIES *in co-operation with* UNIVERSITY OF BAMBERG OTTO-FRIEDRICH-UNIVERSITÄT BAMBERG

Editorial: LLCS progress

John Bynner Executive Editor

The journal is now in its 21st issue, with 134 papers published since the first edition and an increased publication output from three to four issues per year since 2015. The publication of the 22nd issue in April 2016 is therefore a good time to review progress.

Readership

Website visits to access, read and download papers show continuing progress with an increase from almost 14,000 sessions in 2014 to nearly 15,500 sessions in 2015.

Abstract downloads exceed 1,000 for 48 papers - one at 6,995 - and exceed 500 for 115 papers.

Individual readership registrations overall continue to expand, with currently 2,075 ever-registered users. This figure includes, since the beginning of February 2016, 340 active Society for Longitudinal and Life Course Studies (SLLS) members whose subscriptions automatically bring them full reading rights.

Library subscriptions, which give library users full access to all papers, are holding steady at 37 across the world, 10 of which also subscribe to hard copies of the journal.

Submissions

Submissions remain constant, pushing towards a steady 30 under review at any time, which is sufficient to sustain four issues per year. The SLLS annual conference is a major source of submissions to the journal. Submission numbers for Dublin last October reached an all-time high, and have now been superseded by numbers for this year's conference in Bamberg.

Citations

Citation is, of course, only the final stage of a long engagement process with any paper – beginning with downloading an abstract, to reading the full study, before finally deciding whether to cite it. Citation figures reveal the 'tip of the iceberg' of engagement with any paper. Citations, in our case as derived from Google Scholar, show that out of a total of 134 papers published since April 2009, 12 have received 20 or more citations to date, 25 have 10 or more, 44 five or more, 54 three or more and 71 two or more.

Those papers with 20 or more citations are listed below. The exact number of citations is shown in brackets. Volume and issue numbers are also listed, followed by type of publication, where applicable – Study Profile (SP), or included in a part or full Special Issue (SI).

1. *The HILDA Survey: A case study in the design and development of a successful Household Panel Survey* (52) – 3.3 SP
2. *Understanding Society: Design overview* (41) – 3.1 SI
3. *The Panel Study of Income Dynamics: overview, recent innovations and potential for life course research* (34) – 3.2 SP
4. *Socioeconomic gradient in early child outcomes: evidence from the Millennium Cohort Study* (31) – 2.1 SI
5. *Attrition in US and UK Longitudinal Studies of Health and Ageing* (30) – 2.2 SI
6. *Children's educational attainment and the aspirations, attitude and behaviours of parents and children through childhood* (30) – 2.1 SI
7. *The role of attitudes and behaviours in explaining socio-economic differences in attainment* (29) – 2.1 SI
8. *Social class returns to higher education: chances of access to the professions and managerial salariat for men in three British cohort studies* (24) – 2.2
9. *Handling attrition and non-response in longitudinal data (21) – 1.1*
10. *Does mothers' employment affect children's development: evidence from the children of the British 1970 birth cohort and the American NLSY29 (21)*
11. *Family socialisation, economic self-efficacy and the attainment of financial independence in early adulthood (20*) 1.1

12. *Developmental trajectories of body mass index through the life course: an application of latent class growth (mixture) modelling* (20) 2.3

The most frequently cited papers, with the exception of the HILDA study, were all published in the journal's first three volumes (2009-2010, 2011 & 2012), which shows, understandably, that time since publication is a crucial factor in building citations. The data also show that citations go on building well beyond the immediate period in the year or two after publication. In confirmation of this last point, all but 13 of the 44 papers with zero citations were published in Volumes 5 and 6.

Research domain

Because of the interdisciplinary nature of the journal, apportioning citations to the coverage of the four journal domains/sections is problematic. However, by multiple counting of content references in each paper, a crude estimate can be obtained. The somewhat surprising, but satisfying, result was that for those 44 papers with 5 or more citations, the numbers were evenly spread between: 'Social and Economic Sciences', 17; 'Health Sciences', 17; 'Behavioural Sciences and Development', 18.

Only 'Statistical Sciences and Methodology' dropped behind the others at 7, but that may have been partly because, although methodology had been a significant feature of the paper, it had not been mentioned in the title.

This issue

Three *Comment and Debate* sections have now been published:

- *Social class differences in early cognitive development* (July- October 2015),
- *Population Sampling in longitudinal studies* (October 2015)
- *Allostatic Load* (January) 2016)

The April issue will see the fourth debate in the Comment and Debate series. *Life course approach and longevity risk* opens with a discussion paper from David Blane and colleagues and is followed by four contributions from experts in the field. Three research papers on diverse topics complete the issue: *Transmission of cultural capital and status attainment* – Werner Georg; *Children's behavioural and emotional development and physica*l activity – Lucy Griffiths and colleagues; *Socioeconomic disadvantage, children's behaviour problems and early aspirations* – Eirini Flouri and colleagues.

Conclusion

The indicators point toward steady progress toward meeting the journal's key aims. LLCS is filling a gap in the research literature by:

- becoming recognised as a platform for international longitudinal and life course research reporting, as reflected in the website visits and citations;
- achieving its objectives in supplying both an interdisciplinary and a more specialised publication platform for longitudinal and life course research;
- matching publication needs across the three substantive research domains in terms of which the journal's reviewing and, to a lesser extent, publication output, is organised;
- reflecting the main research areas of life course science.
-

Study profiles and special sections comprising papers linked by shared longitudinal and life course study themes, have particular appeal, while Methodology and Statistic needs to be strengthened

Overall we can conclude that the production, coverage and quality targets are meeting the standards set when the idea for it was first conceived.

Transmission of cultural capital and status attainment – an analysis of development between 15 and 45 years of age

Werner Georg University of Konstanz, Germany
werner.georg@uni-konstanz.de

(Received February 2015 Revised September 2015) http://dx.doi.org/10.14301/llcs.v7i2.341

Abstract

Starting with Bourdieu's habitus and capital theory, this paper focuses on the question of whether the cultural resources of families and students have an impact on the status attainment process between the ages of 15 and 45. The analysis is based on the LifE survey, which follows up a youth study conducted by Fend et al. between 1979 and 1983. It can be shown by means of a structural equation model that there is a substantial transmission of cultural capital between parents and their children and that students' cultural resources have an effect on their educational attainment (reproduction effect). Besides this social inheritance, the amount of cultural capital acquired by age 35 also depends on educational attainment. The effect of cultural capital over the life course is limited to the period up to the completion of vocational/professional education.

Keywords

Cultural capital, social inequality, life course, status attainment

Introduction

Previous empirical assessments of Bourdieu's reproduction theory have resulted in a substantial number of publications (in summary: Jaeger, 2011; Lareau & Weininger, 2003). Even with Bourdieu himself, both the theory's logical status and its operationalisation are relatively vague. Thus, it can hardly be surprising that research findings are in part heterogeneous, and it is difficult to gain a comprehensive overview. Many studies do not use primary data, but instead draw on a variety of indicators to identify cultural capital, above all on the level of measurement theory. Also problematic are many study designs intended to capture the effects of cultural capital in various life-course segments.

Thus, for example, researchers ask children to recall their parents' cultural capital (Sullivan, 2001). Data collection may be limited to the cultural resources of one parent or the other (De Graaf, 1986) or of students (DiMaggio, 1982).

Furthermore, it is unclear how cultural capital affects status development for people from different classes in different life segments. Bourdieu assumes habitus to remain constant over the life course (hysteresis). This means that cultural capital would have to be significant over an entire life course. In contrast, however, newer biographical research approaches (Kohli, 1988) assume deinstitutionalisation and individualisation of life-course-specific patterns.

In another research field, lack of clarity prevails around reproduction theory, which developed during the 1960s in the framework of industrial-societal structures. There was widespread agreement with regard to "persistent inequality" in the 1990s (Shavit & Blossfeld, 1993). However, newer studies using larger cumulative data sets increasingly conclude in international comparisons

that upward mobility clearly did occur in twentieth-century educational systems (Breen Luijks, Müller & Pollack, 2010). Furthermore, studies show that schools do not exclusively maintain inequality, but can also contribute to social leveling (for Germany: Meulemann & Wiese, 1984; for America: Entwistle & Alexander, 1992). Against this background, we can question the relevance of reproduction theory for contemporary post-industrial societies, especially since the theory is rather hermetically formulated.

In this context, we can propose a few research desiderata. We use a longitudinal data set (LifE Study) that includes information on both parents and children and follows a target cohort over a period of 33 years. On this basis we examine the following questions:

- Through what process is cultural capital transmitted from parents to children?
- Does cultural capital influence children's academic success?
- Up until what point in the life course between 15 and 45 years of age does a target cohort's cultural capital exert influence upon its status development?
- How stable is cultural capital over a life course?
- Do schools independently contribute to developing cultural capital?

Theory

Alongside rational choice theories, Bourdieu's reproduction theory (Bourdieu & Passeron, 1971; Bourdieu, 1982; Bourdieu, 1983) has become a dominant paradigm for explaining social inequality in educational systems. The core assumption of this theory is that cultural capital, besides transferring economic capital, plays an increasingly significant role in status acquisition. Bourdieu distinguishes three forms of cultural capital: incorporated, institutionalised and objectified cultural capital.

Embodied cultural capital is internalised within the framework of the family of origin's lifestyle and becomes a 'natural' part of habitus. Family cultural practice is acquired in an extended process as a virtual template, and this template's activation has effects on other people as an integral component of personality. In various passages, Bourdieu emphasises that it is precisely this apparent naturalness of incorporated cultural capital and habitus that constitutes its efficacy in socially reproducing ruling class segments.

Institutionalised cultural capital, in contrast, is transmitted and acquired in a methodical and didactic way in educational institutions within a framework of canonised knowledge resources. These institutions dispose of definition power regarding legitimate knowledge and award credentials attesting to general competence, making accessible specific positions and careers. Moreover, not only is knowledge transmitted in educational systems, but a specific habitus is also expected and rewarded, corresponding to that of groups with power of definition. Besides individual competencies and abilities, in Bourdieu's view, successful completion of a study program presupposes a habitual fit between the milieu of origin and the 'culture' of a respective educational institution or field of study. Objectified cultural capital, after all, refers to the possession of cultural artifacts.

According to Bourdieu, embodied cultural capital is unequally distributed in social space and is monopolised by upper classes (literally: 'ruling classes') as a status marker, enabling members to secure competitive advantages over lower classes in educational systems. A necessary core assumption of reproduction theory is that unequally distributed, embodied cultural capital is also passed on to successive generations in the form of familial socialisation processes.

Social inequality in educational systems arises in this context because schools (and universities) implicitly presuppose certain amounts of embodied cultural capital that make it possible to accumulate institutionalised cultural capital in school frameworks. Successful educational habitus is thereby constituted through both familiarity with the dominant 'legitimate' culture and behaviour and non-cognitive abilities such as discipline, high levels of commitment, and belief in one's own self-efficacy. What remains relatively hazy from this viewpoint, however, is how lower-class children are disadvantaged in everyday school interactions. Are cognitively relevant curricular deficiencies responsible (according to Boudon (1974), thus primary effects of origin), or different linguistic codes (Bernstein, 1972), or the self-confident demeanor and presentation characteristic of upper-class habitus, or do teachers arbitrarily reward students who recognise habitual signals of their

own class of origin? This distinction is significant insofar as only differences in competence would be subject to meritocratic legitimisation.

Sullivan (2002) is correct in holding that, with regard to theoretical testability, central elements of Bourdieu's reproduction theory are still astonishingly vague. This is true not only for underlying core processes, such as acquiring embodied cultural capital or the above-described concomitant school interaction and devaluation of lower-class students, but also for the question of how cultural capital can then be measured and operationalised. Thus, it is surprising how much paradigmatic significance reproduction theory has acquired and how many international studies build on this theory.

Previous research

Various empirical studies have given rise to criticism of Bourdieu's capital and reproduction theory. Bourdieu's own empirical findings are limited to bivariate correlations between, on one side, family of origin status and cultural practices, and, on another, class-specific school success. To find support for reproduction theory, it would first be necessary to develop a theoretically grounded measurement theory of cultural capital. After that, one would have to demonstrate intergenerational transmission of cultural capital, and ultimately a substantial effect of incorporated cultural capital on measurements of academic success and later professional status. Previous research has examined only part of this causal chain, and for some data, measurement quality is only to a limited extent satisfactory.

DiMaggio (1982), as well as DiMaggio and Mohr (1985), have examined Bourdieu's assumptions together with Max Weber's status culture theory. In their analyses, they used data from the TALENT Project. Their sample consisted of eleventh-grade students, surveyed in different types of schools. They factor analytically measured cultural capital using indicators such as interest in attending classical music concerts, participating in theatre groups and artistic activities, reading 'serious' literature and having a cultivated self-image. This factor served as an independent variable to explain students' grades in various different subjects. The father's educational attainments (diplomas) and language skills were control variables in a regression model. The strongest effect was demonstrable in English, whereby only language skills and cultural capital exerted influence, but not the father's professional status. In addition, two competing hypotheses were tested – namely 'reproduction hypothesis' and 'mobility hypothesis'. The first hypothesis deals with monopolisation of cultural capital as an indicator of upper-class status culture; the second hypothesis asserts that lower classes can use cultural capital as a means of upward mobility. Confirmation of the reproduction hypothesis could only be found for female respondents, while for male students across all groups, effects varied only to a limited extent and tended rather to confirm the mobility hypothesis. DiMaggio suspects that, for boys, cultural capital has relatively limited influence on upper-class reproduction, because 1960s sons from this group belonged to non-conformist youth sub-cultures that rejected high-cultural lifestyles.

De Graaf (1986) analysed the influence exerted by cultural capital on educational achievements of families' oldest and second-oldest children. For cultural capital, he used two scales: 'parents' cultural consumption' measured by theatre visits, museum visits and visiting historical buildings, and 'reading climate': reading 'serious' literature and visiting libraries. As latent control variables in a structural equation model, he used parents' socioeconomic status (educational attainments of father and mother, as well as the father's professional status), family income and number of siblings. He subdivided the sample into two cohorts (children aged 25-40 and 41-65). His study showed that family socioeconomic status exerted only limited influence on reading climate, but reading climate exerted strong effects on educational attainment. This pattern was reversed for cultural consumption, which depended strongly on family sociocultural background, but had no effect on children's educational success. This finding, in contrast to Bourdieu's assumptions, supports the supposition that high culture does not determine educational outcomes, but rather serves as an indicator for high status culture in Weber's sense. In contrast, reading climate, which serves as an indicator for cognitive and linguistic skills, strongly influences educational outcomes; however, this influence is only half as strong in the younger cohort.

Similar to the above study, De Graaf, De Graaf & Kraaykamp (2000) propose differentiating between

cultural consumption and reading behaviour. They reason that, in countries with modernised school systems like the Netherlands, compared to France, high-cultural content is not as strongly anchored in curricula. In contrast, they assume that developed parental reading culture enables children to acquire language and cognitive skills that make it easier to succeed in modern democratised school systems. In a second step, the authors test DiMaggio's reproduction and mobility thesis using a sample of respondents to the 1992/93 Dutch family survey. On this basis, they calculated three sequential regression models, whereby the first model analysed the influence of cohorts, gender, incomplete families, parental educational attainments and fathers' professional status on children's school attainments. Results showed that parents' education level exerted a significantly stronger influence on children's educational status than the father's profession. In a second step, a combined measure of cultural capital was introduced containing five items related to cultural consumption and reading behaviour. In this model, the predictive power of parental educational attainments and that of the father's professional status decreased substantially. In a final step, they divided the common scale for cultural capital into two subscales for cultural consumption and reading behaviour. In this model variant, only parental reading behaviour significantly influenced children's educational status. To test the reproduction and mobility hypotheses, in the last two model variants constructed the interaction effects between parental educational accomplishments and various measures of cultural capital. This combined scale for cultural capital had a strong negative effect, which suggests that children from families with low educational achievement use cultural capital as a means of upward mobility. Separating the two measures again showed a non-significant effect of cultural consumption, while reading behaviour had almost the same predictive power as the combined scale. One can summarise these results as follows:

In contrast to Bourdieu's results for France in the 1960s and 1970s, consumption of high culture is no longer significant for explaining school success in modernised educational systems like those in the Netherlands. However, cultural capital operationalised as reading behaviour in the sense of verbal and cognitive abilities proved a strong predictor of school success. In this variant, cultural capital serves as an instrument of upward mobility and not as a means of social closure for higher status groups.

Sullivan (2001) surveyed students in four English classes aged 16 with regard to their socioeconomic background and cultural activities in the areas of reading, television consumption, taste in music and participation in high-cultural events, and finally tested their language skills and cultural knowledge. In addition, students were asked about their parents' cultural capital, which was measured in number of books per household, parental reading habits, music and media consumption, participation in high-cultural activities, and topics discussed at home. In a statistical analysis, the influence of cultural capital on children's school success was modeled in three steps: first, a regression model was calculated in which parents' school education, professional status and the types of school attended by children were used as predictors for children's cultural activities. In this connection, membership of the higher service class (Goldthorp class schema) and university degrees turned out to be significant. Parental cultural activities were added in a further model. In this model, the previous model's significant effects disappeared, and only cultural capital exerted a significant influence. These results support intergenerational transmission effects of cultural capital. In two further steps, the effects of the above-named children's cultural practices on language and cultural knowledge tests were examined. Above all, watching thought-provoking television programs and reading intellectually challenging literature were significant predictors, whereas participating in musical activities and formal cultural events had no substantial effects. There were similar findings for the knowledge test, with the exception that the order was reversed. As the last link in a causal chain, the influence of the named variables on a combined index was examined with regard to all of the children's school grades. Aside from scores on the two skill tests, reading behaviour and TV consumption were again the factors with significant effects. In summary, the analysis was successful in modeling cultural capital influences insofar as interconnected causal influence could be shown, starting from the transmission effect up to influences on school performance. Again, it was reading behaviour and not participation in high-

cultural activities that influenced abilities and school success.

Baumert, Watermann & Schümer (2003) analysed the transmission of social inequality using data from the PISA 2000 Study for Eastern and Western Germany in the framework of a family process model that distinguished three levels. Exogenous variables were family socioeconomic status (measured by highest ISEI – International Socio-Economic Index) and educational level (highest school diploma), as well as immigration status and length of residence in Germany. Mediating variables were three latent variables: cultural practice in Bourdieu's sense (investment in cultural artifacts like books or artworks, shared family cultural activities), family-internal communicative practice as described in Coleman's social capital theory (1988), and consumption behaviour (owning luxury goods etc.), alongside two manifest variables: number of siblings and languages spoken at home. The dependent variable was the test score for reading ability. While family cultural practices proved to be strong predictors of reading ability, social capital and consumption behaviour had no substantial effect in this regard. Additionally, the number of siblings and languages used at home had only weak effects. Cultural practice was strongly influenced by the family's socioeconomic background and education levels, while social capital was relatively independent of both factors. Finally, consumption behaviour showed medium dependence. In Eastern Germany, the percentage of explained variance in reading ability was lower, but predictions of test scores showed almost the same pattern as in Western Germany. However, cultural practice was less dependent on families' socioeconomic and educational status, and immigration status had a lower indirect influence on reading ability. The authors conclude from the findings that the concept of cultural capital, which in this model only passes on the effects of social inequality (professional status and education), has significantly greater construct validity than Coleman's concept of social capital.

What observations can we make against the background of previously discussed empirical findings? As a general conclusion, we find that cultural capital can be regarded as a key concept for the transmission of social inequality between generations in various countries. However, in modernised school systems the tendency seems to be that the relevant factor in transmitting social inequality is not participation in high-cultural activities, but rather family reading culture. If the latent variable for cultural capital in the study by Baumert et al. (2003) is deconstructed into measures of attending cultural institutions (museums, theatre, opera) and measures of reading behaviour (number of books in household, possession of classical literature and poetry books), only reading behaviour influences reading ability (author's calculations, publication in preparation). This circumstance makes us ask whether, with this operationalisation of cultural capital, it is not more a matter of transmitting cognitive abilities than of arbitrary familiarity with elements of the dominant high culture. This topic will be dealt with in greater detail below. We still do not know whether upper classes use cultural capital to reproduce their status, or lower and middle classes use it as an instrument of social mobility. DiMaggio's findings support the first assumption only for girls, while De Graaf et al. (2000) found support for the second hypothesis. Most of the studies discussed above feature specific deficiencies in their sampling design or measurements of cultural capital. De Graaf (1986) criticised DiMaggio (1982) for obtaining information only about students' cultural capital but not parents'; as a result, analysis of the transmission process becomes impossible. In contrast, De Graaf's data (1986) included only information on parental cultural activities. Sullivan (2001) reconstructed parental cultural capital using information provided by children, a problematic method with regard to data validity.

Excursus: Measurement theoretical considerations of cultural capital and implications for this study

As is clear from the above overview of previous research, there is no unified measurement or theoretical concept for cultural capital. This may also be the case because Bourdieu's theoretical formulation (1982, 1983) is relatively vague in this regard, which has resulted in different definitions and operationalisation methods being used in previous research (Jaeger, 2011; Lareau & Weiniger, 2003).

For Bourdieu himself (1982, pp. 800 ff.), cultural capital referred above all to high-cultural practices (reading literature, media consumption, music,

attending cultural events, aesthetic preferences) and knowledge of cultural fields (composers, directors, musical pieces). As already shown above, however, research has made an initial rough differentiation between high-cultural practices (Aschaffenburg & Maas, 1997; DiMaggio, 1982; Dumais, 2002; Kalmijn & Kraykamp, 1996; Katsillis & Robinson, 1990; Sullivan, 2001; Van de Werfhorst & Hofstede, 2002) and reading behaviour or reading culture (De Graaf, 1986; De Graaf et al., 2000; Jaeger & Holm, 2007). Besides this differentiation, education-related resources and materials (Deutsches PISA-Konsortium, 2001; Downey, 1995; Eitle & Eitle, 2002; Teachman, 1987), as well as extra-curricular or voluntary school activities (Aschaffenburg & Maas, 1997; Covay & Caborno, 2010; Kaufmann & Gabler, 2004) were drawn on to measure cultural capital.

Lareau and Weininger (2003) criticise the dominant definition, narrowly tied to high-cultural practices, of cultural capital and – drawing on different sources of Bourdieu – propose a broader definition related to negotiating processes for legitimating partial status signals between parents and institutional agents of the education system:

> "As we noted earlier, in our view the critical aspect of cultural capital is that it allows culture to be used as a resource that provides access to scarce rewards, is subject to monopolisation, and, under certain conditions, may be transmitted from one generation to the next…" (Lareau & Weininger, 2003, p. 587).

Suppose one starts from this general definition of cultural capital and understands it as a cultural resource that can be monopolised and that creates access to scarce rewards. This definition would then subsume not just arbitrary familiarity with status signals of legitimate high culture, but also linguistic and cognitive competencies mediated within a family's reading culture.

In view of the definitions and measurement concepts used in previous research on cultural capital, we can summarily conclude that in this regard controversies exist over both theory and operationalisation. Of course, this makes it more difficult to compare findings, but we can nonetheless maintain that, despite these differences, most studies agree that cultural capital exerts a moderate to medium influence on measures of academic success (grades or diplomas).

What do these results mean for evaluating the measures used in this study for cultural capital and their usefulness? First, for parental cultural capital beginning in 1980 we must draw on the few available indicators, namely frequency of reading, number of books per household and course attendance. Overall, this operationalisation is thereby very close to the concept of family reading culture used by De Graaf (1986), as well as De Graaf et al. (2000), and is less oriented to families' high-cultural practices. In both studies, however, it was also found that effects on children's academic success arose solely from reading culture and not from consuming high culture.

Besides reading, available indicators for students aged 15 included particularly music-related activities, namely learning to play a musical instrument and listening to classical music. In a newer DIW (German Institute for Economic Research – Deutsches Institut für Wirtschaftsforschung) study (Hille & Schupp, 2013), it was shown that youth between the ages of eight and 17 who practiced playing musical instruments did better by a quarter of a standard deviation on cognitive language tests than students of the same age lacking this practice, and their average grade was one-sixth of a standard deviation better. Furthermore, they were a quarter of a standard deviation more conscientious and more open, and the probability that they would graduate from a gymnasium (secondary school leading to university study) and want to attend a university was 15% higher than in a comparison group (Hille & Schupp, 2013, p. 23). In this study, a multiplicity of control variables with regard to parents were used and reverse causality was investigated. So far, it appears that, besides reading books, playing musical instruments is a promising indicator for cultural reproduction in educational systems. Listening to classical music serves in this connection as an indicator for high-cultural orientation of young people.

For follow-ups in 2002 and 2012, a new instrument was developed to capture cultural capital, from which, after factor analysis, three items with the highest loading were used (attending classical concerts, theatre performances and art exhibitions, reading 'serious' literature and listening to classical music).

It could be said that, given the various sorts of definitions and measuring concepts of cultural

capital presented above, employing only three items for parents and youths per measurement time-point is not very meaningful. However, in almost all the studies presented above, only a few items were used (usually between two and four indicators per dimension), and in cumulative consideration the state of findings is consistent – insofar as, usually, moderate or medium effects on academic success could be ascertained. In addition, measurements of parental reading culture and high-cultural practices of surveyed persons move within the two 'mainstream' dimensions for measuring cultural capital.

Research Questions and Hypotheses

To correct the deficiencies mentioned above in the previous research on cultural capital and social reproduction, it would be desirable to compare the different influencing factors (e.g. reading habits and cultural consumption) used in previous surveys for both parents and children in order to analyse specific transmission processes, and then to predict what influence these factors have on social status development over the course of life. However, the available data do not include all the information that would be needed for this, and the following analyses are limited to parts of such models. First, the available measures of these factors are limited to combined indicators for reading behaviour and cultural consumption, and second, we can only predict the impact of these factors on educational and training achievements, along with occupational status at ages 35 and 45. Against this background, certain research questions and hypotheses can be formulated, derived from Bourdieu's theory and the recent research discussed above.

Classical path models for status acquisition (Blau & Duncan, 1967) conceptualise the direct transmission of parents' educational attainment to their children's academic careers. These models can be used to analyse openness and social mobility (or social closure) in various societies. Here, however, it remains unclear what processes cause social status transmission from one generation to another. According to Bourdieu's theory, family cultural resources could be the key concept for the inheritance of social status. This would mean that after controlling for direct paths between parents' and children's education levels, a substantial indirect effect should be found that would function through parents' cultural resources and their transmission to children.

Hypothesis 1: In addition to a direct transmission effect of parents' educational attainments to those of their children, there are also indirect effects connected with the transmission of cultural resources from parents to children (transmission effect) and a resulting effect of this on children's own educational attainments (reproduction effect).

Furthermore, Bourdieu supposes that embodied cultural capital's influence is not limited to the results of educational processes, but also influences future professional careers, because mastery of complex cultural codes here leads to competitive advantages.

Hypothesis 2: Cultural resources influence not only levels of educational attainment, but also professional status development over the life course.

According to Bourdieu, habitus is embodied during primary socialisation, and over a life course becomes a dominant personality component.

Hypothesis 3: Cultural capital does not change substantially over a person's life course.

Reproduction theory assumes that incorporated cultural capital is learned exclusively in a family of origin framework (reproduction model). Based on previous studies (e.g., in Germany: Meulemann & Wiese, 1984; in America: Entwisle & Alexander, 1992), however, we can postulate that, as middle class institutions, schools do not serve, as Bourdieu thought, solely to disadvantage lower-class children, but can very well exert egalitarian influences on the acquisition of cultural capital (mobility model). Thus, in the Netherlands, Nagel (2010) found in a separate test of these effects on persons between 14 and 24 years of age that the parental home certainly had a significant effect, but both school and home show effects largely independent of each other.

> "An increase in cultural participation due to increasing educational level occurs for both children of culturally active family backgrounds and children whose parents have less interest in cultural activities." (Nagel, 2010, p. 553)

On this basis, two competing hypotheses were formulated concerning the reproduction and mobility models:

Hypothesis 4a: Consistent with reproduction theory, cultural capital is acquired exclusively in family frameworks.
Hypothesis 4b: Cultural capital is, based on the mobility model, acquired not only in families, but also in school frameworks.

Data and Measurements

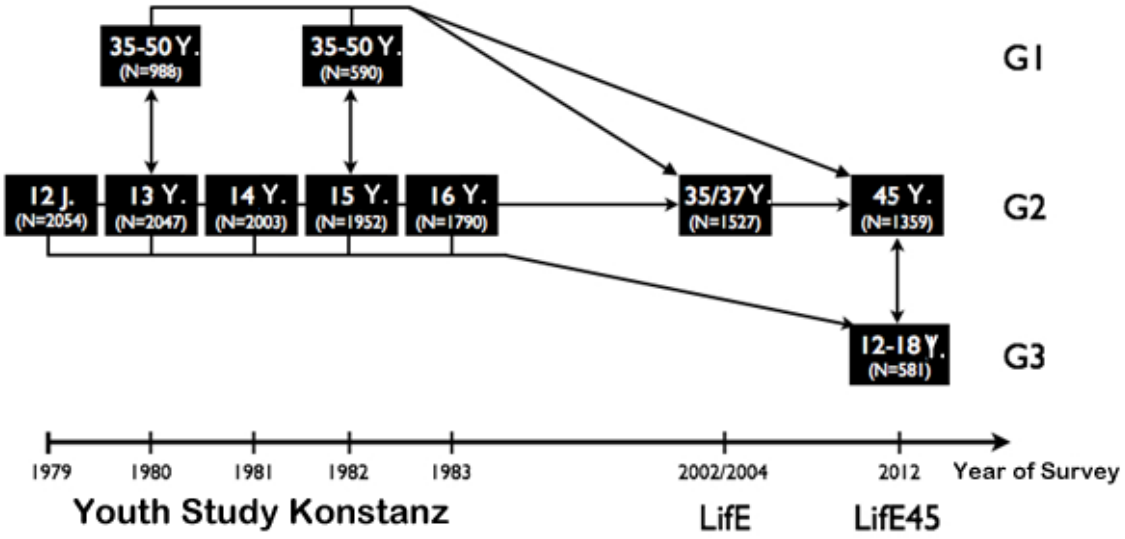
The following analyses are based on two follow-ups of a student survey (2002 and 2012) conducted with a 1979-1983 panel designed by Fend et al. (LifE-Survey: Lebensverläufe ins fortgeschrittene Erwachsenenalter; Pathways from late Childhood to Adulthood. Principal Investigators: Fend, Lauterbach, Grob, Georg & Maag Merki). In 1982, the students were on average 15, in 2002 on average 35, and in 2012 on average 45 years old. The survey covers a cohort from three Frankfurt city districts (Bockenheim, Westend, and Nordweststadt) and Odenwald, a rural district. In these districts, surveys were made of students from all school types who were in sixth grade in 1979. In all, 2,897 students participated at one point in the panel study section, and 1,790 respondents participated at all four measurement times. Due to absence, repeating a class or moving out of their school district, about 14% of participating students changed per year (i.e., some participants withdrew and were replaced). Within the sample context, hauptschüler and gymnasiasten (students in lower secondary schools and secondary schools leading to university study) are slightly under-represented compared to State Statistical Office data, while a strong bias can be observed regarding students from integrated comprehensive schools (gesamtschule, 30.9% in sample, and 16.8% in Hesse). Other differences can be found in a smaller representation of rural and small town residents (62.2% vs. 74.1%) and working class students (28.2% vs. 44.3%) (Fend, 1990).

In 1980 and 1982, students' parents were also interviewed. As part of an address study conducted between 2000 and 2002, it was possible to locate 2,021 of 2,897 students originally questioned at least once. Since 154 addresses were found to be incorrect, the final sample consisted of 1,867 people, of whom 1,527 (81.8%) participated in the 2002 survey. A significant selection effect of this sample in comparison to the original survey can be shown for nationality (German-background students participated more often), city size (large city residents are under-represented), social class (continuous participation declines with lower social status), and school type (larger panel loss of middle school students). The survey was conducted in spring/summer 2002 as a mail survey, where, in addition to a 10 Euro incentive bonus, reminder letters were sent and follow-up telephone calls were made. These two measures increased questionnaire returns to 15.7% and 22.2%. The follow-up survey included various 'subjective' and 'objective' indicators from the areas of school and work, family of origin, politics and worldview, leisure, and lifestyle, as well as psychological and physical health.

Between 2010 and 2012, a further address study was made, in which 1,599 target persons were identified as potential participants (net sample). In spring/summer 2012, a mail survey was again conducted, with a total of 1,368 respondents participating; the response rate was 85.55%. Measures intended to increase response rates were identical to those in 2002 (financial incentives, reminder letters, follow-up telephone calls).

Besides the target cohort (G2), questionnaires were sent (G3) to 685 children between 12 and 18 years old; these partially replicated questionnaires from interviewed students. From this cohort, 581 respondents answered, and thus here the response rate was 85.11%. In the following analyses, the only data used were for parental generation (G1) and target cohort (G2).

Figure 1: Design of the LifE Study



In the structural equation model presented below, the following variables are used (means and standard deviations given in Appendix 1):

Cultural capital of G1 in 1980:
Frequency of reading in last three months (1 = never - 4 = more than twice monthly)
Course attendance in last three months (1 = never - 3 = more than twice)
Number of books in household (1 = up to 10 - 4 = more than 500)
Cultural capital of G2 in 1982:
Frequency of practicing a musical instrument (1 = never - 4 = very often)
Frequency of reading books (1 = never - 4 very often)
Frequency of listening to classical music (1 = never - 4 = very often)
Cultural capital of G2 in 2002:
Frequency of reading 'serious' literature (1 = never - 5 = very often)
Frequency of attending classical concerts, theatre and art exhibitions (1 = never - 5 = very often)
Frequency of listening to classical music or jazz (1 = never - 5 = very often)
Cultural capital of G2 in 2012:
Frequency of reading 'serious' literature (for range, see above)
Frequency of attending classical concerts, theater and art exhibitions (for range, see above)
Frequency of listening to classical music or jazz (for range see above)

Socio-demographic variables:
G2 in 2002:
Highest school diploma (1 = primary school - 5 = higher education entrance qualification/Abitur)
Highest level of education (1 = apprenticeship - 5 = university degree)
Gender (1 = female, 2 = male)
Socioeconomic status of profession according to International Socio-Economic Index (ISEI, Ganzeboom et al., 1992, range 16-90)
G2 in 2012:
Highest educational degree of father and mother (1 = primary school - 4 = university entrance qualification certificate (Abitur) (asked retrospectively with respect to G1)
ISEI of current main profession.

Results

In order to analyse the reliability of the measures for cultural capital preceding the structural equation model, Cronbach's Alpha was computed for each dimension:

Table 1: Cronbach's Alpha for the Latent Dimensions

Dimension	Alpha
Cultural Capital Parents 1980	.59
Cultural Capital Child 1982	.55
Cultural Capital 2002 (35 years)	.64
Cultural Capital 2012 (45 years)	.63

As Cronbach's Alpha depends on the number of items and the dimensions of the model only consist of three items, these values can be regarded as satisfactory (Nunally, 1967).

To test the four hypotheses described earlier in this paper, a structural equation model was developed that included the following measurement model:

Parents' cultural capital (1980) was calculated from the frequency of reading and course attendance in the past three months. In addition, this dimension was associated with the number of books in the parental household. Cultural capital for children at age 15 (1982) was measured based on the frequency of practicing musical instruments, reading books, and listening to classical music. Twenty years later, cultural capital was measured for participants, now on average 35 years old, based on their frequency of reading 'serious' literature, attending theatre performances, classical concerts and art exhibitions, and listening to classical music or jazz. The same measurement model was used in 2012 for now 45-year-old respondents. An auto-correlation of measurement error was allowed for the same items measured in the ten-year period.

Educational status of the family was determined by the highest educational degree of the father and mother, while the highest level of school education and training completed determined that of their children. To capture how the status acquisition process progressed, the ISEI at ages 35 and 45 was included in the model. In this measurement model, respondents' cultural capital was collected over a period of 30 years, three times over the course of development. Two indicators were identical (reading and listening to classical music), while one indicator was different for reasons of varying age-specific cultural practices (people usually learn to play musical instruments in their childhood and youth, and classical concerts or art exhibitions are chiefly attended by adults).

In order to check hypothesis 1 at a structural level, first, a direct influence of parents' educational status on that of their children was assumed (direct educational inheritance), and a path to parents' cultural capital was introduced. It was further supposed that this cultural capital affects children's cultural capital at age 15 (transmission path). To analyse Bourdieu's predicted reproduction effect, it was further suggested that cultural capital at age 15 affects surveyed students' educational status. In addition to the direct effects of parents' educational level, indirect reproduction effects through cultural resources were thus posited.

Hypothesis 2 is related to long-term effects of cultural capital on professional status development, independently of its effects on achieved educational status. Therefore, aside from the effects of educational attainment on professional status, direct effects of cultural capital at age 35 were allowed for in the ISEI in both 2002 and 2012. Additionally, the effects of cultural capital were allowed for in the ISEI at age 45 in 2012.

Finally, hypothesis 3, based on an assumption of habitus hysteresis, posits that cultural capital will be highly stable over the life course. This assumption is

tested by allowing for the direct effects of cultural capital between ages 15 and 35, and between 35 and 45.

In competing hypotheses 4a and 4b, the reproduction model was contrasted with the mobility model with regard to the acquisition of cultural capital. In order to test the two hypotheses, a path was identified from the educational status of individuals surveyed to their cultural capital at age 35.

The thus-specified structural equation model was calculated with Mplus version 7.11 using a WLSMV estimator (Weighted Least Square Mean and Variance Adjusted) for ordinal data. In contrast to full information maximum likelihood or simple maximum likelihood estimators, the WLSMV estimator is distribution free (non-parametric) and assumes no metrical scale niveau or normal distribution of variables; it is thereby suitable for an ordinal scale niveau. The missing value algorithm of this estimator is based on a 'pairwise present' regression approach, i.e., probit regressions are calculated to predict missing values between available pairs of variables (Muthén & Muthén, 2012, p. 8). Accordingly, the respective number of cases varies, and there are in all a maximum of 1,339 cases. In order to compare the sensitivity of this missing value algorithm with a case-wise exclusion (listwise deletion) of missing values, the model was calculated using both procedures. However, no substantial differences were found, so it can be assumed that the results are stable in this regard.

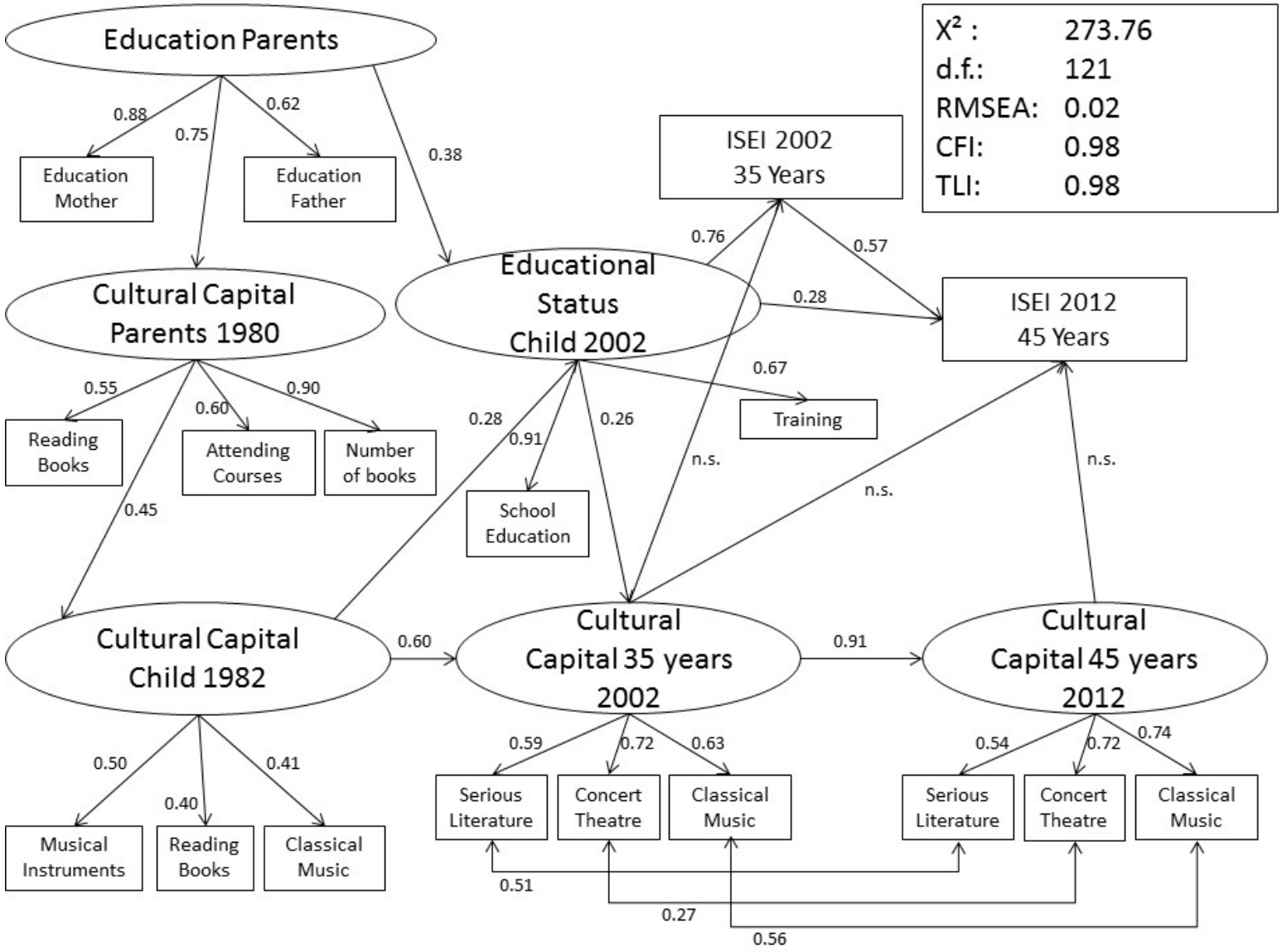
To test the model's goodness-of-fit with the data, different measures are used in Mplus. The likelihood test compares the null hypothesis that the empirical covariance (or correlation) matrix and the matrix estimated based on the model are exactly identical to the alternative hypothesis that the two matrices are significantly different. A problem with the likelihood test is that it is almost always significant if the sample size is large, and therefore the model has to be rejected. Consequently, fit measures independent of sample size are increasingly being used. In this connection, absolute and incremental fit measures can be distinguished. As an absolute fit measure, one can use the Root Mean Square Error of Approximation (RMSEA), which measures approximate data fit. Bentler's (1990) Comparative Fit Measure (CFI) and the Tucker-Lewis Index (TLI) can be regarded as incremental fit measures. In different ways, both measure deviance from a baseline model in which only variances of observed variables are taken into consideration, but they have no relationships in the form of covariances (Muthén, 1998-2004, p. 23). Based on simulation studies, Hu and Bentler (1999), as well as Yu and Muthén (2002), hold that models with a good fit should have a RMSEA <.05 and a CFI or TLI >.95.

De Graaf et al. (2000) and Sullivan (2001) found that reading behaviour had a stronger effect on educational success than knowledge and practice in the field of high-brow culture. In order to test this assumption, two models were estimated, one with the indicators for cultural capital mentioned above and the other one solely with reading practice. However, in contrast to the findings of De Graaf et al. (2000), the effects of reading behaviour on educational attainment turned out to be insignificant.

Table 2: Direct and Indirect Effects of the Model (standardised)

Effect	Beta	P-Value
Education Parents – Cultural Capital Parents	.75	<.001
Education Parents – Cultural Capital Parents	.38	<.001
Cultural Capital Parents – Cultural Capital Child 1982	.45	<.001
Cultural Capital Child 1982 – Educational Status	.28	<.001
Educational Status Child – Cultural Capital Age 35	.26	<.001
Educational Status Child – ISEI 2002	.76	<.001
Educational Status Child – ISEI 2012	.28	<.001
ISEI 2002 – ISEI 2012	.57	<.001
Cultural Capital 1982 – Cultural Capital 2002	.60	<.001
Cultural Capital 2002 – Cultural Capital 2012	.91	<.001
Cultural Capital 2002 – ISEI 2002		n.s.
Cultural Capital 2002 – ISEI 2012		n.s.
Cultural Capital 2012 – ISEI 2012		n.s.
Cultural Capital Parents 1980 – Cultural Capital Child 1982 – Educational Status Child 2002	.13	.001

Figure 2: Structural equation model of cultural capital's influence on status development between 15 and 45 years of age



The estimated structural equation model should be rejected based on the likelihood chi-square test ($p < .001$), as was also expected because of sample size. However, the RMSEA (.02) and the CFI and TLI (both .98) point to a very good model fit with the data. In figure 2, all coefficients shown are standardised and significant at least at the 5% level. In the measurement model framework, the number of books per family household proves by far the most important indicator of parents' cultural capital (.90), whereas reading books and attending courses are about equally important (.55 or .60). In children's cultural capital at age 15 (1982), practicing a musical instrument (.50) is slightly more relevant for the latent variable than reading books and listening to classical music (.40 or .41). At age 35, attending concerts, theatre and art exhibitions (.72) are slightly weightier than reading 'serious' literature (.59) and listening to classical music (.63), whereas ten years later both attending high-cultural events and listening to classical music (.72 and .74) are substantially more important than reading 'serious' literature (.54).

In the model's structural part, there is a close relationship between parents' educational attainments and their cultural capital (.75). The transmission effect of parents' cultural capital to that of their children (.45) indicates strong effects of learning cognitive schemata during primary socialisation and thereby supports Bourdieu's theory of habitus inheritance. Furthermore, there is a substantial path from children's cultural capital to educational status identified in 2002 (.28). Based on these findings, hypothesis 1 cannot be rejected, according to which a (indirect) reproduction effect was posited via transmission of cultural capital within families parallel to the direct effect of parents' education on that of their children.

The influence of cultural capital on the status attainment process is only significant until professional/occupational training is completed, and occupational status at age 35 is exclusively predicted by the educational status attained (.76). Furthermore, cultural capital had no significant effects either in 2002 or 2012 on occupational status at age 45. Occupational status at 45 can best be predicted using ISEI at age 35 (.57), but beyond this, it is also still linked with educational attainment (.28). The status development coming to light here thus suggests that after career training is completed, the effects of educational and vocational systems are strongly intertwined alongside labour market-immanent processes of labour mobility. In summary, we can conclude that, overall, a student's cultural capital has effects only until their career training is completed. The assumption made in hypothesis 2 cannot be confirmed here, that cultural capital has an effect on status development throughout the course of a person's life.

The third hypothesis, assuming hysteresis of habitus, posited a high stability of cultural resources over a life course. The present data set provides a rare opportunity to investigate the stability of cultural capital using three measurements over a period of 30 years. Although only two of the three indicators are identical between 15 and 35 years of age, the use of a different item is due to age-specific cultural practices. Stability is remarkably high between 1982 and 2002, with a coefficient of .60 after an interval of 20 years. Even more remarkable is the fact that, with an identical measurement at a ten-year interval, a stability coefficient of .91, i.e., 83% variance in 2012, can be predicted with measurements from 2002, and the indirect stability effect from 1982 to 2002 and 2012 amounts to .55. Thus, hypothesis 3 cannot be rejected.

Concerning hypotheses 4a and 4b, two possible modes for acquiring cultural capital during the life course are imaginable: namely, quasi-class-based acquisition in the parental home, as reflected here in the high transmission effect of .45, and 'meritocratic' acquisition through educational systems (Nagel, 2010). Thus, by separating these effects between 14 and 24 years of age, Nagel (ibid.) found that parental home effects were indeed more important, but the two modes of acquisition display effects that are largely independent of each other. The path leading from children's educational status to their cultural capital at age 35 confirms this (.26). In the period studied, cultural resources are thus acquired in two different ways, namely, on one hand, by cultural inheritance aided by the parental home and, on another, through mediation in educational institutions. This finding conflicts with Bourdieu's supposition that embodied cultural capital is acquired exclusively within family contexts.

Discussion

Empirical study of Bourdieu's posited reproduction of socioeconomic status through cultural capital transmission at home has drawn attention to certain desiderata. Thus, past research has focused either solely on the effects of children's cultural resources on their academic success (DiMaggio, 1982), which makes an analysis of transmission processes impossible, or has analysed only parents' cultural capital (De Graaf, 1986). Sullivan (2001) and Yaish & Katz-Gerro (2010) chose a third approach and reconstructed parents' cultural capital using information provided by their children. This, however, raises issues of data validity. Moreover, with cross-sectional data collection, the duration of cultural capital influence over a person's life course remains uncertain, and the causal direction of status attainment processes underlying social reproduction cannot be adequately captured. Although some panel studies have been made in this area (Aschaffenburg & Maas, 1997; Kloostermann, Notten, Tolsma & Kraykaamp, 2011), and although data on parents' and children's cultural capital were not collected separately in these studies, the time periods analysed were relatively short (e.g., seven years, Kloostermann et al., 2011) and were limited to periods of school attendance. With the data available here, some of the desiderata can be realised:

- Separate collections of the cultural capital of parents and children make it possible to examine the scope of transmission processes.
- Over a period of 30 years, there are in each case three measurements of target cohort cultural capital (at 15, 35 and 45 years of age). In addition, the status attainment process was also surveyed over the same period (educational attainment, training qualification and occupational/professional status at 35 and 45 years), so that over this period processes of creating social inequality in dependence on cultural capital can be successively modeled.

Starting from four hypotheses about the processes of reproduction through cultural resources, their efficacy, and their stability in life course segments, we reached these key conclusions:

- Parents' cultural capital depends strongly (.75) on their educational status, and we can identify a definite process of transmission to their children (.45). Children's cultural capital affects their educational and training attainments in a substantial way (.28). Thus, some social reproduction occurs through family cultural resources.
- The effects of cultural capital over the life course are, contrary to Bourdieu's theory, limited to the period up to completion of vocational/professional training. Then, further development follows through a synchronization of educational and vocational systems (statutory regulation of access to professional positions) as well as labour-market-internal processes in which educational status continues to play a role beyond previously achieved professional status.
- Additionally, contrary to Bourdieu's suppositions, embodied cultural capital is not acquired exclusively in families (class model), but also in educational systems ("meritocratic" model).
- Between 15 and 45 years of age, there is a high stability of cultural capital (.60 between 15 and 35 years, as well as .91 between 35 and 45 years of age). This finding suggests that orientation to high culture is an integral part of habitus that does not change greatly between ages 15 and 45.

How can we relate these results to Bourdieu's theory of cultural capital, habitus, and social reproduction? First, it has been confirmed, as in the studies presented here, that there are substantial moderate effects of family cultural resources on children's academic success. However, the strength of these effects is far from the only deterministic explanation for success in educational systems, and over the life course is limited to the phase up until completion of training. Furthermore, school cannot be regarded as merely a middle class institution that blocks chances for educationally disadvantaged families and children. Rather, it also has, once children have gained access to higher education (which is increasingly common), a leveling effect (.26) on cultural capital by the age of 35. Against this background, Bourdieu's theory seems too hermetically formulated with regard to processes of reproduction through cultural capital. While family of origin cultural resources appear important, they are not the sole mechanisms of transmitting (or reducing) social inequality.

References

Aschaffenburg, K. & Maas, I. (1997). Cultural and educational careers: The dynamics of social reproduction. *American Sociological Review 62*, 573-587. http://dx.doi.org/10.2307/2657427

Baumert, J., Watermann, R. & Schümer, G. (2003). Disparitäten der Bildungsbeteiligung und des Kompetenzerwerbs. Ein institutionelles und individuelles Mediationsmodell. *Zeitschrift für Erziehungswissenschaften 6*, 46-72. http://dx.doi.org/10.1007/s11618-003-0004-7

Bentler, P. M. (1990). Comparative fit indexes in structural models. *Psychological Bulletin 107*, 238-246. http://dx.doi.org/10.1037/0033-2909.107.2.238

Bernstein, B. (1972). *Studien zur sprachlichen Sozialisation.* Schwann: Düsseldorf.

Blau, P.M. & Duncan, O. D. (1967). *The American occupational structure.* New York: Wiley.

Boudon, R. (1974): *Education, opportunity and social inequality*. New York: Wiley.

Bourdieu, P. & Passeron, J.C. (1971). *Die Illusion der Chancengleichheit.* Stuttgart: Klett.

Bourdieu, P. (1982). *Die feinen Unterschiede. Kritik der gesellschaftlichen Urteilskraft.* Frankfurt a.M.: Suhrkamp.

Bourdieu, P. (1983). Ökonomisches Kapital, kulturelles Kapital und soziales Kapital. In Kreckel, R. (Hrsg.): *Soziale Ungleichheiten (Soziale Welt, Sonderband 2)*. Göttingen: Verlag Otto Schwartz, 183-198.

Breen, R. & Goldthorpe, J. (1997). Explaining educational differentials: towards a formal rational action theory. *Rationality and Society 9*, 275-305. http://dx.doi.org/10.1177/104346397009003002

Breen, R., Luijks, R., Müller, W. & Pollack, R. (2010). Long-term trends in educational inequality in Europe: Class inequalities and gender differences. *European Sociological Review 26*, 31-48. http://dx.doi.org/10.1093/esr/jcp001

Coleman, J. (1988). Social capital in the creation of human capital. *American Journal of Sociology 94*, 95-120. http://dx.doi.org/10.1086/228943

Covey, E. & Carbonaro, W. (2010). After the bell: Participation in extracurricular activities, classroom behavior, and academic achievement. *Sociology of Education 83*, 20-45. http://dx.doi.org/10.1177/0038040709356565

De Graaf, N.D., De Graaf P.M. & Kraaykamp, G. (2000). Parental cultural capital and educational attainment in the Netherlands: A refinement of the cultural capital perspective. *Sociology of Education 73*, 91-111. http://dx.doi.org/10.2307/2673239

De Graaf, P.M. (1986): The impact of financial and cultural resources on educational attainment in the Netherlands. *Sociology of Education 59*, 237-246. http://dx.doi.org/10.2307/2112350

Deutsches PISA-Konsortium (Hrsg.) (2001). *PISA 2000. Basiskompetenzen von Schülerinnen und Schülern im internationalen Vergleich*. Opladen: Leske und Budrich.

DiMaggio, P. & Mohr J. (1985). Cultural Capital, educational attainment and marital status. *American Journal of Sociology 90*, 1231-1257.

DiMaggio, P. (1982). Cultural capital and school success: the impact of status culture participation on the grades of US highschool students. *American Sociological Review 47*, 189-201. http://dx.doi.org/10.2307/2094962

Downey, D.B. (1995). When bigger is not better: Family size, parental resources and children's educational performance. *American Sociological Review 60*, 746-761. http://dx.doi.org/10.2307/2096320

Dumais, S.A. (2002). Cultural capital, gender and school success: The role of habitus. *Sociology of Education 75*, 44-68. http://dx.doi.org/10.2307/3090253

Eitle, P.M. & Eitle, D.J. (2002). Race, cultural capital and the educational effects of participation in sports. *Sociology of Education 75*, 123-146. http://dx.doi.org/10.2307/3090288

Entwisle, D.R. & Alexander, K.L. (1992). Summer setback: Race, school composition and mathematics achievement in the first two years of school. *American Sociological Review 57*, 72-84. http://dx.doi.org/10.2307/2096145

Fend, H. (1990). Vom Kind zum Jugendlichen. Der Übergang und seine Risiken. *Entwicklungspsychologie der Adoleszenz in der Moderne*. Band 1. Bern, Stuttgart, Toronto: Huber.

Ganzeboom, H.B.G., De Graaf, P.M., Treiman, D.J. & de Leeuw, J. (1992). A standard international socio-economic index of occupational status. *Social Science Research 21*, 1-56. http://dx.doi.org/10.1016/0049-089X(92)90017-B

Hille, A. & Schupp, J. (2013). How learning a musical instrument affects the development of skills. *SOEPpapers 591*, 1-33. http://dx.doi.org/10.2139/ssrn.2338467

Hu, L.T. & Bentler, P.M. (1999). Cutoff criteria for fit indices in covariance structure analysis: conventional criteria versus new alternatives. *Structural Equation Modeling 6*, 1-55. http://dx.doi.org/10.1080/10705519909540118

Jaeger, M.M. & Holm A. (2007). Does parent's economic, cultural and social capital explain the social class effect on educational attainment in the Scandinavian mobility regime? *Social Science Research 36*, 719-744. http://dx.doi.org/10.1016/j.ssresearch.2006.11.003

Jaeger, M.M. (2011). Does cultural capital really affect academic achievement? New evidence from combined sibling and panel data. *Sociology of Education 84*, 281-298. http://dx.doi.org/10.1177/0038040711417010

Kalmijn, M. & Kraaykamp G. (1996): Race, cultural capital and schooling: An analysis of trends in the United States. *Sociology of Education 69*, 22-34. http://dx.doi.org/10.2307/2112721

Katsilis, J. & Robinson, R. (1990). Cultural capital, student achievement and educational reproduction: The case of Greece. American Sociological Review 55, pp. 270-279. http://dx.doi.org/10.2307/2095632

Kaufmann, J. & Gabler, J. (2004). Cultural capital and extracurricular activities of girls and boys in the college attainment process. *Poetics 32*, 145-168. http://dx.doi.org/10.1016/j.poetic.2004.02.001

Kloostermann, R., Notten, N., Tolsma, J. & Kraaykamp, G. (2011): The effect of parental reading socialization and early school involvement on children's academic performance: A panel study of primary school pupils in the Netherlands. *European Sociological Review 27,* 291-306. http://dx.doi.org/10.1093/esr/jcq007

Kohli, M. (1988): Normalbiographie und Individuum. Zur institutionellen Dynamik des gegenwärtigen Lebenslaufregimes. In Brose, H.G. & B. Hildenbrand. (Eds*.). Vom Ende des Individuums zur Individualität ohne Ende*. Leverkusen: Leske & Budrich, pp. 33-54. http://dx.doi.org/10.1007/978-3-322-97182-1_2

Lareau, L. & Weininger E.B. (2003). *Cultural capital in educational research: A critical assessment.* Theory and Society 32, pp. 568-606. Theory and Society 32, pp. 568-606. http://dx.doi.org/10.1023/b:ryso.0000004951.04408.b0

Meulemann, H. & Wiese, W. (1984). Bildungsexpansion und Bildungschancen. Zeitschrift für Sozialisationsforschung und Erziehungssoziologie 4, pp. 287-306.

Muthén, B.O. (1998-2004): Mplus technical appendices. Los Angeles, CA: Muthén & Muthén.

Muthén, L.K. & Muthén, B.O. (1998-2012). *Mplus User's Guide.* Seventh Edition.

Nagel, I. (2010). Cultural participation between the ages of 14 and 24. Intergenerational transmission or cultural mobility. *European Sociological Review 26,* 541-556. http://dx.doi.org/10.1093/esr/jcp037

Nunally, J. C. (1967). *Psychometric theory.* New York: McGraw-Hill.

Shavit, Y. & Blossfeld H.P. (Eds.) (1993). *Persistent inequality: Changing educational attainment in thirteen countries.* Boulder, Colo.: Westview Press.

Sullivan, A. (2001). Cultural capital and educational attainment. *Sociology 35*, 893-912. http://dx.doi.org/10.1177/0038038501035004006

Sullivan, A. (2002). Bourdieu and education: How useful is Bourdieu's theory for researchers? *The Netherland's Journal of Social Sciences 38*, 144-166.

Teachman, J.D. (1987). Family background, educational resources and educational attainment. *American Sociological Review 52*, 548-557. http://dx.doi.org/10.2307/2095300

Van de Werfhorst, H.G. & Hofstede, S. (2007). Cultural capital and relative risk aversion? Two mechanisms for educational inequality compared. *British Journal of Sociology 58*, 391-415. http://dx.doi.org/10.1111/j.1468-4446.2007.00157.x

Weber, M. (1976). Wirtschaft und Gesellschaft. *Grundriss der verstehenden Soziologie*. Tübingen: Mohr.

Yaish, M. & Katz-Gerro, T. (2010). Disentangling ´cultural capital´: The consequences of cultural and economic resources for taste and participation. *European Sociological Review 26*, 1-17.

Yu, C.-Y. & Muthén, B. (2002). *Evaluation of model fit indices for latent variable models with categorical and continuous outcomes*. Technical Report. Los Angeles, CA: Muthén & Muthén.

Appendix

Appendix 1: Mean and Standard Deviation of Variables Employed

Variable	Mean	SD
Education Father	1.40	.62
Education Mother	1.38	.62
G1 Frequency of Reading	2.50	1.21
G1 Frequency of Course Work	1.46	.72
G1 Number of Books	2.47	.78
G2 Musical Instrument	1.80	.98
G2 Reading Books	2.50	.91
G2 Classical Music	.53	.72
G2 (2002) Highest School-leaving Qualification	1.20	.73
G2 (2002) Highest Training Qualification/Degree	2.09	1.51
G2 (2002) Serious Literature	1.90	1.00
G2 (2002) Concerts, Theater, Art Exhibits	1.93	.86
G2 (2002) Classical Music, Jazz	1.87	1.07
G2 (2002) ISEI	48.57	13.88
G2 (2012) 'Serious' Literature	2.00	1.20
G2 (2012) Concerts, Theatre, Art Exhibits	1.94	.90
G2 (2012) Classical Music, Jazz	2.00	1.04
G2 (2012) ISEI	48.84	14.45

Associations between children's behavioural and emotional development and objectively measured physical activity and sedentary time: Findings from the UK Millennium Cohort Study

Lucy J Griffiths University College London Institute of Child Health, UK
lucy.griffiths@ucl.ac.uk
Marco Geraci University of South Carolina, USA
Mario Cortina-Borja University College London Institute of Child Health, UK
Francesco Sera University College London Institute of Child Health, UK
Catherine Law University College London Institute of Child Health, UK
Heather Joshi University College London Institute of Education, UK
Andrew Ness University Hospitals Bristol NHS Foundation Trust and the University of Bristol, and Bristol Dental School, UK
Carol Dezateux University College London Institute of Child Health, UK

(Received April 2015 Revised November 2015) http://dx.doi.org/10.14301/llcs.v7i2.353

Abstract

Physical activity (PA) can have a positive influence on mental health. Less is known about the influence of mental health on current and later PA and sedentariness in childhood. This study investigated cross-sectional and distal associations between behavioural and emotional development, and objectively measured moderate-to-vigorous PA (MVPA) and sedentary time, in seven-year-old children participating in the Millennium Cohort Study (n = 6,497). Markers of behavioural/emotional development (scores for total difficulties, internalising and externalising problems) were obtained using the Strengths and Difficulties Questionnaire at ages three, five and seven years. Associations between sedentary time or MVPA (outcomes) and behavioural/emotional development (exposures) were analysed using median regressions, stratified by sex. In cross-sectional analyses, boys' sedentary time decreased with higher total difficulties scores (-1.1 minutes/day per score unit), boys' and girls' sedentary time decreased with higher externalising scores (-2.3 minutes/day per unit), and girls with higher internalising scores were more sedentary (1.4 minutes/day per unit). In analyses of MVPA, boys and girls were marginally more active with higher externalising scores (0.4 and 0.5 minutes/day per unit), and boys were less active for higher internalising scores (-0.7 minutes/day per unit). Distal associations showed similar patterns: children with increasing total difficulty and externalising scores at all ages were less sedentary at age seven; girls with increasing internalising scores particularly so. Boys and girls with increasing externalising scores were more active at age seven, whilst increasing internalising scores reduced MVPA for boys. In conclusion, behavioural/emotional development is associated with mid-childhood sedentary time and, more weakly, MVPA; this is of relevance to public health interventions aimed at increasing activity levels and the wellbeing of our young people.

Keywords

Physical activity, sedentary behaviour, accelerometry, mental health, child, cohort study

Introduction

Approximately one in ten young people currently have a mental health disorder in the United Kingdom (Green, McGinnity, Meltzer, Ford, & Goodman, 2004) and the United States (Merikangas et al., 2010). Physical activity has beneficial effects on psychological wellbeing in children and young people (Harden et al., 2001; Ussher, Owen, Cook, & Whincup, 2007). Reduced levels of anxiety, depression, and behavioural problems and higher self-esteem are reported in children and adolescents who are physically active (Calfas & Taylor, 1994; Ekeland, Heian, & Hagen, 2005; Gruber, 1986; Larun, Nordheim, Ekeland, Hagen, & Heian, 2006; Mutrie & Parfitt, 1998;) and these associations are more marked for boys than girls (Sagatun, Sogaard, Bjertness, Selmer, & Heyerdahl, 2007; Sebire et al., 2011).

Conversely, less is known about the psychological influences on physical activity or sedentary time at a population level, although self-esteem and physical self-perceptions are important for motivation and involvement in physical activity (Biddle & Armstrong, 1992; Crocker, Eklund, & Kowalski, 2000; Raustorp, Mattsson, Svensson, & Stahle, 2006). There is growing, albeit limited, evidence from cross-sectional studies that internalising problems are associated with lower, and externalising problems with higher, levels of physical activity (Brodersen, Steptoe, Williamson, & Wardle, 2005; Gosmann et al., 2015; van Egmond-Frohlich, Weghuber, & de, 2012). Evidence linking internalising problems like depression (Stavrakakis, de Jonge, Ormel, & Oldehinkel, 2012; Van Der, Paw, Twisk, & Van, 2007) or other mental health problems with later physical activity is inconclusive.

Pathways linking behavioural and emotional development with physical activity and sedentary time are likely to be complex and may have bi-directional relationships over the life course. Evidence from longitudinal studies starting in early life is lacking and is needed to shed light on pathways linking social and emotional wellbeing in early life and activity (Department of Health, 2011; National Institute for Health and Clinical Excellence, 2008; U.S. Department of Health and Human Services, 2008).

This paper examines associations between recent parental report of behavioural and emotional development and objective measures of physical activity and sedentary time in seven-year old children living in the United Kingdom (UK), recruited to a longitudinal study in infancy and in whom earlier reports of behavioural and emotional development had also been obtained at ages three and five years. We analysed cross-sectional and distal associations between recent and earlier behavioural and emotional development, and objectively measured activity and sedentariness at age seven years. Based on evidence from existing literature we hypothesised that children with higher recent total difficulties and externalising scores would be less sedentary and more active; that those with higher recent internalising scores would be more sedentary and less active; and that these relationships would also be found when these facets of development were measured earlier and at repeated time-points.

Methods

Participants and procedures

We used data from the Millennium Cohort Study (MCS), a national longitudinal study of the social, economic and health-related circumstances of children living in the UK. Children were recruited between September 2000 and January 2002 when aged nine months (Smith & Joshi, 2002) using a disproportionately stratified clustered sampling design to over-represent children living in Wales, Scotland and Northern Ireland, disadvantaged areas and areas with high proportions of ethnic minority groups. The original cohort comprised 18,818 children (an estimated 72% of those approached) whose parents were first interviewed at home when their child was aged nine months (MCS1). Our analyses used data collected at this first survey as well as at subsequent interviews carried out when children were aged three (MCS2), five (MCS3) and seven (MCS4) years. Objective measures of physical activity and sedentary time were made following the interview at age seven. Although further interviews have been carried out at age 11 and 14, these data were not available at the time of this analysis. We obtained the MCS data from the UK Data Service. The MCS was approved by the South West Multi-Centre Research Ethics Committee (MCS1), London Multi-Centre Research Ethics Committee (MCS2 and MCS3) and the Northern and Yorkshire Multi-Centre Research Ethics Committee (MCS4).

Outcome variables: objectively measured

physical activity and sedentary time

Physical activity and sedentary time were measured objectively using the Actigraph GT1M accelerometer (Actigraph, Pensacola, Florida), a small and lightweight, non-waterproof device, which was worn on an elastic belt around the child's waist. The Actigraph GT1M has been extensively validated in children and compares favourably against observational techniques (Fairweather, Reilly, Grant, Whittaker & Paton, 1999), heart rate monitoring (Ott, Pate, Trost, Ward, & Saunders, 2000), indirect and room calorimetry (Puyau, Adolph, Vohra, & Butte, 2002; Trost et al., 1998) and doubly labelled water techniques (Ekelund, Yngve, Brage, Westerterp, & Sjostrom, 2004). It has been shown to be robust when used in other large-scale physical activity studies in children (Riddoch et al., 2004, 2007; Troiano et al., 2008). The units of measurement reported from the accelerometer are called "counts" and these are then summarised by epochs, which in our case spanned 15 seconds.

A total of 13,681 singleton children were interviewed at age seven years in the MCS and invited to participate in the accelerometry study, which took place over a 15-month period between May 2008 and August 2009 after the completion of the MCS4 interviews. Those who consented (12,872; 94.5%) were posted an accelerometer, programmed to collect and aggregate data over 15-second epochs. Participants were instructed to position the monitor on top of their right hip, fitted tightly but comfortably to their body, either on top of indoor clothing or against their skin. They were asked to start wearing their accelerometer the morning after they received it and to continue doing so during waking hours for seven days. They were asked to remove the monitor when bathing or swimming. The accelerometer measurements commenced only after the MCS4 interviews had been initiated, resulting in a median interval of 36 weeks (interquartile range (IQR) 29 - 45) between the MCS4 interview and the date accelerometers were worn. Letters reminding participants to wear and return their accelerometer were sent out, as detailed previously (Rich et al., 2013b).

Accelerometers were returned from 9,772 singleton children (75.9% of those who consented). Data were downloaded using Actigraph software version 3.8.3 (Actigraph, Pensacola, Florida) and processed using the package `pawacc` (Geraci, 2012; Geraci et al., 2012) for the R statistical computing environment (R Development Core Team, 2014). Non-wear time was defined as any time period of consecutive zero-counts lasting 20 minutes or more: these periods were removed from the summation of activity. In addition, we removed moderate-to-vigorous physical activity (MVPA) values ≥11715 counts per minute (cpm) from the dataset, based on a reliability study (Rich et al., 2014) that indicated that count values above this threshold were extreme and likely to be spurious. Only days with ten hours or more of recorded time were retained in the dataset, and only participants with at least two such days (week or weekend days) were included in the analyses (Rich et al., 2013a). The application of these criteria resulted in a sample size of 6,497 singleton children. Reliable accelerometer data were less likely to be acquired from children who were: male; overweight/obese; white, mixed or 'other' ethnicity; living in disadvantaged areas; had less educated mothers and/or lone mothers (Rich et al., 2013b). However, overall, the differences in demographic characteristics between our analytic sample and the whole cohort sample interviewed at age seven were small (Griffiths et al., 2013a).

For each child, mean daily minutes spent in sedentary time (defined as <100 cpm) and in MVPA (2240 to 11715 cpm) were calculated, and both standardised for child's total wear time (Griffiths et al., 2013b). The cut-off points used to define the physical intensity thresholds were those determined in a calibration study in children of a similar age (Pulsford et al., 2011).

Exposure variables: total difficulties, internalising and externalising problems

At ages three, five and seven years, the main respondent (97% were natural mothers at MCS4) completed the Strengths and Difficulties Questionnaire (SDQ), which provides a measure of emotional and behavioural problems in children; this tool has high test-retest reliability and good validity (Goodman, 1997), and has been used in other large epidemiological studies in this age group (Goodman, Ford, Simmons, Gatward, & Meltzer, 2000; Wiles et al., 2006).

The SDQ includes 20 items relating to (i) conduct problems, (ii) hyperactivity and inattention problems, (iii) emotional symptoms, and (iv) peer-relationship problems (Figure 1). These (i-iv) were summed to create a 'total difficulties' score

bounded between 0 and 40, with higher scores indicating more difficulties. In addition, subscales (i) and (ii), and subscales (iii) and (iv) were summed to obtain, respectively, externalising and internalising problem scores, both with maximum conceivable scores of 20; these broader subscales are recommended for analyses in non-clinical populations (Goodman, Lamping, & Ploubidis, 2010). SDQ total difficulties score, internalising and externalising problem scores were therefore used as exposure variables. Cronbach's alpha coefficients were calculated for these variables at ages three, five and seven years; they were as follows: total difficulties scores (0.76, 0.7 and 0.80, respectively); internalising problem scores (0.58, 0.65, and 0.69); and externalising problem scores (0.77, 0.77, and 0.79). One unit on any of these scores is the equivalent of a difficulty / problem being 'somewhat true' rather than 'not true', or the difference between it being 'certainly true' rather than 'somewhat true'.

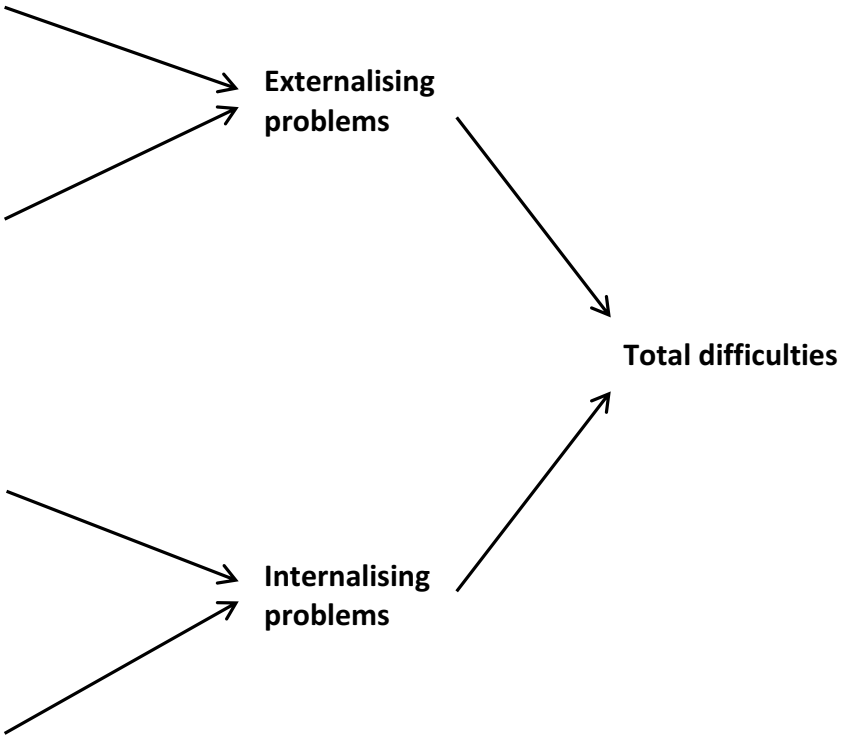
Figure 1: Strengths and Difficulties Questionnaire items and groupings

Conduct Problems
Often has temper tantrums or hot tempers
Generally obedient, usually does what adults request*
Often fights with other children or bullies them
Often lies or cheats
Steals from home, school or elsewhere

Hyperactivity / inattention problems
Restless, overactive, cannot stay still for long
Constantly fidgeting or squirming
Easily distracted, concentration wanders
Thinks things out before acting*
Sees tasks through to the end, good attention span*

Emotional symptoms
Often complains of headaches, stomach aches or sickness
Many worries or often seems worried
Often unhappy, down-hearted or tearful
Nervous or clingy in new situations, easily loses confidence
Many fears, easily scared

Peer relationship problems
Rather solitary, tends to play alone
Has at least one good friend*
Generally liked by other children*
Picked on or bullied by other children
Gets on better with adults than other children



* SDQ items are scored on a 0-2 scale (not true, somewhat true, certainly true). Items denoted here with '*' are reversely scored.

Confounding factors

Information on confounding factors was collected from the first four MCS surveys. These included cohort child's ethnicity, prevalence of a longstanding illness (if main respondents reported at least once at MCS2-4 that their child had any illness or disabilities that had troubled them over a period of time) and body mass index (BMI: kg/m^2) derived from direct measurement. In addition, we included relative poverty captured at age seven (a binary variable denoting whether net equivalised family income, before housing costs, was below 60% of the national median (Bradshaw & Holmes, 2010)) and maternal psychological distress, measured using the Kessler-6 scale (Kessler et al., 2002). In the following, we refer to BMI, relative poverty, and maternal distress as time-varying confounders (i.e., confounders whose values can change over time).

Statistical analyses

Linear regression models were fitted to assess the association between behavioural and emotional development scores and sedentary time or MVPA levels. Given the non-normality and heteroscedasticity (i.e., non-constant variance) in the error terms, we used median rather than mean regression (Geraci, 2013). The former leads to valid inference without assuming a specific probability distribution for the error. The interpretation of the median regression coefficients is analogous to that seen in other types of regression analysis, i.e. the 'slope' measures the expected change in the conditional median outcome for a one-unit increase in the corresponding predictor, holding all other variables at any fixed value. Ethnicity, longstanding illness, and relative poverty were entered in the models as categorical variables, with SDQ scores, BMI, and maternal distress entered as continuous variables.

Analyses were stratified by sex given established differences in activity levels between boys and girls in this sample (Griffiths et al., 2013a), including gender differences within ethnic group ($p < 0.001$) and gender differences in children of Pakistani origin as compared to those in White children ($p = 0.001$). Two types of analyses were performed distinguished by the ages at which the behavioural and emotional development exposure variables (total difficulties, internalising and externalising scores) were measured. In the first set of analyses, the MVPA and sedentary time outcomes were analysed by examining the influence of exposure variables at age seven with and without adjustment for all confounding factors (including time-varying confounders) measured at the same age only. These analyses are approximate cross-sectional analyses due to the interval noted above between the MCS4 interview and the accelerometer measurements.

In the second set of analyses, the MVPA and sedentary time variables were analysed as distal outcomes by examining background effects of the exposure variables at ages three, five and seven, with and without adjustment for all confounding factors (including time-varying confounders). We adopted the parameterisation for distal outcomes outlined by De Stavola et al (De Stavola et al., 2006, equation 5) and we defined the following median regression model:

$$\begin{aligned} Med(Y) &= a + (b_3 + b_5 + b_7)Z_3 + (b_5 + b_7)(Z_5 - Z_3) \\ &\quad + b_7(Z_7 - Z_5) \\ &= a + c_1 Z_3 + c_2(Z_5 - Z_3) + c_3(Z_7 - Z_5), \quad (1) \end{aligned}$$

where Z_j denotes the exposure measured at age *j*, *a* is the model's intercept and the 'slopes' of the model measure (i) the cumulative effect of increasing the exposure at each age by one unit, that is, the sum of all conditional effects $c_1 = (b_3 + b_5 + b_7)$; (ii) the effect of increasing the exposure between ages three and five by one unit, with that change shifting the exposure at ages five and seven, which is the sum of the conditional effects $c_2 = (b_5 + b_7)$; and (iii) the effect of increasing the exposure between ages five and seven by one unit, with that change shifting the exposure at age seven only, i.e. the conditional effect $c_3 = b_7$. Note that equation (1) is algebraically equivalent to the equation $Med(Y) = a + b_3 Z_3 + b_5 Z_5 + b_7 Z_7$. The latter, however, does not provide a straightforward interpretation from a life-course epidemiology perspective (De Stavola et al., 2006). In contrast, the parameters c_1, c_2, and c_3 have a natural interpretation when measurements accumulate monotonically with age (e.g. height, head circumference etc.), in which case changes in the value of the exposure at a particular age imply a shift in the same direction of the exposure at subsequent ages. It should be stressed that lack of monotonicity is by no means a hindrance if the

purpose is estimating trajectories that change direction over time (in this case, a linear combination of c_1, c_2, and c_3 will be sufficient). We assessed empirically (results not shown) changes in direction of SDQ score trajectories and found that only in about 20% of the cases was an increase (or decrease) between ages three and five followed by a decrease (or increase) between ages five and seven in externalising, internalising or total SDQ scores.

The MCS sampling design was accounted for in the estimation (Geraci, 2013), with probability weights adjusted for the non-response in the MCS1 through MCS4 surveys as well as for the non-response in the physical activity survey (Griffiths et al., 2013b). Standard errors of quantile regression coefficients were computed using a bootstrap approach based on 100 replications (Geraci, 2013). Given the presence of missing values, the regression analyses were performed on five imputed datasets. Final estimates and standard errors were then computed according to Rubin's rules. A summary of the missing data as well as the multiple imputation approach are described as follows.

As a result of the data selection procedure, the outcome variables were fully observed. However, exposure variables were not completely observed. In particular, the percentages (out of 6,497 children) of missing values for emotional problems score were 8.5, 4.3, and 1.5% in sweeps MCS2, MCS3 and MCS4, respectively. Similar proportions were observed for conduct problems score (8.4, 4.2, 1.4%), hyperactivity score (9.2, 4.5, 1.6%) and peer relationship problems score (8.9, 4.4, 1.5%). As for time-varying confounders, there were missing values for BMI (17.3, 3.4, 1.0%), relative poverty (17.3, 3.0, < 0.0%), and maternal distress (18, 8.5, 2.8%) (although the proportion of missing values for these variables declined from sweep to sweep, individual patterns of missing values were not monotonic). Longstanding illness was completely observed and ethnicity had only one missing value. Forty percent of children had at least one missing value; 11% had at least five missing values; only 2% had 10 or more missing values. Three children had 22 missing values, which was the maximum number observed.

Under the assumption of missing at random, we carried out a multiple imputation by chained equations (Geraci, 2013), with five iterations per chain. The matrix feeding into the imputation algorithm consisted of the outcome, the exposure and the confounding variables (26 variables in total), in addition to five auxiliary variables which were: two sampling design variables (probability weights adjusted for non-response and the MCS stratification variable) and SDQ scores for social behaviour (measured at ages three, five and seven). Continuous variables (SDQ scores, BMI, maternal distress) were imputed using quantile regression, while relative poverty was imputed using logistic regression. The only one missing value for ethnicity was imputed using polytomous regression.

The analyses were carried out using the R packages `quantreg` (Koenker, 2012), `survey` (Lumley, 2004; Lumley, 2011), and `mice` (Van Buuren & Groothuis-Oudshoorn, 2011). Statistical significance was set at the 5% level.

Results

Subject characteristics

Children were on average aged 7.5 years when they wore the accelerometers. Approximately half the children included in these analyses were girls (*n*=3321; 51%) and most (88%) were White (table 1). Parents of around one third reported them to have a longstanding illness at least once and one third of families were below the relative poverty threshold, comparable to the MCS4 sample as a whole (29.6%) (Hansen, Jones, Joshi, & Budge, 2010). The median score for maternal psychological distress was 2. The median score for BMI at age seven was 16.0 (IQR: 15.1 – 17.3), which is very close to the BMI presented for children of this age in UK growth charts (Royal College of Paediatrics and Child Health, 2013).

Table 1: Sample characteristics

Variable	All children (*n*=6,497)	Girls (3,321)	Boys (3,176)
	Sample size (weighted percentage)		
Child's ethnicity (9 months, confirmed at 3 years)			
White	5,711 (87.9)	2,917 (87.9)	2,794 (88.0)
Indian	139 (2.1)	78 (2.3)	61 (1.9)
Pakistani	177 (2.7)	84 (2.5)	93 (2.9)
Black	142 (2.2)	71 (2.1)	71 (2.2)
Bangladeshi	70 (1.1)	39 (1.2)	31 (1.0)
Mixed	168 (2.6)	83 (2.5)	85 (2.7)
Other	90 (1.4)	49 (1.5)	41 (1.3)
Longstanding illness (age 3, 5 or 7)			
Yes	1,991 (31.4)	929 (28.6)	1,062 (34.0)
No	4,506 (68.6)	2,392 (71.4)	2,114 (66.0)
Poverty (age 7)			
Above threshold*	5,034 (69.8)	2,547(69.1)	2,487 (70.4)
Below threshold	1,463 (30.2)	774 (30.9)	689 (29.6)
	Weighted median (lower quartile, upper quartile)		
SDQ scores			
Total difficulties (age 3)	9 (6, 13)	8 (5, 12)	9 (6, 13)
Total difficulties (age 5)	6 (4, 10)	6 (3, 9)	7 (4, 11)
Total difficulties (age 7)	6 (3, 10)	6 (3, 9)	7 (4, 11)
Externalising problems (age 3)	6 (4, 9)	6 (4, 9)	7 (4, 10)
Externalising problems (age 5)	4 (2, 7)	4 (2, 6)	5 (3, 7)
Externalising problems (age 7)	4 (2, 7)	3 (2, 6)	5 (3, 7)
Internalising problems (age 3)	2 (1, 4)	2 (1, 4)	2 (1, 4)
Internalising problems (age 5)	2 (1, 3)	2 (1, 3)	2 (1, 4)
Internalising problems (age 7)	2 (1, 4)	2 (1, 4)	2 (1, 4)
Child's Body Mass Index (age 7)	16.0 (15.1, 17.3)	16.1 (15.1, 17.4)	16.0 (15.1, 17.2)
Maternal psychological distress (age 7)**	2 (0, 4)	2 (0, 4)	2 (0, 4)
Sedentary time mins/day	391 (358, 424)	400 (367, 432)	384 (351, 415)
MVPA mins/day	60 (47, 76)	54 (43, 67)	67 (53, 84)

* Threshold: 60% of the national median.
** Measured using the Kessler-6 scale (Kessler et al., 2002).
Missing observations (all children): Ethnic group (1); Poverty (1); Total difficulties age 3 (684); Total difficulties age 5 (315); Total difficulties age 3 (122); Externalising problems age 3 (608); Externalising problems age 5 (296) Externalising problems age 7 (108); Internalising problems age 3 (596); Internalising problems age 5 (291) Internalising problems age 7 (104); Child's BMI (67); Maternal distress (179).

Median total difficulties and externalising scores reported by parents were higher at age three than ages five and seven (table 1). Median internalising scores were the same at all three ages. Distributions were skewed towards higher values for all scores.

Children spent a median of 60 minutes (IQR: 47-76) each day in MVPA and this was higher in boys (67 mins/day; IQR: 53 – 84) than girls (54 mins/day, IQR: 43 – 67). Approximately 50% of children were sedentary for six and a half hours or more each day (IQR: 358 – 424 median mins/day), with girls (400 mins/day; IQR: 367 – 432) slightly more sedentary than boys (384 mins/day; IQR: 351 – 415).

Cross-sectional associations of behavioural and emotional development

The results of the first set of median regression analyses are reported in table 2. The regression coefficients associated with the exposures are expressed in minutes/SDQ-score unit.

Boys with higher total difficulty scores were less sedentary: median daily sedentary time in boys decreased by 1.1 minutes for each unit increase on the total score scale at seven years, ($p < 0.001$). Thus, for example, the predicted median time spent being sedentary each day was 381.0 minutes for boys with a total score of 7, as opposed to 388.7 minutes for boys with a total score of 0. Boys and girls with higher externalising scores had lower median sedentary time (-2.3 daily minutes/unit score for both boys and girls, $p < 0.001$). In contrast, girls with higher internalising scores were more sedentary (1.4 daily minutes/unit score, $p = 0.01$); the median sedentary time each day for girls with an internalising score of 2 is estimated to be 2.8 minutes a day greater relative to those with zero scores, a predicted median time of 402.5 compared with 399.7 minutes.

Boys and girls with higher externalising scores engaged in slightly more MVPA (0.4 daily minutes/unit score, $p = 0.025$; 0.5 minutes/unit score, $p = 0.005$, respectively) but this association was not seen for total difficulties scores. Conversely, boys, but not girls, with higher internalising scores had lower median MVPA (-0.7 daily minutes/unit score, $p = 0.029$).

Table 2: Results of adjusted[a] median regression cross-sectional analyses. Estimates and standard errors are expressed as minutes per day per unit SDQ score.

		Sedentary time			MVPA		
		Estimate	**SE**	***p*-value**	**Estimate**	**SE**	***p*-value**
Boys	Intercept	388.7	2.4	< 0.001	64.8	1.3	< 0.001
	Total difficulties (age 7)	-1.1	0.3	< 0.001	0.1	0.1	0.677
Girls	Intercept	404.9	4.0	< 0.001	51.5	1.1	< 0.001
	Total difficulties (age 7)	-0.6	0.5	0.229	0.2	0.1	0.288
Boys	Intercept	391.1	2.5	< 0.001	63.7	1.2	< 0.001
	Externalising problems (age 7)	-2.3	0.5	< 0.001	0.4	0.2	0.025
Girls	Intercept	408.9	3.1	< 0.001	50.6	1.1	< 0.001
	Externalising problems (age 7)	-2.3	0.6	< 0.001	0.5	0.2	0.005
Boys	Intercept	381.5	2.0	< 0.001	65.7	1.3	< 0.001
	Internalising problems (age 7)	0.0	0.7	0.975	-0.7	0.3	0.029
Girls	Intercept	399.7	3.1	< 0.001	52.5	1.0	< 0.001
	Internalising problems (age 7)	1.4	0.6	0.011	-0.3	0.2	0.157

Table abbreviations: MVPA, moderate to vigorous physical activity; SE, standard error.

[a] Adjusted for ethnicity, longstanding illness, BMI, maternal psychological distress, relative poverty. (Supplementary unadjusted results are available in eTable1).

Note: Baseline for all models: white ethnic group, no longstanding illness, BMI = 8, Kessler = 0, above 60% poverty line, all score variables = 0.

Associations of distal sedentary time and MVPA outcomes with age-related changes in behavioural and emotional development

Overall, distal associations of sedentary time and age-related changes in behavioural and emotional development were more consistent and stronger for sedentary time than for MVPA (table 3). Increasing total difficulties scores at all ages were associated with a reduction in median sedentary time; the cumulative effects were of similar magnitude in boys (-1.1 minutes/unit score, p = 0.01) and girls (-1.2, p = 0.03). Similarly, boys experienced a reduction in median sedentary time for a change in total difficulties score between ages five and seven (-1.2, $p < 0.001$). A one unit increase in externalising problem scores at all ages was associated with 2.5 fewer minutes in median sedentary time for boys ($p < 0.001$) and 3.3 fewer minutes for girls ($p < 0.001$). This diminution in sedentary time was also seen in relation to increasing externalising problem scores for both boys and girls between the ages of three and five (-2.0 minutes/unit score for boys (p = 0.002) and -2.4 daily minutes/unit score for girls (p = 0.001)), but in boys only for increasing externalising problem scores between ages five and seven (-2.0 daily minutes/unit score, p = 0.001). In contrast, an association between increasing internalising problem scores and sedentary time was only observed in girls: a one unit increase in internalising scores at all ages, and between ages five and seven, was associated with an increase of 1.8 minutes (p =0.034) and 1.6 minutes (p = 0.029), respectively, in median sedentary time at age seven.

No substantial association was observed between total difficulty scores and MVPA in these analyses (table 3). However, a small increase in median MVPA time with increasing externalising problems at all ages was seen in boys (0.9, p = 0.001) and girls (0.6, p = 0.006). Increasing the score of internalising problems in boys by one unit between ages three and five was associated with a decrease of 1.0 minute (p = 0.001) in daily MVPA at age seven.

Table 3: Results of adjusted[a] median regression analyses with sedentary time and moderate-to-vigorous physical activity as distal outcomes. Estimates and standard errors are expressed as minutes per day per unit SDQ score.

		Sedentary time			MVPA		
		Estimate	**SE**	***p*-value**	**Estimate**	**SE**	***p*-value**
Boys	Total difficulties intercept	389.6	3.6	< 0.001	62.1	1.6	< 0.001
	Total difficulties (sum of conditional effects at ages 3, 5, 7)	-1.1	0.4	0.010	0.3	0.2	0.095
	Total difficulties (sum of conditional effects at ages 5 and 7)	-0.9	0.5	0.053	-0.2	0.2	0.233
	Total difficulties (conditional effect at age 7)	-1.2	0.3	< 0.001	-0.1	0.2	0.522
Girls	Total difficulties intercept	408.4	4.5	< 0.001	51.7	1.3	< 0.001
	Total difficulties (sum of conditional effects at ages 3, 5, 7)	-1.2	0.6	0.030	0.2	0.2	0.284
	Total difficulties (sum of conditional effects ages 5 and 7)	-0.7	0.6	0.261	0.2	0.2	0.286
	Total difficulties (conditional effect at age 7)	0.4	0.6	0.520	0.1	0.2	0.727
Boys	Externalising problems intercept	392.8	3.4	< 0.001	59.8	1.5	< 0.001
	Externalising problems (effects at ages 3, 5, 7)	-2.5	0.6	< 0.001	0.9	0.2	0.001
	Externalising problems (effects at ages 5 and 7)	-2.0	0.6	0.002	0.3	0.3	0.389
	Externalising problems (effects at age 7)	-2.0	0.6	0.001	0.0	0.3	0.995
Girls	Externalising problems intercept	414.3	3.5	< 0.001	50.2	1.4	< 0.001
	Externalising problems (effects at ages 3, 5, 7)	-3.3	0.7	< 0.001	0.6	0.2	0.006
	Externalising problems (effects at ages 5 and 7)	-2.4	0.7	0.001	0.5	0.3	0.079
	Externalising problems (effects at age 7)	-0.7	0.8	0.385	0.4	0.3	0.167
Boys	Internalising problems intercept	379.7	2.2	< 0.001	65.8	1.4	< 0.001
	Internalising problems (effects at ages 3, 5, 7)	0.7	0.7	0.292	-0.6	0.4	0.141
	Internalising problems (effects at ages 5 and 7)	0.4	0.7	0.536	-1.0	0.3	0.001
	Internalising problems (effects at age 7)	-0.7	0.7	0.356	-0.4	0.4	0.285
Girls	Internalising problems intercept	398.5	3.3	< 0.001	53.1	1.1	< 0.001
	Internalising problems (effects at ages 3, 5, 7)	1.8	0.8	0.034	-0.4	0.3	0.097
	Internalising problems (effects at ages 5 and 7)	1.1	0.9	0.245	-0.1	0.3	0.834
	Internalising problems (effects at age 7)	1.6	0.7	0.029	-0.3	0.3	0.350

Table abbreviations: MVPA, moderate to vigorous physical activity; SE, standard error.

[a] Adjusted for ethnicity, longstanding illness, BMI, maternal distress, relative poverty (Supplementary unadjusted results are available in eTable2).

Note: Baseline for all models: white, no longstanding illness, BMI = 8, Kessler = 0, above 60% poverty line, all score variables = 0.

Discussion

Summary of main findings

We have identified modest associations of behavioural and emotional development with sedentary time in primary (elementary) school-aged children, and weaker and less consistent associations with physical activity, as assessed by MVPA. In cross-sectional analyses at age seven, boys with higher total difficulties scores were less sedentary but not more likely to engage in MVPA. Both boys and girls with higher externalising scores were less likely to be sedentary and more likely to engage in MVPA. Girls with higher internalising scores were more sedentary but not less active, and boys less active but not more sedentary.

Median regression models parameterised according to the life-course approach described in De Stavola et al (2006) allowed estimation of associations between increasing problem scores through early childhood on MVPA and sedentary time measured at age seven. We observed a reduction in sedentary time at age seven in both boys and girls with more total difficulties and more externalising problems. Associations between internalising problems and sedentary time were not found in boys, although in girls higher scores during early-childhood were in general associated with greater sedentariness at age seven. There were positive associations in both boys and girls between time in MVPA and the externalising problem scores. Finally, boys with rising internalising problem scores between ages three and five years were less active at seven years.

Comparisons with other evidence

Comparison with previously published studies is limited by a lack of consistency between measures used to assess behavioural and emotional development, as well as a paucity of studies using objective measures of MVPA and/or sedentary time. Furthermore, few studies have examined associations between these factors in primary school aged children, an age when between child variation in activity and sedentariness has been documented. We have not identified any studies with repeat measures of behavioural and emotional development in the preschool years: examination of associations with activity and sedentary time using longitudinal measures of child behavioural and emotional development is – to our knowledge – novel. This study used SDQ scores as continuous variables instead of using bands to identify children with disorders; this enabled us to investigate associations with the normal spectrum of scores.

Of the available evidence, depression, an internalising problem, has been found to negatively influence activity levels during adolescence (Stavrakakis et al., 2012), supporting our findings in boys. Evidence from cross-sectional studies is more plentiful but such a study design does limit inferences about causality, or the direction of the effects, to be made. Findings from other studies are however generally in agreement with those reported here, notwithstanding methodological differences or differences in the populations studied. Active adolescents are reported to have fewer emotional, behavioural or social problems (Kantomaa, Tammelin, Ebeling, & Taanila, 2008; Kirkcaldy, Shephard, & Siefen, 2002), fewer total difficulties (Ussher et al., 2007) and fewer depressive symptoms (Motl, Birnbaum, Kubik, & Dishman, 2004). Sebire et al. (2011) reported that higher objectively-measured physical activity levels were related to more conduct problems, also measured using the SDQ, and support our results. Gosmann et al. (2015) reported that Brazilian youth with internalising disorders were less active (lower levels of daily energy expenditure), whilst those with externalising disorders had more energy expenditure variability. Similarly, poor emotional wellbeing and difficulties with peers have been found to be associated with more self-reported sedentariness in British youth aged 11 to 12 years (Brodersen et al., 2005), whilst more conduct and hyperactivity problems were associated with higher activity levels. van Egmond-Fröhlich et al. (2012) also found that youth with SDQ-assessed externalising disorders had higher self-reported levels of physical activity. In contrast to our findings, Khalife et al. (2014) reported that children with conduct problems or symptoms of attention-deficit/hyperactivity disorder (ADHD) were at increased risk of becoming physically inactive adolescents. This discordance with our findings may be explained by the younger age of our sample or Khalife et al.'s use of self-reported activity levels.

Study strengths and weaknesses

Our study has several methodological strengths. These include longitudinal prospective data based on a large, contemporary and nationally representative sample of children. We stratified

analyses by sex and examined cross-sectional and distal effects of behavioural and emotional development during early childhood, using the SDQ which has been shown to be a reliable measure of mental health in young people (Goodman & Goodman, 2011). We recognise that parental recognition and report of problems, especially internalising ones, can be difficult; however, we hope that the use of the broader externalising and internalising subscales in this study, instead of the four individual SDQ subscales, may have reduced measurement error in our exposure variables as they are based on a larger number of SDQ items (Goodman et al., 2010).

We used objective measures of MVPA and sedentary time, which while overcoming the limitations of child or parental report, may underestimate activities not involving vertical movement of the trunk (such as cycling). We also acknowledge that the children in this study were only asked to wear the accelerometer for a single week. If the week had been abnormal for the child in terms of usual activities undertaken, under- or overestimation of activity levels or sedentary time may have occurred and influenced the effect sizes. However, inclusion of children with data for ≥ two days, lasting ≥10 hours/day, is considered to provide a reliable estimate of habitual physical activity in large-scale epidemiological studies (Rich et al., 2013a). Whilst we also used validated cut-off points to define the physical intensity thresholds (Pulsford et al., 2011), misclassification may have occurred for children with high externalising problem scores if their scores were affected by marked symptoms of hyperactivity, such as fidgeting and troubles with sitting still. We suspect that fidgeting while seated would not be extensively misclassified as MVPA, but excess movement may have reduced the time registered as sedentary, which is a possible study limitation.

We have not been able to examine trajectories of activity and sedentary time concurrently with behavioural and emotional development trajectories since objective measures with accelerometers were only obtained once at age seven; we were therefore also unable to control for activity levels at the earlier ages.

We have adjusted for a range of confounding factors collected prospectively through early childhood and prior to measurement of the outcome, although we acknowledge that the possibility of residual confounding remains. As there was an interval between the interview at MCS4 and accelerometer measurements, the associations reported here are not truly cross-sectional. However the exposure and confounding factors were always measured before the outcome thus providing some support for a causal association.

Our statistical analyses allow inferences to be made to all UK children by using survey weights to adjust for non-response in the MCS surveys as well as the physical activity survey. We fitted median regression models to allow for non-normality in the distribution of daily minutes of sedentary time and MVPA. Finally, we accounted for missing values using multiple imputation under missing-at-random assumptions – this method performs better in terms of bias reduction than other *ad hoc* procedures, even when data are missing not at random (i.e., non-ignorable or informative missing) (Catellier et al., 2005).

Implications of this research for policy and research

Our study has identified weak but consistent associations at a population level between behavioural and emotional development in primary school aged children and sedentary time and, to a lesser extent, with MVPA. Different patterns were also observed between boys and girls and for internalising and externalising scores. Identifying these at-risk groups, and the mechanisms underlying these relationships, has relevance for policies that aim to increase activity levels and decrease sedentariness in our youth (Department of Health, 2011; U.S. Department of Health and Human Services, 2008). For example, social intervention programs designed to prevent or treat internalising problems, like therapeutic approaches for emotional symptoms such as unhappiness or nervousness and coping-skills training for children who may experience bullying, may help to reduce sedentariness in young girls by reducing withdrawal from social activities.

Our findings are consistent with Brodersen et al.'s (2005) proposition that physical activity may be an outlet for children with behavioural (externalising) problems. These problems are therefore not detrimental to activity levels *per se*, although their energetic nature may be developmentally and socially challenging.

Further longitudinal research should explore relationships in the opposite direction, to evaluate whether activity levels and sedentary time are risk factors for emotional and behavioural development. Studies should also examine more specific internalising and externalising problems, such as hyperactivity and inattention problems, and the influence of other dimensions of physical activity, such as light intensity levels.

Acknowledgements

The accelerometer data collection was funded by the Wellcome Trust (principal investigator Professor Carol Dezateux) [grant 084686/Z/08/A]. The fourth sweep of the Millennium Cohort Study was funded by grants to Professor Heather Joshi, former director of the study, from the Economic and Social Research Council and a consortium of Government funders. The co-operation of the participating families is gratefully acknowledged as is the contribution of the Centre for longitudinal Studies and others involved in the MCS4 physical activity project fieldwork and data processing and in the creation of the MCS dataset in which it is linked. We are grateful to the UK Data Archive, and Economic and Social Data Service, for making the datasets available. However, they bear no responsibility for the analysis or interpretation of these data. The persistent identifiers of the datasets used in this paper are:

MCS First Survey: http://dx.doi.org/10.5255/UKDA-SN-4683-3;
For MCS2: http://dx.doi.org/10.5255/UKDA-SN-5350-3
For MCS3: http://dx.doi.org/10.5255/UKDA-SN-5795-3
For MCS4: http://dx.doi.org/10.5255/UKDA-SN-6411-5
For Physical Activity: http://dx.doi.org/10.5255/UKDA-SN-7238-1

The Population, Policy and Practice Programme was formed in 2014, incorporating the activities of the Centre for Paediatric Epidemiology and Biostatistics (CPEB). The CPEB was supported in part by the Medical Research Council in its capacity as the MRC Centre of Epidemiology for Child Health (award G0400546). Research at the UCL Institute of Child Health and Great Ormond Street Hospital for Children receives a proportion of the funding from the Department of Health's National Institute for Health Research Biomedical Research Centres funding scheme. The study sponsors played no part in the design, data analysis and interpretation of this study, the writing of the manuscript, or the decision to submit the paper for publication and the authors' work was independent of their funders.

References

Biddle, S. & Armstrong, N. (1992). Children's physical activity: an exploratory study of psychological correlates. *Social Science & Medicine, 34,* 325-331. http://dx.doi.org/10.1016/0277-9536(92)90274-T

Bradshaw, J. & Holmes, J. (2010). Child poverty in the first five years of life. In K.Hansen, H. Joshi, & S. Dex (Eds.), *Children of the 21st Century: the first five years*. Bristol: The Policy Press. http://dx.doi.org/10.1332/policypress/9781847424761.003.0002

Brodersen, N. H., Steptoe, A., Williamson, S., & Wardle, J. (2005). Sociodemographic, developmental, environmental, and psychological correlates of physical activity and sedentary behavior at age 11 to 12. *Annals of Behavioral Medicine, 29,* 2-11. http://dx.doi.org/10.1207/s15324796abm2901_2

Calfas, K. J. & Taylor, W. C. (1994). Effects of physical activity on psychological variables in adolescents. *Pediatric Exercise Science, 6,* 406-423.

Catellier, D. J., Hannan, P. J., Murray, D. M., Addy, C. L., Conway, T. L., Yang, S. & Rich, J. C. (2005). Imputation of missing data when measuring physical activity by accelerometry. *Medicine & Science in Sports & Medicine, 37,* S555-S562. http://dx.doi.org/10.1249/01.mss.0000185651.59486.4e

Crocker, P. R., Eklund, R. C., & Kowalski, K. C. (2000). Children's physical activity and physical self-perceptions. *Journal of Sports Science, 18,* 383-394. http://dx.doi.org/10.1080/02640410050074313

De Stavola, B. L., Nitsch, D., Dos, S. S., I, McCormack, V., Hardy, R., Mann, V. Cole, T. J., Morton, S. & Leon, D. A. (2006). Statistical issues in life course epidemiology. *American Journal of Epidemiology, 163,* 84-96. http://dx.doi.org/10.1093/aje/kwj003

Department of Health. 2011. *Start active, stay active: a report on physical activity from the four home countries' Chief Medical Officers.* London, Department of Health.

Ekeland, E., Heian, F., & Hagen, K. B. (2005). Can exercise improve self esteem in children and young people? A systematic review of randomised controlled trials. *British Journal of Sports Medicine, 39,* 792-798. http://dx.doi.org/10.1136/bjsm.2004.017707

Ekelund, U., Yngve, A., Brage, S., Westerterp, K., & Sjostrom, M. (2004). Body movement and physical activity energy expenditure in children and adolescents: how to adjust for differences in body size and age. *American* Journal *of Clinical Nutrition*, *79,* 851-856.

Fairweather, S. C., Reilly, J., Grant, S., Whittaker, A. & Paton, J. Y. (1999). Using the Computer Science and Applications (CSA) Activity Monitor in Preschool Children. *Pediatric Exercise Science,* 11, 413-420.

Geraci, M. (2012). pawacc: Physical activity with accelerometers (Version R package version 1.01). Retrieved from: http://r-forge.r-project.org/projects/pawacc

Geraci, M. (2013). Estimation of regression quantiles in complex surveys with data missing at random: An application to birthweight determinants. *Statistical Methods in Medical Research,* 23. http://dx.doi.org/10.1177/0962280213484401

Geraci, M., Rich, C., Sera, F., Cortina-Borja, M., Griffiths, L. J., & Dezateux, C. (2012). Technical report on accelerometry data processing in the Millennium Cohort Study. London, UK: University College London. Retrieved from: http://discovery.ucl.ac.uk/1361699

Goodman, A. & Goodman, R. (2011). Population mean scores predict child mental disorder rates: validating SDQ prevalence estimators in Britain. *Journal of Child Psychology and Psychiatry, 52,* 100-108. http://dx.doi.org/10.1111/j.1469-7610.2010.02278.x

Goodman, A., Lamping, D. L., & Ploubidis, G. B. (2010). When to use broader internalising and externalising subscales instead of the hypothesised five subscales on the Strengths and Difficulties Questionnaire (SDQ): data from British parents, teachers and children. *Journal of Abnormal Child Psychology, 38,* 1179-1191. http://dx.doi.org/10.1007/s10802-010-9434-x

Goodman, R. (1997). The Strengths and Difficulties Questionnaire: a research note. *Journal of Child Psychology and Psychiatry, 38,* 581-586. http://dx.doi.org/10.1111/j.1469-7610.1997.tb01545.x

Goodman, R., Ford, T., Simmons, H., Gatward, R., & Meltzer, H. (2000). Using the Strengths and Difficulties Questionnaire (SDQ) to screen for child psychiatric disorders in a community sample. *British Journal of Psychiatry, 177:534-9.,* 534-539. http://dx.doi.org/10.1192/bjp.177.6.534

Gosmann, N. P., Salum, G. A., Schuch, F., Silveira, P. P., Bosa, V. L., Goldani, M. Z. & Manfro, G. G. (2015). Association Between Internalizing Disorders and Day-to-Day Activities of Low Energetic Expenditure. *Child Psychiatry & Human Development, 46*(1):67-74. http://dx.doi.org/10.1007/s10578-014-0450-x

Green, H., McGinnity, A., Meltzer, H., Ford, T., & Goodman, R. (2004). *Survey of the mental health of children and young people in Great Britain, 2004.* Palgrave MacMillan; HMSO.

Griffiths, L. J., Cortina-Borja, M., Sera, F., Pouliou, T., Geraci, M., Rich, C. et al. (2013a). How active are our children? Findings from the Millennium Cohort Study. *BMJ Open, 3*(8), e002893. doi:10.1136/bmjopen-2013-002893. http://dx.doi.org/10.1136/bmjopen-2013-002893

Griffiths, L. J., Rich, C., Geraci, M., Sera, F., Cortina-Borja, M., Pouliou, T., Platt, L., Johnson, J. & Dezateux, C. (2013b). Technical report on the enhancement of Millennium Cohort Study data with accelerometer-derived measures of physical activity and sedentary behaviour in seven year olds. Retrieved from: http://www.esds.ac.uk/doc/7238/mrdoc/pdf/mcs4_pa_technical_report.pdf

Gruber, J. J. (1986). Physical activity and self-esteem development in children: a meta analysis. *Proceedings of the American Academy of Physical Education, 19,* 30-48.

Hansen, K., Jones, E., Joshi, H., & Budge, D. (2010). *Millennium Cohort Study Fourth Survey: A User's Guide to Initial Findings* London: Centre for Longitudinal Studies, University of London.

Harden, A., Rees, R., Shepherd, J., Brunton, G., Oliver, S., & Oakley, A. (2001). *Young people and mental health: a systematic review of research on barriers and facilitators.* London: EPPI-Centre, Social Science Research Unit, Institute of Education, University of London.

Kantomaa, M. T., Tammelin, T. H., Ebeling, H. E., & Taanila, A. M. (2008). Emotional and behavioral problems in relation to physical activity in youth. *Medicine & Science in Sports & Medicine,* 40, 1749-1756. http://dx.doi.org/10.1249/mss.0b013e31817b8e82

Kessler, R. C., Andrews, G., Colpe, L. J., Hiripi, E., Mroczek, D. K., Normand, S. L., Walters, E.E. & Zaslavsky, A.M. (2002). Short screening scales to monitor population prevalences and trends in non-specific psychological distress. *Psychological Medicine, 32,* 959-976. http://dx.doi.org/10.1017/S0033291702006074

Khalife, N., Kantomaa, M., Glover, V., Tammelin, T., Laitinen, J., Ebeling, H. Hurtig, T., Jarvelin, M.R. & Rodriguez, A. (2014). Childhood attention-deficit/hyperactivity disorder symptoms are risk factors for obesity and physical inactivity in adolescence. *Journal of the American Academy of Child & Adolescent Psychiatry, 53*, 425-436. http://dx.doi.org/10.1016/j.jaac.2014.01.009

Kirkcaldy, B. D., Shephard, R. J., & Siefen, R. G. (2002). The relationship between physical activity and self-image and problem behaviour among adolescents. *Social Psychiatry and Psychiatric Epidemiology, 37*, 544-550. http://dx.doi.org/10.1007/s00127-002-0554-7

Koenker, R. (2012). Quanteg: Quantile Regression R package version 4.79. Retrieved from: http://CRAN.R-project.org/package=quanteg

Larun, L., Nordheim, L. V., Ekeland, E., Hagen, K. B., & Heian, F. (2006). Exercise in prevention and treatment of anxiety and depression among children and young people. *Cochrane.Database.Syst.Rev., 3,* CD004691. http://dx.doi.org/10.1002/14651858.CD004691.pub2

Lumley, T. (2004). Analysis of complex survey samples. *Journal of Statistical Software, 9,* 1-19. http://dx.doi.org/10.18637/jss.v009.i08

Lumley, T. (2011). *Survey: analysis of complex survey samples. R package version 3.26*.

Merikangas, K. R., He, J. P., Brody, D., Fisher, P. W., Bourdon, K., & Koretz, D. S. (2010). Prevalence and treatment of mental disorders among US children in the 2001-2004 NHANES. *Pediatrics, 125,* 75-81. http://dx.doi.org/10.1542/peds.2008-2598

Motl, R. W., Birnbaum, A. S., Kubik, M. Y., & Dishman, R. K. (2004). Naturally occurring changes in physical activity are inversely related to depressive symptoms during early adolescence. *Psychosomatic Medicine, 66,* 336-342.

Mutrie, N. & Parfitt, G. (1998). Physical activity and its link with mental, social and moral health in young people. In S.Biddle, J. Sallis, & N. Cavill (Eds.), *Young and active* (pp. 49-68). London: Health Education Authority.

National Institute for Health and Clinical Excellence (2008). *PH12 Social and emotional wellbeing in primary education.* London: National Institute for Health and Clinical Excellence.

Ott, A. E., Pate, R. R., Trost, S. G., Ward, D. S., & Saunders, R. (2000). The use of uniaxial and triaxial accelerometers to measure children's "free-play" physical activity. *Pediatric Exercise Science, 12,* 360-370.

Pulsford, R. M., Cortina-Borja, M., Rich, C., Kinnafick, F. E., Dezateux, C., & Griffiths, L. J. (2011). Actigraph accelerometer-defined boundaries for sedentary behaviour and physical activity intensities in 7 year old children. *PLOS ONE, 6,* e21822. http://dx.doi.org/10.1371/journal.pone.0021822

Puyau, M. R., Adolph, A. L., Vohra, F. A., & Butte, N. F. (2002). Validation and calibration of physical activity monitors in children. *Obesity Research, 10,* 150-157. http://dx.doi.org/10.1038/oby.2002.24

R Development Core Team (2014). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. Retrieved from: http://www.R-project.org/

Raustorp, A., Mattsson, E., Svensson, K., & Stahle, A. (2006). Physical activity, body composition and physical self-esteem: a 3-year follow-up study among adolescents in Sweden. *Scandinavian Journal* of *Medicine & Science in Sports*, *16,* 258-266. http://dx.doi.org/10.1111/j.1600-0838.2005.00483.x

Royal College of Paediatrics and Child Health (2013). UK Childhood and Puberty Close Monitoring Growth Chart. http://www.rcpch.ac.uk/improving-child-health/public-health/uk-who-growth-charts/school-age-2-18-years/school-age-charts-an#bmi

Rich, C., Geraci, M., Griffiths, L., Sera, F., Dezateux, C., & Cortina-Borja, M. (2013a). Quality control methods in accelerometer data processing: defining minimum wear time. *PLOS ONE, 8,* e67206. http://dx.doi.org/10.1371/journal.pone.0067206

Rich, C., Cortina-Borja, M., Dezateux, C., Geraci, M., Sera, F., Calderwood, L., Joshi, H., Griffiths, L.J. (2013b). Predictors of non-response in a UK-wide cohort study of children's accelerometer-determined physical activity using postal methods. *BMJ Open*, *3*(3): e002290. http://dx.doi.org/10.1136/bmjopen-2012-002290

Rich, C., Geraci, M., Griffiths, L., Sera, F., Dezateux, C., & Cortina-Borja, M. (2014). Quality control methods in accelerometer data processing: identifying extreme counts. *PLOS ONE, 9,* e85134. http://dx.doi.org/10.1371/journal.pone.0085134

Riddoch, C. J., Bo, A. L., Wedderkopp, N., Harro, M., Klasson-Heggebo, L., Sardinha, L. B. Cooper, A.R. & Ekelund, U. (2004). Physical activity levels and patterns of 9- and 15-yr-old European children. *Medicine & Science in Sports & Medicine, 36,* 86-92. http://dx.doi.org/10.1249/01.mss.0000106174.43932.92

Riddoch, C. J., Mattocks, C., Deere, K., Saunders, J., Kirkby, J., Tilling, K., Leary, S.D., Blair, S.N. & Ness, A.R. (2007). Objective measurement of levels and patterns of physical activity. *Archives of Disease in Childhood, 92,* 963-969. http://dx.doi.org/10.1136/adc.2006.112136

Sagatun, A., Sogaard, A. J., Bjertness, E., Selmer, R., & Heyerdahl, S. (2007). The association between weekly hours of physical activity and mental health: a three-year follow-up study of 15-16-year-old students in the city of Oslo, Norway. *BMC Public Health, 7,* 155. http://dx.doi.org/10.1186/1471-2458-7-155

Sebire, S. J., Jago, R., Fox, K. R., Page, A. S., Brockman, R., & Thompson, J. L. (2011). Associations between children's social functioning and physical activity participation are not mediated by social acceptance: a cross-sectional study. *International Journal of Behavioral Nutrition and Physical Activity, 8.* 106. http://dx.doi.org/10.1186/1479-5868-8-106

Smith, K. & Joshi, H. (2002). The Millennium Cohort Study. *Population Trends,* 30-34.

Stavrakakis, N., de Jonge, P., Ormel, J., & Oldehinkel, A. J. (2012). Bidirectional Prospective Associations Between Physical Activity and Depressive Symptoms. The TRAILS Study. *Journal of Adolescent Health, 50,* 503-508. http://dx.doi.org/10.1016/j.jadohealth.2011.09.004

Troiano, R. P., Berrigan, D., Dodd, K. W., Masse, L. C., Tilert, T., & McDowell, M. (2008). Physical activity in the United States measured by accelerometer. *Medicine & Science in Sports & Medicine, 40,* 181-188. http://dx.doi.org/10.1249/mss.0b013e31815a51b3

Trost, S. G., Ward, D. S., Moorehead, S. M., Watson, P. D., Riner, W., & Burke, J. R. (1998). Validity of the computer science and applications (CSA) activity monitor in children. *Medicine & Science in Sports & Medicine, 30,* 629-633. http://dx.doi.org/10.1097/00005768-199804000-00023

U.S.Department of Health and Human Services (2008). *2008 Physical Activity Guidelines for Americans* Washington: U.S. Department of Health and Human Services.

Ussher, M. H., Owen, C. G., Cook, D. G., & Whincup, P. H. (2007). The relationship between physical activity, sedentary behaviour and psychological wellbeing among adolescents. *Social Psychiatry and Psychiatric Epidemiology, 42,* 851-856. http://dx.doi.org/10.1007/s00127-007-0232-x

Van Buuren, S. & Groothuis-Oudshoorn, K. (2011). mice: Multivariate Imputation by Chained Equations in R. *Journal of Statistical Software*, *45*, 3, 1-67. http://dx.doi.org/10.18637/jss.v045.i03

Van Der, H. K., Paw, M. J., Twisk, J. W., & Van, M. W. (2007). A brief review on correlates of physical activity and sedentariness in youth. *Medicine & Science in Sports & Medicine, 39,* 1241-1250. http://dx.doi.org/10.1249/mss.0b013e318059bf35

van Egmond-Frohlich, A. W., Weghuber, D., & de, Z. M. (2012). Association of symptoms of attention-deficit/hyperactivity disorder with physical activity, media time, and food intake in children and adolescents. *PLOS ONE, 7,* e49781. http://dx.doi.org/10.1371/journal.pone.0049781

Wiles, N. J., Peters, T. J., Heron, J., Gunnell, D., Emond, A., & Lewis, G. (2006). Fetal growth and childhood behavioral problems: results from the ALSPAC cohort. *American Journal of Epidemiology, 163,* 829-837. http://dx.doi.org/10.1093/aje/kwj108

Appendix

Supplementary tables – unadjusted results

eTable1: Unadjusted results of median regression cross-sectional analyses. Estimates and standard errors are expressed as minutes per day per unit SDQ score.

		Sedentary time			MVPA		
		Estimate	**SE**	***p*-value**	**Estimate**	**SE**	***p*-value**
Boys	Intercept	399.0	2.5	0.000	274.7	1.6	0.000
	Total difficulties (age 7)	-1.1	0.3	0.000	0.7	0.2	0.000
Girls	Intercept	389.3	1.8	0.000	274.9	2.0	0.000
	Total difficulties (age 7)	-0.8	0.2	0.001	0.8	0.3	0.002
Boys	Intercept	402.7	1.7	0.000	272.7	1.2	0.000
	Externalising problems (age 7)	-2.5	0.3	0.000	1.6	0.2	0.000
Girls	Intercept	392.2	2.3	0.000	273.4	1.7	0.000
	Externalising problems (age 7)	-1.7	0.4	0.000	1.6	0.3	0.000
Boys	Intercept	388.9	1.5	0.000	280.4	1.2	0.000
	Internalising problems (age 7)	0.7	0.3	0.031	-0.1	0.3	0.694
Girls	Intercept	383.3	1.8	0.000	281.3	1.6	0.000
	Internalising problems (age 7)	0.1	0.7	0.891	0.1	0.4	0.730

Table abbreviations for eTable1 and eTable 2: MVPA, moderate-to-vigorous physical activity; SE, standard error.

eTable2: Unadjusted results of median regression analyses with sedentary behaviour and physical activity as distal outcomes. Estimates and standard errors are expressed as minutes per day per unit SDQ score.

		Sedentary time			MVPA		
		Estimate	**SE**	***p*-value**	**Estimate**	**SE**	***p*-value**
Boys	Total difficulties intercept	391.4	3.5	0.000	274.5	2.5	0.000
	Total difficulties (sum of conditional effects at ages 3, 5, 7)	-0.9	0.4	0.013	0.9	0.3	0.003
	Total difficulties (sum of conditional effects at ages 5 and 7)	-0.6	0.3	0.052	0.8	0.3	0.013
	Total difficulties (conditional effect at age 7)	-0.8	0.3	0.010	0.6	0.4	0.094
Girls	Total difficulties intercept	408.7	3.6	0.000	271.7	2.2	0.000
	Total difficulties (sum of conditional effects at ages 3, 5, 7)	-1.2	0.5	0.016	1.0	0.3	0.003
	Total difficulties (sum of conditional effects ages 5 and 7)	-0.6	0.6	0.299	0.7	0.4	0.084
	Total difficulties (conditional effect at age 7)	0.4	0.6	0.567	-0.1	0.4	0.739
Boys	Externalising problems intercept	395.7	3.4	0.000	272.7	2.2	0.000
	Externalising problems (effects at ages 3, 5, 7)	-2.1	0.6	0.000	1.6	0.4	0.000
	Externalising problems (effects at ages 5 and 7)	-1.4	0.5	0.007	1.3	0.5	0.005
	Externalising problems (effects at age 7)	-1.3	0.6	0.025	1.2	0.5	0.012
Girls	Externalising problems intercept	415.0	2.6	0.000	268.3	2.4	0.000
	Externalising problems (effects at ages 3, 5, 7)	-3.0	0.5	0.000	2.1	0.6	0.000
	Externalising problems (effects at ages 5 and 7)	-1.8	0.7	0.015	1.5	0.7	0.024
	Externalising problems (effects at age 7)	-0.7	0.9	0.401	0.5	0.5	0.356
Boys	Internalising problems intercept	380.9	2.1	0.000	281.8	1.9	0.000
	Internalising problems (effects at ages 3, 5, 7)	0.9	0.6	0.119	0.0	0.6	0.956
	Internalising problems (effects at ages 5 and 7)	0.5	0.7	0.463	0.1	0.6	0.889
	Internalising problems (effects at age 7)	-0.6	0.8	0.406	0.2	0.5	0.756
Girls	Internalising problems intercept	396.3	2.7	0.000	279.8	2.4	0.000
	Internalising problems (effects at ages 3, 5, 7)	1.3	0.9	0.145	-0.4	0.8	0.560
	Internalising problems (effects at ages 5 and 7)	0.9	1.0	0.373	-0.2	0.8	0.784
	Internalising problems (effects at age 7)	1.1	0.8	0.168	-0.8	0.6	0.157

Socioeconomic disadvantage and children's emotional and behavioural problems: the role of early aspirations

Eirini Flouri UCL Institute of Education, University College London, UK
E.Flouri@ioe.ac.uk
Emily Midouhas UCL Institute of Education, University College London, UK
Heather Joshi UCL Institute of Education, University College London, UK
Alice Sullivan UCL Institute of Education, University College London, UK

(Received July 2015 Revised December 2015) http://dx.doi.org/10.14301/llcs.v7i2.364

Abstract

Using data from the UK's Millennium Cohort Study, we investigated the association of early family socioeconomic disadvantage (measured when cohort children were age three) with children's aspirations and emotional and behavioural problems at age seven (N = 11,656). Aspirations were gauged by children's written responses to the question 'when you grow up, what would you like to be'. Responses were classified to reflect the prestige of the aspired occupation and its sex composition, and the degree of intrinsic/extrinsic motivation inferred from the aspiration. Disadvantage predicted problems both directly and via its association with low prestige and intrinsic aspirations. Children aspiring to more prestigious occupations had fewer emotional and hyperactivity problems, and those with more extrinsic aspirations had fewer emotional symptoms. Both girls and particularly boys with apparently more intrinsic aspirations had more peer problems. The association between hyperactivity and disadvantage was attenuated among children aspiring to more feminised jobs.

Keywords

Aspirations, emotional and behavioural problems, MCS, resilience, socioeconomic disadvantage

Introduction

It is well established that children exposed to family socioeconomic disadvantage are more likely to have problems with emotional and behavioural adjustment than their non-poor counterparts (Bradley & Corwyn, 2002; Conger & Donnellan, 2007). There are several explanations for the association between socioeconomic disadvantage and children's emotional and behavioural adjustment – including transfer of genetic endowments, low availability of resources to support learning and cognitive development, low quality of the home learning environment, and high levels of stress and parental psychological distress (Evans, Gonnella, Marcynyszyn, Gentile, & Salpekar, 2005; Hackman, Farah, & Meany, 2010; Kiernan & Huerta, 2008; Kim-Cohen, Moffitt, Caspi, & Taylor, 2004). However, some poor children show better than expected emotional and behavioural outcomes (that is, they show emotional and behavioural resilience to socioeconomic disadvantage). Individual factors related to such resilience include effortful control (Obradovic, 2010), executive function skills (Masten et al., 2012) and outgoing temperament (Kim-Cohen et al., 2004). In this study, we investigate whether the type of early aspirations children hold may be related to such resilience. The role of aspirations in children's emotional/behavioural resilience to socioeconomic disadvantage is largely untested. To the best of our knowledge, only one pilot study (using a cross-sectional design and not correcting for confounding) has examined this (Flouri & Panourgia, 2012). There

is also little research examining the role of early aspirations in children's emotional/behavioural adjustment, in general. The present study attempts to fill both gaps – namely to examine the role of aspirations firstly in promoting adjustment and then in promoting resilience in young children. We do this using longitudinal data from a large sample of UK children followed at ages three, five and seven years, when children were asked directly about what they would like to be in the future.

The development of children's aspirations

According to the theory of circumscription and compromise (Gottfredson, 2002), children's aspirations are developed in stages. At stage one, which can start as early as three years old, children's aspirations are focused on size and power. At stage two (six – eight years), children become aware of gender differences and begin to eliminate occupations from further consideration if they are not typical for their own gender. Aspirations evolve with age from the fantastical to the concrete and so, as children grow into adolescents, they revise their aspirations based on their views of their own abilities and interests, as well as on societal and parental expectations. They begin to think more abstractly about their occupational choices and become more aware of barriers to occupations as well as characteristics of occupations such as status or prestige. Therefore, seven-year-old children would be less aware than older children and adolescents of potential constraints to achieving their aspirations. Thus, aspirations at this age may reflect children's sense of hope and possibilities for the future rather than their assessments of potential barriers, abilities or their parents' expectations. If so, such early aspirations may be a very good proxy for factors that have been associated with resilience to a number of risk factors (Cicchetti & Rogosch, 2009).

Children's aspirations do not vary only by age. Research on adolescents' aspirations, for example, has shown that they are strongly influenced by family background, especially parents' socioeconomic status (SES) – and in particular education and occupation (Jodl, Michael, Malanchuk, Eccles, & Sameroff, 2001). Adolescents' aspirations are also indirectly related to parental SES, via parental expectations and aspirations (Jodl et al., 2001) and parental involvement (Hill et al., 2004). Important individual-level antecedents include self-concept, self-regulation, locus of control, self-efficacy and expectancy, confidence or agency beliefs (Bandura, 2011; Dweck & Leggett, 1988; Eccles et al., 1983; Ford, 1992; Lefcourt, 1982; Mouratidis, Vansteenkiste, Lens, Michou, & Soenens, 2013; Nagengast & Marsh, 2012), as well as hobbies, activities and interests pursued outside school (Archer, DeWitt, & Wong, 2014), cognitive ability (Creed, Conlon, & Zimmer-Gembeck, 2007; Massey, Gebhardt, & Garnefski, 2008) and academic achievement (Bond & Saunders, 1999). Perhaps the most extensively researched predictors of adolescents' aspirations, however, are gender and ethnicity. Research in the UK and US shows clear gender differences, whereby girls tend to have 'higher' aspirations than boys as well as greater motivation for school (Schoon, 2001), whereas boys tend to be more adventurous in their dreams, more confident in their abilities, and more likely to aspire to unusual jobs (Helwig, 2008). Nonetheless, there are also gender similarities. Both girls and particularly boys tend to express gender-typed aspirations (Croll, 2008), although less so than in the past (Croll, Attwood, & Fuller, 2009). As for the role of ethnicity, ethnic minority adolescents in many countries, including the UK and US, have higher aspirations than other adolescents (Archer et al., 2014; Croll, 2008; Goodman & Gregg, 2010; Strand, 2007). Importantly, their aspirations are high despite a lack of what would typically be seen as 'cultural capital' (Modood, 2004) – arguably because their parents are more likely to want them to stay on at school and attend university, pay for private tuition, supervise them closely and be involved with their schools (Croll, 2008; Strand, 2011). There has been less research on the determinants of aspirations in younger children and most of it has explored the roles of ethnicity, SES and gender. It appears that, as with adolescents' aspirations, there are persistent gender, SES and ethnic differences, but also cohort effects. For example, a recent review (Hartung, Porfeli, & Vondracek, 2005) concluded that, in general, preadolescent girls aspire to a more restricted range of occupations and engage in less career exploration during the primary school years, relative to preadolescent boys. However, later female cohorts aspire to more prestigious occupations, relative to earlier female cohorts. These occupations tend to be currently male-dominated, have higher educational requirements, and involve greater competition and selectivity.

Children's aspirations and emotional and behavioural problems

Although there has been a fair amount of interest in the role of aspirations in academic outcomes in adolescence (Croll et al., 2009; Eccles, 2009), only a few studies have linked aspirations to emotional/behavioural problems, especially in children. Yet there are reasons to anticipate such a link. Aspirations are related to motivation and self-concept, associated with emotional and behavioural adjustment and psychological wellbeing (Cohen & Cohen, 1996; Lekes, Gingras, Philippe, Koestner, & Fang, 2010; Williams, Cox, Hedberg, & Deci, 2000). For example, 'high' aspirations may be related to emotional and behavioural adjustment in children because achievement motivation, mastery over problems, general 'toughness' or 'hardiness', commitment, self-confidence, optimism, perseverance, self-efficacy and, in general, personal agency beliefs are all associated with both high aspirations and emotional/behavioural adjustment. Additionally, aspirations often reflect the gendered context in which they are reported, and can be indicative of gender role identity – in turn related to psychological adjustment. The direction of the relationship between gender role identity and psychological adjustment, however, is not always clear. Although some studies have found positive links between gender a-typical cognitions or behaviours and psychological maladjustment in children (Muris, Meesters, & Knoops, 2005; Young & Sweeting, 2004), others have shown that associations between psychological outcomes and aspects of femininity or masculinity do not differ by gender. For example, Hoffman, Powlistha, and White (2004) found, for both boys and girls, a relationship between masculine elements in adolescent identity (instrumentality) and fewer internalising symptoms. They also found a corresponding association of feminine elements (expressivity) with fewer externalising problems. Finally, aspirations can reflect intrinsic goals that directly satisfy basic human needs (such as affiliation, personal growth or community feeling) or extrinsic goals (such as wealth, fame or image). These goals are linked (positively and negatively, respectively) with adjustment in both adults and adolescents (Ryan & Deci, 2000).

As well as being sparse, however, the empirical evidence for the association between aspirations and emotional/behavioural problems in youth is somewhat mixed. For example, Beal and Crockett (2010) found that career aspirations in adolescence were not related to either of their measures of problem behaviour (i.e., delinquency and substance use). By contrast, Moulton, Flouri, Joshi, and Sullivan (2015b) found that low career aspirations were related to emotional problems in young children, and Boxer, Goldstein, Delorenzo, Savoy, and Mercado (2011) found that adolescents' high academic aspirations were associated with less antisocial behaviour. Studies taking a psychological theory approach to classifying children's and adolescents' aspirations have been more successful in finding associations with psychological adjustment than those measuring aspirations solely by their prestige. For example, Moulton, Flouri, Joshi, and Sullivan (2015a) linked problem behaviour in young children with the realism and maturity revealed by their aspirations. Children with fantasy aspirations (e.g., 'superhero') were more hyperactive and had more conduct and peer problems, whereas those with ambitions for unusual occupations had fewer emotional and peer problems. Their suggested explanation was that, at that age, aspiring to fantasy occupations may indicate developmental difficulties whereas aspiring to unusual occupations may indicate self-efficacy. Developmental difficulties and self-efficacy are in turn associated, negatively and positively respectively, with emotional/behavioural adjustment. Also successful was the attempt by Dickson and MacLeod (2004a, 2004b) to link adolescents' life aspirations – operationalised as approach or avoidance motivational goals – to depression and anxiety. Approach goals represent the ambition or effort to move from a present towards a desired state, and avoidance goals the ambition or effort to move away from an undesired state. As expected, anxiety was related to avoidance goals, and depression was related positively to avoidance and negatively to approach goals.

As little is known about aspirations in mid-childhood, there is clearly little evidence of their relationship to future outcomes or aspirations. There are some arguments for mid-childhood aspirations being associated with current adjustment in various ways, depending on the aspect of the aspiration considered, the type of adjustment difficulties and the child's circumstances.

The present study

This study had two aims, as explained above. The first was to explore whether early aspirations (measured at age seven) may be associated with children's emotional and behavioural problems. The second was to investigate whether early aspirations may be related to emotional/behavioural resilience to socioeconomic disadvantage (measured at age three years) – defined as family poverty, low maternal education and low maternal social class. We gauged aspirations, as far as possible, by the children's written responses to the single question 'when you grow up, what would you like to be?' Within these limits, we attempted to reflect three domains of aspiration that could be related to emotional and behavioural adjustment in children: degree of occupational prestige, gender type of the role aspired to (as a proxy for gender identity) and the child's intrinsic/extrinsic motivation (see Measures). To investigate our two research questions it was necessary to estimate a comprehensive model of the development of children's emotional and behavioural problems, showing direct and indirect effects of socioeconomic disadvantage and estimating interaction effects.

Regarding our first aim, we allowed aspirations to predict emotional/behavioural problems, and be predicted by what previous research has identified as their important family and individual antecedents, so as to rule out potential confounds. In our study, therefore, aspirations were predicted directly by socioeconomic disadvantage and indirectly via cognitive ability and maternal involvement in activities with the child. Cognitive ability and maternal involvement were also allowed to mediate the effect of socioeconomic disadvantage on emotional and behavioural problems, in line with previous research (Hackman et al., 2010). Also in line with research on the role of maternal depression in mediating the effect of poverty on child outcomes (Petterson & Albers, 2001), we allowed maternal psychological distress to explain the effect of socioeconomic disadvantage on both emotional/behavioural problems and aspirations. All three proposed mediator variables (child cognitive ability, maternal involvement and maternal psychological distress) were measured prior to age seven years, in the previous sweep of the study at age five years. As well as via these mediators, socioeconomic disadvantage was allowed to predict emotional and behavioural problems directly (Costello, Compton, Keeler, & Angold, 2003; Kiernan & Huerta, 2008; Shanahan, Copeland, Costello, & Angold, 2008). In view of the evidence for gender and ethnic differences in children's aspirations but also cognitive ability (Reynolds, Keith, Ridley, & Patel, 2008; Schoon, 2001; Sullivan, Joshi, & Leonard, 2011) and emotional/behavioural problems (Ford, Goodman, & Meltzer, 2003; Goodman, Patel, & Leon, 2008; Green, McGinnity, Meltzer, Ford, & Goodman, 2005), effects on these variables were adjusted for both gender and ethnicity. Effects on maternal psychological distress were also adjusted for ethnicity (Weich et al., 2004), and those on maternal involvement were adjusted for both gender and ethnicity (Hill et al., 2004).

In investigating our second aim, we expected to see evidence for resilience (i.e., less of an impact of socioeconomic disadvantage) in children holding aspirations that were: i) higher (i.e., for more prestigious occupations) and ii) more intrinsically motivated. Higher aspirations in disadvantaged children could signal optimism and perceived self-competence, both of which have been associated with better than expected outcomes for children at risk (Cicchetti & Rogosch, 2009; Wright & Masten, 2005). Similarly, young children in disadvantaged circumstances with intrinsic aspirations (associated with prosocial behaviour) may be more resistant to the effects poverty and adversity can have on increasing the risk of antisocial or general 'acting-out' behaviour (Flouri & Sarmadi, 2016). We also expected that aspirations for male-dominated occupations would be associated with emotional resilience to socioeconomic disadvantage, whereas aspirations for more feminised jobs or roles would predict behavioural resilience. We put forward this hypothesis on the basis that a preference – expressed by girls or boys – for a job done typically by men might reflect a more 'masculine' gender identity and reveal the protection it offers against the development of emotional problems. A preference for more feminised types of roles might reflect a feminine orientation, found to be protective against behavioural problems (Hoffmann et al., 2004). We allowed for the possibility of the gender a-typicality of the aspiration affecting outcomes (Muris et al., 2005; Young & Sweeting, 2004) by testing for an interaction between the gender of the aspiration with the gender of the child. Figure 1 shows our hypothesised model.

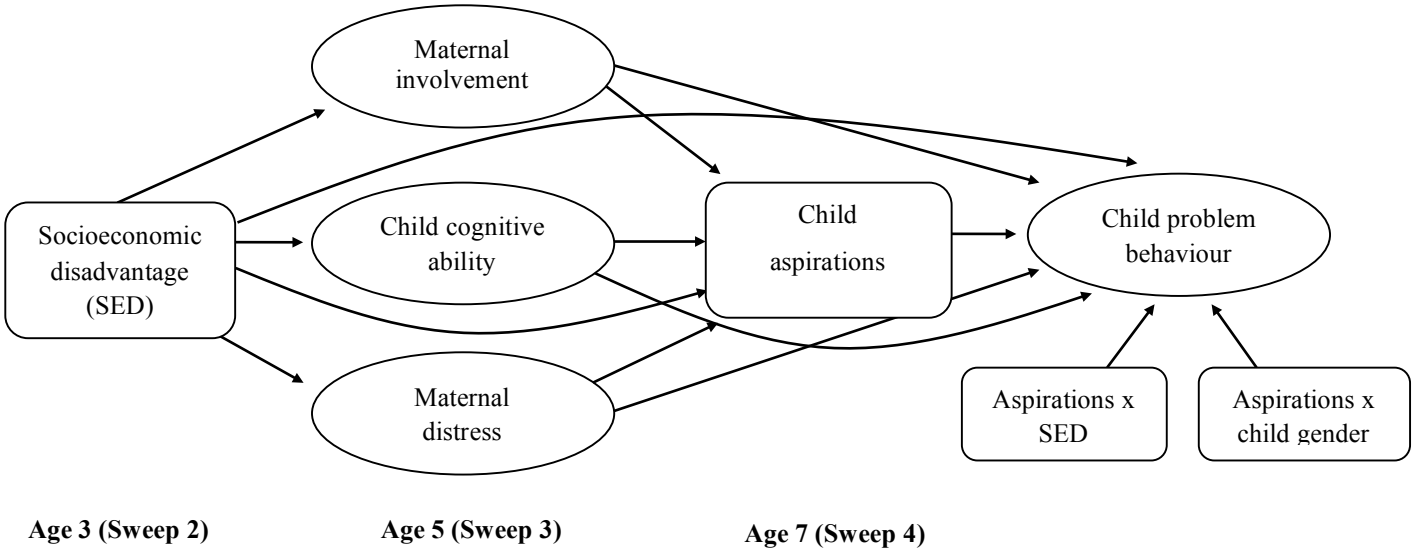


Figure 1. Hypothesised model

Notes: Family SED comprises three observed variables (family poverty, low maternal social class, and low maternal education). Aspirations comprise three observed variables (prestige, gender type, and intrinsic/extrinsic motivation). Covariances are allowed among all variables within each sweep except for aspirations, which are not allowed to covary with child problem behaviour. Child problem behaviour refers to the four latent variables of emotional symptoms, peer problems, hyperactivity, and conduct problems. Controls for child's gender and ethnicity are included in each regression path with the exception that child's gender is not included in the path from family SED to maternal psychological distress. Problem behaviour is also adjusted for child's age given that MCS children's problem behaviour was assessed at different ages at sweep four (around age seven years).

Method

We used data from the first four sweeps of the Millennium Cohort Study (MCS), a large longitudinal survey of children born in 2000-2002 in the UK (Plewis, 2007). Sweep one took place when the children were around nine months, and sweeps two, three and four took place at around three, five and seven years respectively. MCS was designed to over-represent areas with high proportions of ethnic minorities in England, areas of high child poverty, and the three smaller UK countries (Northern Ireland, Scotland and Wales). The main respondent was usually the child's biological mother. In total 18,552 families took part at MCS1. At MCS2, MCS3 and MCS4 the number of productive families was, respectively, 15,590 (including 692 new families not interviewed at MCS1), 15,246 and 13,857. A total of 19,519 children (19,244 families) participated in at least one sweep of MCS. MCS4 included a new mode of data collection, the child paper self-completion questionnaire (completed by 13,244 cohort children), which included the item on aspirations ('When you grow up, what would you like to be?'). Children could indicate more than one aspiration but only 960 children did. For those children with multiple aspirations, we used the aspiration written first, under the assumption that it was the primary aspiration. For 1,433 of the 13,244 children, the response to the aspiration item was 'don't know' (n = 607), 'nothing' (n = 22), uninterpretable (n = 171) or missing (n = 633). These children were removed from the sample used here. Most aspirations were occupational. The non-occupational aspirations were either fantasy aspirations (e.g., 'fairy' or 'superhero') or descriptions of mental or physical states (e.g., 'happy' or 'tall') and were included where it was possible to classify them to any one of the two remaining domains. The analytic sample (N = 11,656) included all children whose first aspiration could be coded to at least one of these categories[i]. The non-analytic sample (N = 7588) included children who participated in MCS at some point but who did not provide data on aspirations that could be coded to one of these categories. Both samples excluded the later-born of families who had multiple births (i.e., twins or triplets) in the cohort. This decision enabled us to avoid having to account for clustering of children within families, and resulted in making the number of cohort children equal to the number of cohort families.

Measures

Emotional and behavioural problems (age seven) were the parent's (almost invariably the mother's) scores on the 'difficulties' scales of the Strengths and Difficulties Questionnaire (SDQ; http://www.sdqinfo.com). The SDQ is a 25-item three-point screening measure of three to 16 year olds' behaviours, emotions and relationships (Goodman, 1997). It consists of four five-item scales of difficulties – namely conduct problems (e.g., 'often lies or cheats'; α = .60), hyperactivity/inattention (e.g., 'restless, overactive, cannot stay still for long'; α = .78), peer problems (e.g., 'gets on better with adults than with other children'; α = .57), and emotional symptoms (e.g., 'many fears; easily scared'; α = .65).

Aspirations (age seven) were coded to *prestige, gender type*, and level of *intrinsic/extrinsic motivation* (Flouri et al., 2012). After familiarising themselves with all the children's responses and the coding scheme (see below), each of six coders coded a sixth (around 2,200 cases) of the children's responses. The Senior Data Base Manager responsible for MCS assigned custom identity numbers to children's responses, so that coders could not link these responses to any MCS data. Also, each coder was blind to the child's gender and could not identify which of these aspirations formed part of multiple responses. Once this first stage was completed, the six coders formed three pairs and each member of the pair coded a random 25% (around 550) of the other member's cases. Inter-rater reliability was high (kappas >.80), and where there were discrepancies they were resolved by two moderators. A seventh coder reviewed all the coded responses, and refined the coding on the gender type of the aspiration. This was achieved by using (as explained below) as detailed information as possible on the type of occupation aspired to. A random check by a moderator showed that agreement was in excess of 90%.

To rank on *prestige*, the Standard Occupation Classification 2000 (SOC 2000) from the Office for National Statistics was used. SOC 2000 classifies occupations into nine major (and 353 unit) groups from the highest to the lowest level of occupational status, which we aggregated into five: I) Managers and Senior Officials and Professional Occupations; II) Associate Professional and Technical Occupations; III) Administrative and Secretarial and Skilled Trades Occupations; IV) Personal Service and

Sales and Customer Service Occupations; and V) Process, Plant and Machine Operatives and Elementary Occupations. In general, children's aspirations were very high. In the overall sample of 13,244, 80.2% of those children with an aspiration that could be ranked on prestige (n = 11,366) aspired to a SOC I or II occupation.

We looked at the *gender type* of an occupation as a way of elaborating the information embodied in occupational prestige scores, and of recognising that children lived in a gendered world and would be looking forward to a gendered world of work. They might already be displaying the sorts of differentiated gender identities that the literature associates with differences in adjustment. We therefore treated prestige and gender type as two separate and identifiable aspects of aspiration. The gender type of each occupational aspiration was coded using the proportion of UK working-age women in that occupation. Using similar methodology to Sullivan et al. (2011), occupations employing more men overall than women were classified as either 'masculine' (those with fewer than 25% women) or 'integrated' (those with 25% to 49.9% women). We split the occupations that were majority women into 'feminine' (50%-74.9% women) and 'ultra-feminine' (>=75% women) where men were as rare as women in the group classified as 'masculine'. The % value was the proportion of women in that occupation (4-digit SOC 2000 Unit Group, where possible) using the Labour Force Survey data for 2008, the same year the MCS children were asked about their aspirations. Where information about the percentage of UK working-age women in an aspired occupation was not available for a particular unit group in SOC 2000, the most detailed classification available was used. For aspiration categories where no SOC 2000 classification could be given (e.g., for fantasy responses or social roles), an appropriate gender category was allocated where possible. For example, responses such as 'mum' and 'dad' were coded 'ultra-feminine' and 'masculine', respectively. Where no inference could be made about the gender type of the aspiration (for example, 'happy'), the response was coded missing. In general, aspirations were gender-typed, especially in boys. Among the 11,652 children of the overall sample of 13,244 with data on the gender type of their aspirations, over a third (38.2%) of boys aspired to masculine, 51% to integrated, 8.1% to feminine and 2.7% to ultra-feminine jobs or roles. The respective percentages for girls were 6%, 33.9%, 38.6% and 21.6%.

Finally, each aspiration was classified to *'extrinsic' 'extrinsic-intermediate', 'neutral' or 'intrinsic-intermediate'.* Although this classification broadly reflects 'the self-determination continuum' (Ryan & Deci, 2000) we could not code aspirations to a continuum because in MCS4 the children were only asked what they would like to be when they grow up, but not why. We treated as 'extrinsic' aspirations that could reflect materialistic goals or concerns about image, power or popularity (such as 'supermodel', 'billionaire', or 'popstar'). 'Extrinsic-intermediate' goals were those that could reflect concerns about or preoccupations with financial success, image, praise or popularity (e.g., 'actor', 'singer', or 'fashion designer'), but also a degree of intrinsic motivation (therefore, 'singer' was extrinsic-intermediate and 'popstar' extrinsic). Aspirations that could not be identified as extrinsic, extrinsic-intermediate or intrinsic-intermediate (see below), such as 'farmer', were coded 'neutral' but also included in the analysis. There were only a very few children who, unprompted, gave responses reflecting intrinsic goals such as community feeling (e.g., 'look after poor people'). Therefore, these aspirations were merged with those that might be intrinsically motivated as they involved helping or caring for people and animals (such as 'nurse', 'vet', 'teacher', or 'doctor'). All such responses were coded 'intrinsic-intermediate'. In general, most children did not show excessive preoccupation with power, status, wealth or fame. Less than 5% of the aspirations of those with valid data on this aspiration dimension (n = 11,811) were coded extrinsic.

Family socio-economic disadvantage (age three) was defined as family poverty, and low maternal social class and education. Family poverty was a four-item summary index of overcrowding [> 1.5 people per room, excluding bathroom and kitchen, lack of home ownership, receipt of income support, and income poverty (below the poverty line)]. Maternal education was measured with the highest academic qualification the mother had achieved at sweep two. Academic qualifications were: 1) Higher degree, 2) First degree, 3) 'A level' or higher education diploma, 4) General Certificate of Secondary Education (GCSE) a-c, 5) GCSE d-g, 6) Other qualification and 7) No qualification.

Maternal social class (using SOC 2000) was measured with the most prestigious occupation of the mother at either sweep one or two.

Control factors were the child-level variables of exact age at sweep four, gender and ethnicity. Ethnicity was measured with the UK government census classification to white, Indian, Pakistani or Bangladeshi, black, mixed and 'other'.

The *age five mediators* of the effect of socioeconomic disadvantage on adjustment were child's cognitive ability and mother's involvement and psychological distress. Cognitive ability was measured with three tests of the British Ability Scales II (BASII): Pattern Construction, Picture Similarities and Naming Vocabulary. The first two tests assess non-verbal ability (spatial realisation and reasoning ability, respectively), and the third language skills. Maternal involvement was measured with seven items of how frequently the mother engaged in the following activities with the child: reading, telling stories, doing musical activities, teaching songs/poems/rhymes, painting/drawing, playing physically active games and playing games/with toys indoors (α = .68). All items were measured on a five-point scale from 1 (*every day*) to 5 (*never*). Maternal psychological distress was measured with the 6-item Kessler scale (Kessler et al., 2003; α = .87), which assesses the experience of recent non-specific psychological distress.

Analytic strategy and hypothesised model

First, we investigated whether the families in our analytic sample (N = 11,656) were different from those not in it (N = 7,588) on the study variables. Then, we inspected the correlations among the study variables, and fitted structural equation models (SEMs) to meet our two research aims. SEMs allowed us to model variables as latent factors, thereby reducing measurement error. We modelled child cognitive ability, maternal involvement, maternal psychological distress and the four specific domains of child problem behaviour as latent constructs loading on their scales' items. We specified regression paths as explained above ('The present study'), and allowed covariances among all variables within each sweep except for aspirations which were specified to predict (not covary with) emotional/behavioural problems. Finally, to explore the role of aspirations in resilience, we included in the model terms for the effects of the interaction between socioeconomic disadvantage and aspirations on emotional/behavioural problems. A significant aspiration x socioeconomic disadvantage interaction term would show that the effect of socioeconomic disadvantage on the outcome (emotional/behavioural problems) differs by the level of the moderator (i.e., aspiration). We also tested for gender differences in a) the effects of aspirations on emotional/behavioural problems and b) any significant effects of aspirations on emotional/behavioural resilience to socioeconomic disadvantage. We therefore tested three two-way interactions of the three aspiration domains by child's gender, and nine two-way interactions of the three aspiration domains by the three socioeconomic disadvantages. To test whether any significant moderated effects of socioeconomic disadvantage by aspirations differed for boys and girls, we carried out a multigroup analysis.

We used Mplus 7 (Muthen & Muthen, 1998-2010) to fit all SEMs, and we accepted $p < .01$ for all tests given the number and complexity of the models we fitted. We used several criteria to assess goodness of model fit to the data (Brown, 2006). The Comparative Fit Index (CFI) and the Tucker Lewis Index (TLI) measure the proportional improvement in fit by comparing the hypothesised model with a less restricted nested model. The values range from 0 to 1, and a value greater than .90 indicates good fit. The Root Mean Square Error of Approximation (RMSEA) assesses the error of approximation in the population, with a value less than .05 indicating good fit. To account for the clustered stratified sampling design of MCS, we used probability weights with the TYPE = COMPLEX analysis command. This command computes standard errors and a chi-square test of model fit taking into account stratification and unequal probability of selection. For all SEMs, we used the Maximum Likelihood Robust (MLR) estimator. In multigroup analyses comparing boys and girls, we used the MODEL TEST command to obtain a Wald test of parameter constraints, recommended to be used with the MLR estimator.

Results

Girls and white children were more likely to be in the analytic sample, as were children with higher cognitive ability and fewer emotional and behavioural problems. Also more likely to be in the

analytic sample were children of less poor families and those whose mothers had higher education and social class and lower psychological distress (tables 1 and 2). Table 3 shows the pairwise correlations between our key study variables in the analytic sample. As can be seen, socioeconomic disadvantage, particularly low maternal education and family poverty, was associated with child problem behaviour, as was maternal psychological distress. Aspirations were very weakly related to socioeconomic disadvantage and child problem behaviour, but the aspiration domains showed overlap, as expected. For example, low aspirations were likely to be extrinsic, and extrinsic aspirations tended to be male-type. Maternal psychological distress was not related to aspirations, cognitive ability was related (positively) to prestigious and female-type aspirations, and maternal involvement was related only to female-type aspirations. Figure 2 shows the results from the SEM (without interactions) fitted to meet our first research aim. The model fitted the data well (χ^2 (971) = 6847.326, p < .001; RMSEA = .023; CFI = .917; TLI = .904), and most of the path coefficients were significant. The significant coefficients (both those shown in the figure and those of the covariate effects not presented in the figure) are discussed below.

Table 1. Descriptives of Observed Categorical Study Variables in the Analytic and Non-analytic Samples

	Analytic sample (N = 11,656)		*Non-analytic sample* (N = 7588)		*Test*
Variable	***N***	**%**	***N***	**%**	***F***
Girl	5896	50.75	3453	45.28	32.92***
Ethnicity					
White	9815	88.78	5926	84.13	39.90***
Black	379	2.25	350	3.39	11.61***
Indian	301	1.78	196	1.89	0.22
Pakistani/Bangladeshi	691	3.52	659	5.21	15.43***
Mixed	309	2.76	285	3.80	13.43***
Other	155	.91	148	1.58	18.88***

Note: ***p < .001. F = F statistic for design-based Pearson chi-square that is converted to F test to account for the MCS sampling design. The analytic sample comprises those children whose reported aspirations could be coded using at least one of our three classification systems. The non-analytic sample comprises all other MCS children (see Method). Proportions are weighted to account for sampling design and non-response in MCS. Ns are unweighted.

Table 2. Descriptives of Continuous Observed Study Variables in the Analytic and Non-analytic Samples

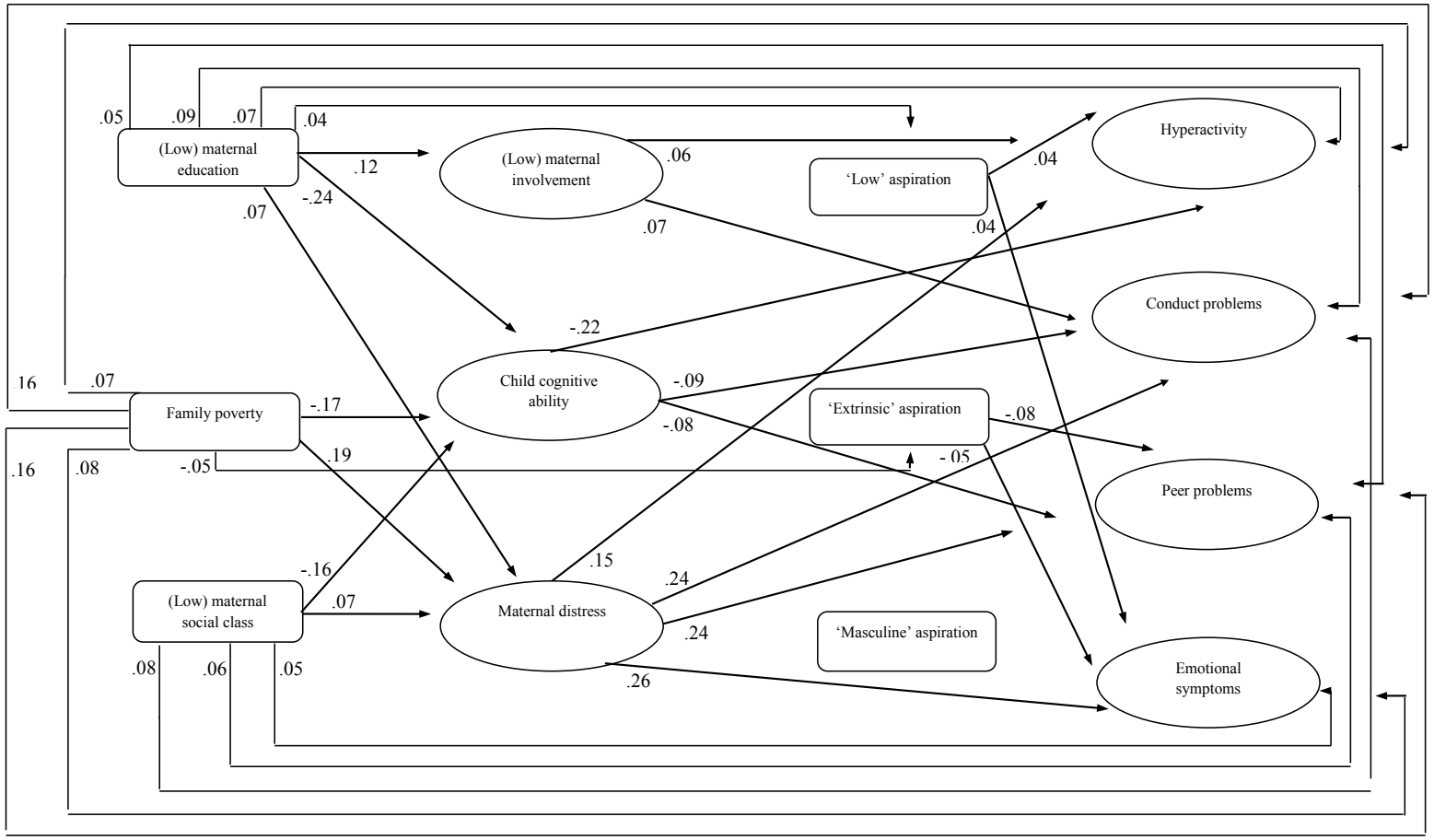
	Analytic sample (N = 11,656)			*Non-analytic sample* (*N* = 7588)		
Variable	***n***	**M (SE)**	**95% CI**	***n***	**M (SE)**	**95% CI**
Conduct problems	11,397	1.41 (0.02)	[1.36, 1.45]	2075	1.66 (0.05)	[1.57, 1.76]
Hyperactivity	11,356	3.37 (0.04)	[3.30, 3.44]	2066	3.82 (0.07)	[3.69, 3.96]
Peer problems	11,381	1.23 (0.02)	[1.18, 1.27]	2071	1.48 (0.05)	[1.39, 1.58]
Emotional symptoms	11,374	1.53 (0.02)	[1.49, 1.58]	2069	1.73 (0.05)	[1.62, 1.83]
Age (years) at Sweep 4	11,656	7.23 (0.25)	[7.23, 7.24]	2201	7.24 (0.24)	[7.22, 7.25]
Family poverty	9072	0.74 (0.02)	[0.70, 0.79]	3931	1.09 (0.03)	[1.02, 1.15]
(Low) maternal education	11,622	4.66 (0.05)	[4.56, 4.76]	7533	5.12 (0.06)	[5.01, 5.24]
(Low) maternal social class	10,470	4.61 (0.06)	[4.49, 4.73]	6368	5.11 (0.07)	[4.98, 5.25]
Maternal psychological distress	10,252	3.01 (0.04)	[2.92, 3.09]	3527	3.33 (0.08)	[3.17, 3.48]
BAS Pattern Construction	11,052	51.13 (0.17)	[50.79, 51.47]	3852	49.07 (0.25)	[48.59, 49.56]
BAS Picture Similarities	11,052	56.06 (0.17)	[55.72, 56.39]	3852	54.46 (0.23)	[54.00, 54.92]
BAS Naming Vocabulary	11,074	55.36 (0.19)	[54.99, 55.73]	3887	53.00 (0.27)	[52.47, 53.54]
(Low) maternal involvement	11,121	3.09 (0.01)	[3.07, 3.11]	4055	3.13 (0.02)	[3.10, 3.16]

Note: Means are weighted to account for both sampling design and non-response in MCS. Ns are unweighted. BAS = British Ability Scales. CI = Confidence Interval. All three BAS scores are age-adjusted.

Table 3. Pairwise Correlations of Key Observed Study Variables (ns 8232 - 11,622)

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
1. Conduct problems	-														
2. Hyperactivity	.54**	-													
3. Emotional symptoms	.37**	.31**	-												
4. Peer problems	.35**	.34**	.43**	-											
5. Family poverty	.24**	.20**	.16**	.22**	-										
6. (Low) maternal education	.23**	.20**	.15**	.20**	.46**	-									
7. (Low) maternal social class	.20**	.18**	.14**	.17**	.46**	.56**	-								
8. (Low) maternal involvement	.12**	.13**	.06**	.08**	.11**	.20**	.12**	-							
9. Maternal psychological distress	.25**	.20**	.26**	.22**	.22**	.15**	.15**	.10**	-						
10. BAS Pattern Construction	-.15**	-.22**	-.12**	-.14**	-.20**	-.21**	-.17**	-.10**	-.08**	-					
11. BAS Picture Similarities	-.11**	-.14**	-.08**	-.11**	-.15**	-.17**	-.15**	-.08**	-.07**	.35**	-				
12. BAS Naming Vocabulary	-.15**	-.17**	-.13**	-.15**	-.31**	-.35**	-.28**	-.20**	-.12**	.35**	.33**	-			
13. 'Low' aspiration	.04**	.06**	.02	.02	.03	.03**	.04**	.00	.00	-.04**	-.04**	-.01	-		
14. 'Extrinsic' aspiration	.04**	.05**	-.04**	-.03**	-.03**	-.01	.00	.01	.01	-.03**	-.03**	.01	.22**	-	
15. 'Masculine' aspiration	.07**	.12**	-.02	.04**	-.01	.02	.01	.05**	.01	-.07**	-.05**	-.03**	-.10**	.38**	-

Note: **p < .01. BAS = British Ability Scales



(N = 11,656; $\chi^2(971) = 6847.326$, $p < .001$; RMSEA = .023; CFI = .917; TLI = .904)

Figure 2. The linear effects of socioeconomic disadvantage (family poverty, low maternal education, and low maternal social class), maternal psychological distress and involvement, and cognitive ability and aspirations on problem behaviour at age seven.

Notes: Only paths with coefficients that are statistically significant at $p < .01$ are included. All coefficients are reported in standard deviation units. Covariances and covariate effects (see note to Fig. 1) are not shown.

Paths

1) From age three socioeconomic disadvantage to age seven problem behaviour.

As can be seen in figure 2, children of more educated mothers had fewer conduct, peer and hyperactivity problems. Early family poverty was associated positively with all four problem types at age seven. Low maternal social class was related positively to conduct, peer and emotional problems. Boys (not shown in figure 2) had more conduct, hyperactivity and peer problems compared to girls. Children of Pakistani/ Bangladeshi, black, and 'other' ethnicity had fewer conduct and hyperactivity problems compared to white children. Compared to white children, Indian and Pakistani/Bangladeshi children had more peer problems and black children had fewer emotional symptoms.

2) From age three socioeconomic disadvantage to age five ability, maternal psychological distress and maternal involvement.

All three socioeconomic disadvantages were related negatively to child cognitive ability and positively to maternal psychological distress. Mother's education was positively associated with her involvement. Maternal involvement was higher with girls and lower with Indian, Pakistani/ Bangladeshi and black, compared to white children. Cognitive ability was higher in girls and lower in children of Indian, Pakistani/Bangladeshi, black and 'other' ethnicity, compared to white children. Finally, psychological distress was higher in Pakistani/Bangladeshi, compared to white mothers.

3) From age three socioeconomic disadvantage and age five ability, maternal psychological distress and maternal involvement to age seven aspirations.

None of the age five mediators significantly predicted children's aspirations. However, children with more educated mothers reported higher aspirations, whereas those in poorer families reported more intrinsic aspirations. None of the socioeconomic disadvantages of the family predicted the gender type of the child's aspiration. Mother's social class was not significantly associated with any domain of aspirations, given the level of her education. Compared to girls, boys had lower, more 'masculine' and more extrinsic aspirations. Children from all ethnic minority groups had higher aspirations than white children. Compared to white, children of mixed or 'other' ethnicity aspired to more masculinised jobs and children of Pakistani/Bangladeshi or 'other' ethnicity had less extrinsic aspirations.

4) From age seven aspirations and age five ability, maternal psychological distress and maternal involvement to age seven problem behaviour.

Low maternal involvement was positively related to conduct and hyperactivity problems and maternal psychological distress was associated positively with all four problem types. Cognitive ability was negatively related to conduct, hyperactivity and peer problems. Lower aspirations were associated with more hyperactivity and emotional problems. More extrinsic aspirations were related to fewer peer and emotional problems. The gender type of the aspiration was not related to any problem behaviour.

Interactions

First, in separate models, we examined whether the direct effects of the three socioeconomic disadvantages on child problem behaviour were moderated by aspirations (i.e. whether aspirations were related to emotional/behavioural resilience to the three early socioeconomic disadvantages we examined). Table 4 shows the coefficients for the main and the interaction effects for the interactions that were found to be statistically significant at $p < .01$. Of the nine two-way interactions tested, two were significant at $p < .01$. Children of poorer families ($\beta = .128$, se = .046, $p = .005$) and those of less educated mothers ($\beta = .144$, se = .049, $p = .003$) had less hyperactivity if they had more female-type aspirations.

Subsequently, we tested whether the effects of aspirations on problem behaviour differed for boys and girls. Only one of the interactions tested (table 4), that of gender and extrinsic aspirations on peer problems, was statistically significant ($\beta = .101$, se = .035, $p = .004$). Although both boys and girls with more intrinsic aspirations had more peer problems, the gap between those with more and less intrinsic

aspirations was much greater in boys. There was no evidence for an effect of gender a-typical aspirations (i.e., girls nominating male-type roles or boys nominating typically female ones) in these models.

Lastly, we explored whether the two significant interactions between aspirations and socioeconomic disadvantage on hyperactivity differed for boys and girls. The Wald test for the interaction between family poverty and gender type of the aspiration was nonsignificant ($\chi^2(1) = 0.064$, $p = .800$), as was that for the interaction between maternal education and gender type of the aspiration ($\chi^2(1) = 1.788$, $p = .181$). Therefore, having aspirations for more feminised jobs 'protected' both boys and girls from the adverse effects of family poverty and low maternal education.

Table 4. Main and Interaction Effect Estimates (Statistically Significant Interactions Only)

	Family poverty x 'masculine' aspiration on hyperactivity		(Low) maternal education x 'masculine' aspiration on hyperactivity		Extrinsic aspiration x female on peer problems	
Family poverty	0.045	0.042				
(Low) maternal education			-0.036	0.037		
'Masculine' aspiration	-0.010	0.019	0.077	0.035		
Family poverty x 'masculine' aspiration	0.128*	0.046				
(Low) maternal education x 'masculine' aspiration			0.144*	0.049		
Extrinsic aspiration					-0.126*	0.022
Female					-0.166*	0.035
Extrinsic aspiration x female					0.101*	0.035

Note: *p < .01. Coefficients in standardised units.

Discussion

This study, using longitudinal data from a large cohort of UK children followed at ages nine months and three, five and seven years, had two aims. Its first aim was to explore the role of aspirations in children's emotional/behavioural adjustment. Its second was to investigate their role in children's emotional/behavioural resilience to the effects of early socioeconomic disadvantage. To our knowledge, this is the first study to examine whether aspirations may promote such resilience in young children, and one of the few to investigate the role of aspirations in young children's emotional/behavioural adjustment in general. Resilience in this study was defined as better than expected emotional/behavioural outcomes at age seven years despite exposure to the early socioeconomic disadvantages of low maternal education, low maternal social class and family poverty (measured at age three years). We expected to see evidence for emotional/behavioural resilience in seven-year-old children holding aspirations that were higher and more intrinsic. We also expected that aspirations for typically male jobs or roles would moderate the effect of early socioeconomic disadvantage on emotional problems, and aspirations for typically female jobs or roles would moderate the impact of that disadvantage on behavioural problems.

In general, our findings confirmed previous research that socioeconomic disadvantage has strong and long-term effects on children's emotional and behavioural outcomes (Bradley & Corwyn, 2002; Conger & Donnellan, 2007; Costello et al., 2003; Kiernan & Huerta, 2008; Shanahan et al., 2008). Importantly, the effects we found were robust to adjustment for parenting, maternal mental health and child cognitive ability. As for resilience, aspirations did moderate some of the impact of socioeconomic disadvantage but the moderator effects found were weak and involved a high degree of specificity. Neither high nor intrinsic aspirations protected from the effect of early socioeconomic disadvantage. However, children who had fewer hyperactivity problems than is typical among those living in less educated and poorer families had more female-type aspirations. Previous research has shown that masculinity and femininity may be beneficial for both boys and girls because masculinity (instrumentality) and femininity (expressivity) appear to play a protective role in the development of emotional and behavioural problems, respectively (Hoffmann et al., 2004). Our study showed that aspirations for feminised jobs were related to fewer hyperactivity problems among boys and girls of less educated or poor parents.

As well as predicting some resilience, aspirations were related to adjustment, but again the association was between specific aspects of aspirations and specific domains of adjustment. For example, in line with previous research (Beal & Crockett, 2010), we found no link between aspirations and conduct problems. However, children with higher aspirations had fewer hyperactivity and emotional problems, whereas those with more intrinsic aspirations had more emotional and peer problems. Although the first finding is in line with some research with adolescents (Boxer et al., 2011), the second was unexpected, especially in view of the evidence that, in general, intrinsic aspirations are related to positive outcomes (Mouratidis et al., 2013).

Also unexpected was our finding that neither cognitive ability nor maternal involvement appeared to be related to aspirations. Aspirations in our study were predicted only by maternal education, family poverty, and child's gender and ethnicity. Non-white children and those with more educated mothers reported higher aspirations, whereas children in poorer families reported more intrinsic aspirations. As for the role of gender in aspirations and their 'effects', we found, as expected, that boys had lower prestige, more male-type and more extrinsic aspirations than girls. However, we did not find, in general, gender differences in the effects of aspirations, including those classified by gender-type of role, on either adjustment or resilience. In both boys and girls, lower aspirations were associated with more hyperactivity and emotional problems, more extrinsic aspirations were related to fewer emotional problems, and aspirations for more feminised jobs or roles were related to behavioural resilience to socioeconomic disadvantage. The only gender difference found was in the effect of the intrinsic/extrinsic goal of the aspiration on peer problems. Having an intrinsic aspiration was associated positively with peer problems, particularly among boys. One reason could be that such aspirations tend to be gender-atypical, and gender-atypical behaviour is penalised by peer rejection, especially in boys (Young & Sweeting, 2004).

Together therefore these findings suggest that, in the UK, seven-year-old children's aspirations differ by gender, are directly shaped by their parents'

educational, economic and ethnic backgrounds, and are related, to an extent, to their emotional and behavioural adjustment and to their behavioural resilience to socioeconomic disadvantage. The lack of evidence for 'process paths' to aspirations (i.e., via child cognitive ability, parenting or maternal mental health) suggests that, in our sample, young children's aspirations were influenced directly by their parents' levels of education and material resources, and not because higher parental education and income were related to higher child cognitive ability, more involved parenting or better maternal mental health.

These findings should be viewed in the light of three important limitations, however: the use of parent reports of child problem behaviour, the absence of individual achievement data (which we did not use because they were not available for all four UK countries), and a classification of aspirations based on limited data. We ranked children's aspirations on gender composition and prestige using official data on the sex segregation and prestige of the occupations of the UK working-age population in the same year the MCS children were asked about their aspirations. However, to a seven-year-old, 'train driver' may be a more prestigious occupation than 'teacher', for example. We had no direct evidence on the child's sense of gender identity beyond the single answer given on aspirations. Similarly, we ascribed intrinsic/extrinsic occupational and life goals to children without having data on the children's reasons for them. For example, 'doctor' may be an extrinsic goal if the motivation is the high status and public prestige usually enjoyed by doctors, but intrinsic if the motivation is to help those in need. Other limitations are the exclusion from the analysis of multiple aspirations and children with uncertain aspirations or uninterpretable responses, and the absence of information about children's exposure to people with different kinds of occupations, which likely covaries with parental background. Perhaps the most crucial limitations are the weak associations of aspirations with emotional/behavioural problems, the cross-sectional modelling of the 'effects' of aspirations on emotional/behavioural problems, and, related to this, the absence of longitudinal data on aspirations. Causal interpretations are difficult to justify as the temporal ordering of our two main variables – aspirations and adjustment – is unclear, and reciprocal relations between them are likely. Nonetheless, we feel reassured by findings from studies testing cross-lagged models of emotional/behavioural adjustment and constructs closely related to aspirations, such as career orientation (Skorikov & Vondracek, 2007), that aspirations are likely to be the precursor rather than the outcome of adjustment in children and young people.

Despite these limitations, our study has many strengths. This was the first study to examine the role of early aspirations in promoting emotional/behavioural resilience to socioeconomic disadvantage in children. Its additional strengths are the use of a large, nationally representative cohort of children followed from infancy to middle childhood, and the simultaneous examination of several aspiration domains. Our findings suggest that early aspirations are related to emotional/behavioural adjustment in children, and this applies to boys as well as girls in most cases. The 'effects' of aspirations were small. Our study showed that aspirations were not as powerful predictors of child adjustment as cognitive ability, maternal psychological distress or socioeconomic disadvantage. However, it also showed that a very simple question, and one that most children would be eager to answer, can help identify not only children who struggle emotionally or behaviourally but also those who do better than expected. We think this is an important contribution of our study.

Our findings also suggest that, to the extent that the sex composition of adults' occupations adequately reflects children's orientation to feminine/masculine roles, socioeconomically disadvantaged children with aspirations for more feminised jobs act out less than expected. Perhaps surprisingly, this also applies equally to boys and girls, though boys were less likely to have aspirations for female-type jobs. From a policy perspective, there has been far more focus on opening up 'masculine' aspirations to girls than on encouraging gender-atypical aspirations in boys, and our findings suggest that poor boys could benefit from being able to express 'feminine' aspirations. This is in line with the view that conventional masculinity is damaging for the prospects of disadvantaged boys.

Acknowledgements

This research was supported by the UK Economic and Social Research Council (grant ES/J001414/1). We are grateful to Vanessa Moulton for her helpful comments.

References

Archer, L., DeWitt, J., & Wong, B. (2014). Spheres of influence: What shapes young people's aspirations at age 12/13 and what are the implications for education policy? *Journal of Education Policy*, *29*, 58-85. http://dx.doi.org/10.1080/02680939.2013.790079

Bandura, A. (2011). Social cognitive theory. In P. A. M. van Lange, A. W. Kruglanski, & E. T. Higgins (Eds.), *Handbook of theories of social psychology* (pp. 349-373). London: Sage.

Beal, S. J., & Crockett, L. J. (2010). Adolescents' occupational and educational aspirations and expectations: Links to high school activities and adult educational attainment. *Developmental Psychology, 46,* 258-265. http://dx.doi.org/10.1037/a0017416

Bond, R., & Saunders, P. (1999). Routes of success: Influences on the occupational attainment of young British males. *British Journal of Sociology*, *50*, 217-249. http://dx.doi.org/10.1111/j.1468-4446.1999.00217.x

Boxer, P., Goldstein, S. E., Delorenzo, T., Savoy, S., & Mercado, I. (2011). Educational aspiration-expectation discrepancies: Relation to socioeconomic and academic-risk related factors. *Journal of Adolescence, 34,* 609-617. http://dx.doi.org/10.1016/j.adolescence.2010.10.002

Bradley, R. H., & Corwyn, R. F. (2002). Socioeconomic status and child development. *Annual Review of Psychology*, *53*, 371-399. http://dx.doi.org/10.1146/annurev.psych.53.100901.135233

Brown, T. A. (2006). *Confirmatory factor analysis for applied research*. New York: Guilford Press.

Cicchetti, D., & Rogosch, F. A. (2009). Adaptive coping under conditions of extreme stress: Multi-level influences on the determinants of resilience in maltreated children. In E. A. Skinner & M. J. Zimmer-Gembeck (Eds.), *Coping and the development of regulation*, a volume for the series, *New directions in child and adolescent development*, (pp. 47-59). San Francisco: Jossey-Bass. http://dx.doi.org/10.1002/cd.242

Cohen, P., & Cohen, J. (1996). *Life values and adolescent mental health*. Mahwah, NJ: Erlbaum.

Conger, R. D., & Donnellan, M. B. (2007). An interactionist perspective on the socioeconomic context of human development. *Annual Review of Psychology*, *58*, 175-199. http://dx.doi.org/10.1146/annurev.psych.58.110405.085551

Costello, E. J., Compton, S. N., Keeler, G., & Angold, A. (2003). Relationships between poverty and psychopathology: A natural experiment. *Journal of the American Medical Association, 290*, 2023-2029. http://dx.doi.org/10.1001/jama.290.15.2023

Creed, P. A., Conlon, E. G., & Zimmer-Gembeck, M. J. (2007). Career barriers and reading ability as correlates of career aspirations and expectations of parents and their children. *Journal of Vocational Behavior, 70*, 242-258. http://dx.doi.org/10.1016/j.jvb.2006.11.001

Croll, P. (2008). Occupational choice, socio-economic status and educational attainment: A study of the occupational choices and destinations of young people in the British Household Panel Survey. *Research Papers in Education*, *23*, 243-268. http://dx.doi.org/10.1080/02671520701755424

Croll, P., Attwood, G., & Fuller, C. (2009). *Children's lives, children's futures*. London: Continuum.

Dickson, J. M., & MacLeod, A. K. (2004a). Anxiety, depression, and approach and avoidance goals. *Cognition and Emotion, 18*, 423-430. http://dx.doi.org/10.1080/02699930341000013

Dickson, J. M., & MacLeod, A. K. (2004b). Approach and avoidance goals and plans: Their relationship to anxiety and depression. *Cognitive Therapy and Research, 28*, 415-432. http://dx.doi.org/10.1023/B:COTR.0000031809.20488.ee

Dweck, C. S., & Leggett, E. L. (1988). A social-cognitive approach to motivation and personality. *Psychological Review, 95,* 256-273. http://dx.doi.org/10.1037/0033-295X.95.2.256

Eccles, J. S., Adler, T. F., Futterman, R., Coff, S. B., Kaczala, C. M., Meece, J. L., & Midgley, C. (1983). Expectancies, values and academic behaviors. In J. T. Spence (Ed.), *Achievement and academic motivation* (pp. 75-146). San Francisco, CA: Freeman.

Eccles, J. S. (2009). Who am I and what am I going to do with my life? Personal and collective identities as motivators of action. *Educational Psychologist, 44*, 78-89. http://dx.doi.org/10.1080/00461520902832368

Evans, G. W., Gonnella, C., Marcynyszyn, L. A., Gentile, L., & Salpekar, N. (2005). The role of chaos in poverty and children's socioemotional adjustment. *Psychological Science*, *16*, 560-565. http://dx.doi.org/10.1111/j.0956-7976.2005.01575.x

Flouri, E., Moulton, V., & Panourgia, C. (2012). *MCS data note: Coding the aspirations of children at age 7.* London: Centre for Longitudinal Studies, Institute of Education, University of London.

Flouri, E., & Panourgia, C. (2012). *Do primary school children's career aspirations matter? The relationship between family poverty, career aspirations, and emotional and behavioural problems*. CLS Working Paper 2012/5. London: Centre for Longitudinal Studies, Institute of Education, University of London.

Flouri, E., & Sarmadi, Z. (2016). Prosocial behaviour and childhood trajectories of internalising and externalising problems: The role of neighbourhood and school contexts. *Developmental Psychology,* 52, 253-258. http://dx.doi.org/10.1037/dev0000076

Ford, M. E. (1992). *Motivating humans: Goals, emotions, and personal agency beliefs*. London: Sage. http://dx.doi.org/10.4135/9781483325361

Ford, T., Goodman, R., & Meltzer, H. (2003). The British Child and Adolescent Mental Health Survey 1999: The prevalence of *DSM-IV* disorders. *Journal of the American Academy of Child & Adolescent Psychiatry*, *42*, 1203-1211. Psychiatry, 42, 1203-1211. http://dx.doi.org/10.1097/00004583-200310000-00011

Goodman, R. (1997). The Strengths and Difficulties Questionnaire: A research note. *Journal of Child Psychology and Psychiatry, 38*, 581-586. http://dx.doi.org/10.1111/j.1469-7610.1997.tb01545.x

Goodman, A., & Gregg, P. (2010). *Poorer children's educational attainment: How important are attitudes and behaviour?* York, UK: Joseph Rowntree Foundation.

Goodman, A., Patel, V., & Leon, D. A. (2008). Child mental health differences amongst ethnic groups in Britain: A systematic review. *BMC Public Health, 8*, 258. http://dx.doi.org/10.1186/1471-2458-8-258

Gottfredson, L. S. (2002). Gottfredson's theory of circumscription, compromise, and self-creation. In D. Brown (Ed.), *Career choice and development* (4th ed., pp. 85-148). San Francisco, CA: Jossey-Bass.

Green, H., McGinnity, A., Meltzer, H., Ford, T., & Goodman, R. (2005). *Summary Report: Mental health of children and young people in Great Britain, 2004.* Retrieved from http://www.esds.ac.uk/doc/5269/mrdoc/pdf/5269technicalreport.pdf

Hackman, D. A., Farah, M. J., & Meany, M. J. (2010). Socioeconomic status and the brain: Mechanistic insights from human and animal research. *Nature Reviews Neuroscience*, *11*, 651-659. http://dx.doi.org/10.1038/nrn2897

Hartung, P. J., Porfeli, E. J., & Vondracek, F. W. (2005). Child vocational development: A review and reconsideration. *Journal of Vocational Behavior, 66,* 385-419. http://dx.doi.org/10.1016/j.jvb.2004.05.006

Helwig, A. A. (2008). From childhood to adulthood: A 15-year longitudinal career development study. *The Career Development Quarterly*, *57*, 38-50. http://dx.doi.org/10.1002/j.2161-0045.2008.tb00164.x

Hill, N. E., Castellino, D. R., Lansford, J. E., Nowlin, P., Dodge, K. A., Bates, J. E., & Pettit, G. S. (2004). Parent academic involvement as related to school behavior, achievement, and aspirations: Demographic variations across adolescence. *Child Development*, *75*, 1491-1509. http://dx.doi.org/10.1111/j.1467-8624.2004.00753.x

Hoffmann, M. L., Powlishta, K. K., & White, K. J. (2004). An examination of gender differences in adolescent adjustment: The effect of competence on gender role differences in symptoms of psychopathology. *Sex Roles, 50,* 795-810. http://dx.doi.org/10.1023/B:SERS.0000029098.38706.b1

Jodl, K. M., Michael, A., Malanchuk, O., Eccles, J. S., & Sameroff, A. S. (2001). Parents' roles in shaping early adolescents' occupational aspirations. *Child Development*, *72*, 1247-1266. http://dx.doi.org/10.1111/1467-8624.00345

Kessler, R. C., Barker, P. R., Colpe, L. J., Epstein, J. F., Gfroerer, J. C., Hiripi, E., Howes, M. J., Normand, S-L. T., Manderscheid, R. W., Walters, E. E., & Zaslavsky, A. M. (2003). Screening for serious mental illness in the general population. *Archives of General Psychiatry, 60*, 184-189. http://dx.doi.org/10.1001/archpsyc.60.2.184

Kiernan, K. E., & Huerta, M. C. (2008). Economic deprivation, maternal depression, parenting and children's cognitive and emotional development in early childhood. *The British Journal of Sociology, 59*, 783-806. http://dx.doi.org/10.1111/j.1468-4446.2008.00219.x

Kim-Cohen, J., Moffitt, T. E., Caspi, A., & Taylor, A. (2004). Genetic and environmental processes in young children's resilience and vulnerability to socioeconomic deprivation. *Child Development, 75*, 651-668. http://dx.doi.org/10.1111/j.1467-8624.2004.00699.x

Lefcourt, H. (1982). *Locus of control: Current trends in theory and research* (2nd ed.). Hillsdale, NJ: Erlbaum.

Lekes, N., Gingras, I., Philippe, F. L., Koestner, R., & Fang, J. (2010). Parental autonomy-support, intrinsic life goals, and well-being among adolescents in China and North America. *Journal of Youth and Adolescence*, *39*, 858-869. http://dx.doi.org/10.1007/s10964-009-9451-7

Massey, E. K., Gebhardt, W. A., & Garnefski, N. (2008). Adolescent goal content and pursuit: A review of the literature from the past 16 years. *Developmental Review*, *28*, 421-460. http://dx.doi.org/10.1016/j.dr.2008.03.002

Masten, A. S., Herbers, J. E., Desjardins, C. D., Cutuli, J. J., McCormick, C. M., Sapienza, J. K., Long, J. D., & Zelazo, P. D. (2012). Executive function skills and school success in young children experiencing homelessness. *Educational Researcher*, *41,* 375-384. http://dx.doi.org/10.3102/0013189X12459883

Modood, T. (2004). Capitals, ethnic identity and educational qualifications. *Cultural Trends, 13*, 87-105. http://dx.doi.org/10.1080/0954896042000267170

Moulton, V., Flouri, E., Joshi, H., & Sullivan, A. (2015a). Fantasy, unrealistic and uncertain aspirations and children's emotional and behavioural adjustment in primary school. *Longitudinal and Life Course Studies, 6*, 107-119. http://dx.doi.org/10.14301/llcs.v6i1.277

Moulton, V., Flouri, E., Joshi, H., & Sullivan, A. (2015b). The role of aspirations in young children's emotional and behavioural problems. *British Educational Research Journal,* 41, 925-946. http://dx.doi.org/10.1002/berj.3188

Mouratidis, A., Vansteenkiste, M., Lens, W., Michou, A., & Soenens, B. (2013). Within-person configurations and temporal relations of personal and perceived parent-promoted aspirations to school correlates among adolescents. *Journal of Educational Psychology*, *105*, 895-910. http://dx.doi.org/10.1037/a0032838

Muris, P., Meesters, C., & Knoops, M. (2005). The relation between gender role orientation and fear and anxiety in nonclinic-referred children. *Journal of Clinical Child & Adolescent Psychology*, *34*, 326-332. http://dx.doi.org/10.1207/s15374424jccp3402_12

Muthén, L. K., & Muthén, B. O. (1998-2010). *Mplus user's guide* (6th ed.). Los Angeles, CA: Muthén & Muthén.

Nagengast, B., & Marsh, H. W. (2012). Big fish in little ponds aspire more: Mediation and cross-cultural generalizability of school-average ability effects on self-concept and career aspirations in science. *Journal of Educational Psychology*, *104*, 1033-1053. http://dx.doi.org/10.1037/a0027697

Obradovic, J. (2010). Effortful control and adaptive functioning of homeless children: Variable-focused and person-focused analyses. *Journal of Applied Developmental Psychology*, *31*, 109-117. http://dx.doi.org/10.1016/j.appdev.2009.09.004

Petterson, S. M., & Albers, A. B. (2001). Effects of poverty and maternal depression on early childhood development. *Child Development*, *72*, 1794-1813. http://dx.doi.org/10.1111/1467-8624.00379

Plewis, I. (2007). *The Millennium Cohort Study: Technical report on sampling* (4th ed.). London: Centre for Longitudinal Studies, Institute of Education, University of London.

Reynolds, M. R., Keith, T. Z., Ridley, K. P., & Patel, P. G. (2008). Sex differences in latent general and broad cognitive abilities for children and youth: Evidence from higher-order MG-MACS and MIMIC models. *Intelligence*, *36,* 236-260. http://dx.doi.org/10.1016/j.intell.2007.06.003

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist*, *55*, 68-78. http://dx.doi.org/10.1037/0003-066X.55.1.68

Schoon, I. (2001). Teenage job aspirations and career attainment in adulthood: A 17-year follow-up study of teenagers who aspired to become scientists, health professionals, or engineers. *International Journal of Behavioral Development*, *25,* 124-132. http://dx.doi.org/10.1080/01650250042000186

Shanahan, L., Copeland, W., Costello, E. J., & Angold, A. (2008). Specificity of putative psychosocial risk factors for psychiatric disorders in children and adolescents. *Journal of Child Psychology and Psychiatry, 49*, 34-42. http://dx.doi.org/10.1111/j.1469-7610.2007.01822.x

Skorikov, V., & Vondracek, F. W. (2007). Positive career orientation as an inhibitor of adolescent problem behaviour. *Journal of Adolescence*, *30*, 131-146. http://dx.doi.org/10.1016/j.adolescence.2006.02.004

Strand, S. (2007). *Minority ethnic pupils in the longitudinal study of young people in England* (LSYPE). Department of Children, Schools, and Families: Research Report 002.

Strand, S. (2011). The limits of social class in explaining ethnic gaps in educational attainment. *British Educational Research Journal*, *37*, 197-229. http://dx.doi.org/10.1080/01411920903540664

Sullivan, A., Joshi, A., & Leonard, D. (2011). Single-sex schooling and labour market outcomes. *Oxford Review of Education, 37*, 311-332. http://dx.doi.org/10.1080/03054985.2010.545194

Weich, S., Nazroo, J., Sproston, K., McManus, S., Blanchard, M., Erens, B., Karlsen, S., King, M., Lloyd, K., Stansfeld, S., & Tyrer, P. (2004). Common mental disorders and ethnicity in England: The EMPIRIC Study. *Psychological Medicine*, *34*, 1543-1551. http://dx.doi.org/10.1017/S0033291704002715

Williams, G. C., Cox, E. M., Hedberg, V. A., & Deci, E. L. (2000). Extrinsic life goals and health-risk behaviors in adolescents. *Journal of Applied Social Psychology, 30,* 1756-1771. http://dx.doi.org/10.1111/j.1559-1816.2000.tb02466.x

Wright, M. O. D., & Masten, A. S. (2005). Resilience processes in development. In S. Goldstein & R. B. Brooks (Eds.), *Handbook of resilience in children* (pp. 17-37). New York: Springer. http://dx.doi.org/10.1007/0-306-48572-9_2

Young, R., & Sweeting, H. (2004). Adolescent bullying, relationships, psychological well-being, and gender-atypical behavior: A gender diagnosticity approach. *Sex Roles*, *50,* 525-537. http://dx.doi.org/10.1023/B:SERS.0000023072.53886.86

Endnotes

[1] For 11,366 of the 13,244 children the first aspiration was an occupational aspiration (and could, therefore, be assigned a value indicating its prestige). For 11,652 the first aspiration could be coded to gender type, and for 11,811 it could be coded to level of intrinsic/extrinsic motivation.

COMMENT AND DEBATE

What can the life course approach contribute to an understanding of longevity risk?

David Blane ESRC International Centre for Life Course Studies in Society Health and University College London, UK
d.blane@imperial.ac.uk
Bola Akinwale ESRC International Centre for Life Course Studies in Society and Health and Imperial College London, UK
Rebecca Landy ESRC International Centre for Life Course Studies in Society and Health and Queen Mary College London, UK
Katey Matthews ESRC International Centre for Life Course Studies in Society and Health and University of Manchester, UK
Morten Wahrendorf ESRC International Centre for Life Course Studies in Society and Health and University of Duesseldorf, Germany
Hans-Werner Wahl Heidelberg University, Germany
Mark D. Hayward University of Texas at Austin, USA
Aart C. Liefbroer Netherlands Interdisciplinary Demographic Institute, University Medical Center Groningen and Vrije Universiteit Amsterdam, Netherlands
Gita D. Mishra University of Queensland, Australia
Isabel Ferreira University of Queensland, Australia
Ilona Koupil Stockholm University and Karolinska Institutet, Sweden

http://dx.doi.org/10.14301/llcs.v7i2.343

Abstract

Longevity risk means living longer than predicted. Attempts to understand longevity risk to date have concentrated on single diseases, usually coronary heart disease, and sought explanations in terms of risk factor change and medical innovation. In an opening paper, David Blane and colleagues point to evidence that suggests changes in positive health also should be considered; and that a life course approach can do so in a way that is socially and biologically plausible. Applying this approach to UK citizens currently aged 85 years suggests that life course research should give priority to trajectories across the whole life course and to the social and material contexts through which each cohort has passed. Testing these ideas will require inter-disciplinary and international comparative research. The opening paper is followed by commentaries from Hans-Werner Wahl, Mark Hayward, Aart Liefbroer and Gita Mishra. Finally Blane and colleagues respond to the points raised by the commentators.

Keywords

Longevity risk, positive health, social and biological plausibility, life course trajectories, social history context

Introduction

The increase in life expectancy at middle age was one of the defining characteristics of the late twentieth century, with all-cause mortality around the state pension age in England and Wales falling by some two thirds during 1971-2001 (Akinwale et al., 2011), and similar improvements occurring in many other countries (World Health Organisation, 2008).

The actuarial profession led research into the causes of this change. Their thinking includes the idea of the *golden cohort*, born in the 1930s, who were the first in the UK to experience the fall in middle aged mortality (Willets, 2004), and the concept of *longevity risk* to describe the phenomenon of living longer than predicted (Willets et al., 2004).

The rate of improvement in middle-aged mortality was not anticipated, with serious consequences for the financing of pension arrangements. In the UK, the market for annuities collapsed, employers closed defined benefit pension schemes for much of the private sector and the age at which the state pension is paid was increased first by five years for women, to be followed by a further increase of three years for all citizens.

Most of the actuarial and epidemiological research into the causes of this increasing longevity is disease-specific, usually coronary heart disease (Unal, Critchley & Capewell, 2005; Bajekal et al., 2013) or cerebrovascular disease (Raine et al., 2009); and assumed that the main determinants of the falling mortality rates would be either change in risk factors or the introduction of new medical treatments. Positive health, in the sense of growth and development, functional capacity, vitality and resilience, was largely ignored. The present paper attempts to rectify this neglect by arguing that positive health should be considered alongside risk factor change and medical innovation as driving the increase in life expectancy at middle age; and that the life course approach can contribute to the understanding of longevity risk by bringing both biological and social plausibility (Blane, Kelly-Irving, d'Errico, Bartley & Montgomery, 2013) to the idea of positive health.

Two pieces of evidence support the idea of positive health. Table 1 shows for England and Wales, the disease-specific mortality rates for the most prevalent causes of death, which together account for some two-thirds of all deaths. Between 1971 and 2001 their mortality rates tended to fall by proportionately similar amounts. The tendency was stronger for men than for women. Male mortality rates for all of these prevalent causes of death reduced by around 50-75%. For women, in contrast, the fall in mortality rates was in the 50-75% range for only five of the prevalent causes of death, while another reduced by around one-third and two increased (it is tempting to attribute the rise in women's COPD and lung cancer mortality to their tobacco smoking, although the fall in their CHD mortality, which is also tobacco-related, gives pause for thought).

Table 1. Age-standardised mortality rates per million population; England & Wales, 1971-2010; selected causes, by prevalence.

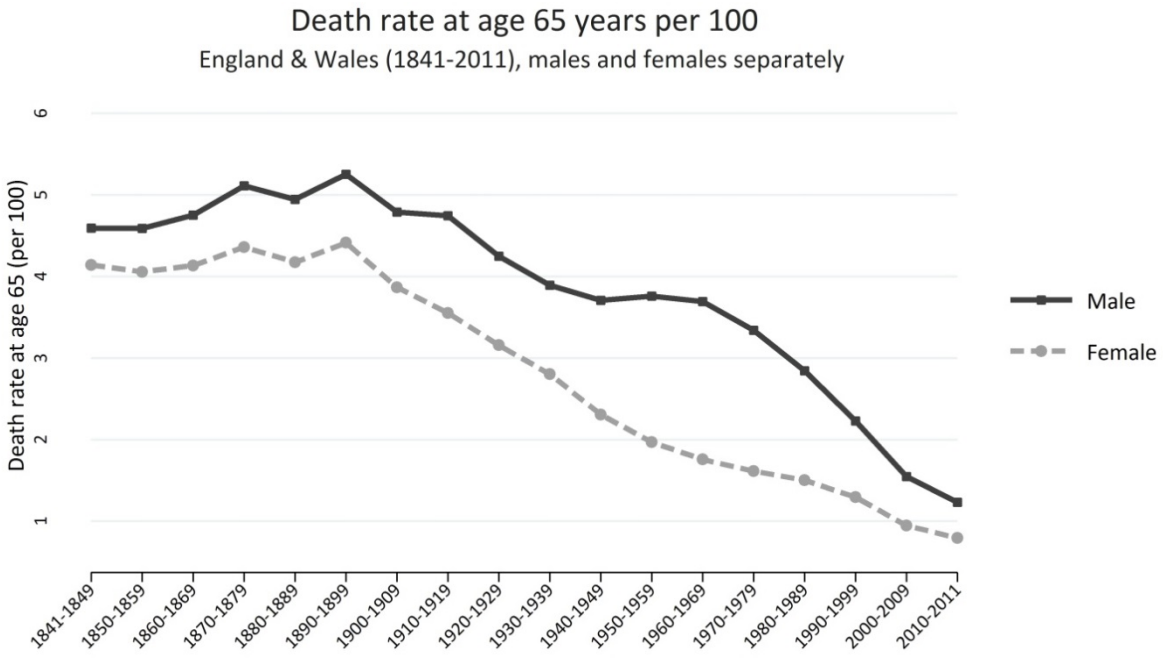
	Males			Females		
	1971	2010	Percentage change 1971-2010	1971	2010	Percentage change 1971-2010
Ischaemic heart disease	3,801	1,083	-71.5	1,668	478	-71.3
Cerebrovascular disease	1,541	422	-72.6	1,352	396	-70.7
Chronic obstructive pulmonary disease	944	314	-66.7	193	212	+9.8
Pneumonia	920	260	-71.7	624	212	-66.0
Carcinoma of lung	1,066	465	-56.4	183	299	+63.4
Accidents and violence	333	170	-48.9	166	53	-68.1
Carcinoma of breast	4	2	-50.0	379	245	-35.4
Carcinoma of stomach	317	72	-77.3	149	33	-77.9

Source: Office for National Statistics (2011).

Something similar happened in the late nineteenth and early twentieth centuries when mortality due to most of the prevalent infectious diseases of childhood fell at around the same time (McKeown & Lowe, 1966; McKeown, 1979), although in that instance the situation was simpler conceptually because infectious disease epidemiology already contained the idea of host resistance. Positive health can be seen as the chronic degenerative disease equivalent of host resistance.

Figure 1 shows the change in the death rates of people aged 65 years in England and Wales from the 1840s to 2010. The mortality rates of women and men changed little (if anything they increased) during the nineteenth century from 1841-1849 to 1891-1899. After 1900 women's mortality rate at age 65 years fell in an approximately linear fashion across the whole of the twentieth century. Men's mortality in contrast, after an initial fall, plateaued from 1931-39 to 1961-69 followed by a precipitous fall to near-equality with the women's rate by 2011.

Figure 1. Death rates of men and women at age65 years per 100 live population of that age in England and Wales 1841 to 2011



Source: Human Mortality Database.

The century-long, near linear fall in women's mortality may have received too little attention. It suggests a cumulative process driven by rising living standards, with little sign of any large impact from the introduction of antibiotics, the start of the National Health Service or the changing prevalence of tobacco smoking; also, it is easier to predict future developments, including the necessary level of pension contributions, from linear change. Prediction would have been more difficult from the change in men's mortality at age 65 years: first the three-decade plateau from the 1930s to the 1960s suggested stability rather than change, then the subsequent precipitous decline suggested rapid change. On one reading, it is the former that requires explanation (the plateau coincided with the introduction of antibiotics and widened access to, and sizeable investment in, medical care), with the latter a process of catching up for lost time.

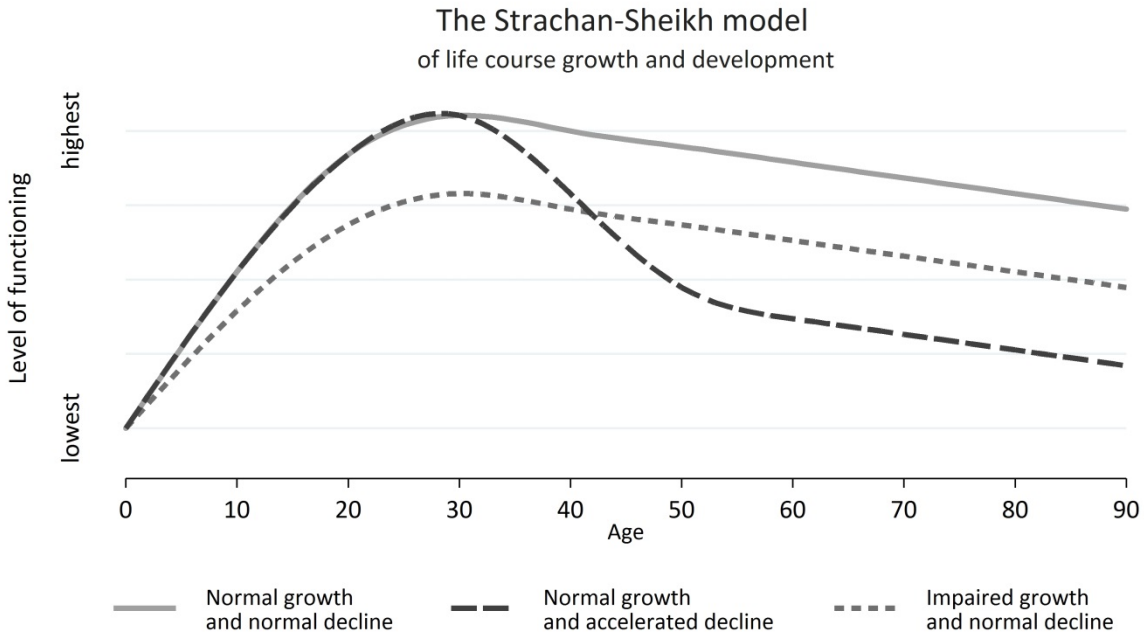
If it is accepted that risk factor change and medical innovation have difficulty, on their own, in accounting for the twentieth century's near linear fall in the mortality of 65 year old women and the proportionately similar fall in mortality from most of the prevalent causes of death, then it may be worth considering positive health as a third factor in the explanation of longevity risk. The next section of the present paper attempts to do so by examining the biological and social life course of the *golden cohort*, operationalised as those currently aged 85

years. In both cases, biological and social, the various life course stages of these 85-year-old persons will be located within their UK social history context.

Biological Life Course

Figure 2 presents a model of the biological life course. The model was described by Strachan and Sheikh (2004) in relation to lung function; here it is generalised to positive health.

Figure 2.



Source: based on Strachan and Sheikh (2004), own visualization.

First there is a phase of growth and development, during which an initial fertilised cell divides and replicates to an estimated 37.2 trillion cells by around age 20 years (Bianconi et al., 2003). Functional capacity subsequently is lost: slowly at first, when the loss is more than compensated by experience, anticipation and conditioned reflexes, as shown by professional footballers and Olympic track and field champions; then a more rapid decline to morbidity and eventual death (full line in figure 2).

Social and material circumstances can affect both the rate of growth and development and the rate of functional decline. Adverse circumstances can constrain growth and development to produce sub-optimal peak functioning, with the result that subsequently the normal rate of loss of function will still produce early death (dotted line in figure 2); for example, in Swedish linked register data childhood social disadvantage, in terms of parental social class and residential crowding, is associated with late adolescent sub-clinical abnormality (erythrocyte sedimentation rate, proteinuria, blood pressure, body mass index, vulnerability to stress) which, in turn, is associated with premature death in middle age (Sundin, Udumyan, Sjostrom & Montgomery, 2014; Bergh et al., 2014). Early death also results when normal growth and development is followed by adverse circumstances which accelerate the rate of functional loss (dashed line in figure 2); for example, when health selection into employment is followed by years of physically arduous and hazardous work (Costa & d'Errico, 2006). The social structure, with its tendency towards life course continuity of advantage or disadvantage (Goldthorpe, Llewellyn & Payne, 1980; Berney et al., 2000; Holland et al., 2000; Erikson & Goldthorpe, 1993), ensures that some people experience both sub-optimal growth and accelerated decline.

Applying figure 2 to a UK citizen currently aged 85 years shows that their period of growth and development would have occurred during 1928-1948 and their subsequent decline during 1949-2013, which latter period can be sub-divided usefully into working life (women 1949-1988; men 1949-1993) and retirement (women 1989-2013; men 1994-2013). The UK social history context in which each of these stages was lived will be examined next.

Growth and development 1928-48

This *golden cohort's* childhood was spent during the economic depression of the 1930s and their adolescence during World War II and its post-war austerity. What this meant in terms of childhood social circumstances varied by geographic region and social class. New light industries in the east midlands and south-east England brought employment and less hazardous work to some of the cohort's parents, although pay remained low and jobs insecure, together with new suburban housing and commuting via new transport infrastructure. The heavy industrial areas of north and west Britain, in contrast, experienced high unemployment, protracted poverty and poor housing (Stevenson, 1984). The high prevalence of poor diets among workers' children in the 1930s was documented by John Boyd Orr's careful studies of child health and nutrition (Harvey, 1955; Gunnell, 1996; Maynard et al., 2006) and motivated demands for welfare payments (family allowances) to cover some of the extra costs of children (Rathbone, 1924).

The war brought family disruption to the cohort's adolescence, as the result of the conscription of fathers and older siblings into the armed forces and the evacuation of urban children to rural areas, while bombing produced casualties and widespread damage to the housing stock and basic utilities like sewage. More positively, war-time full employment brought wages to mothers, which enabled them to buy their somewhat meagre rations of food, and jobs to the adolescents when they left education (Stevenson, 1984). The cohort completed its period of growth and development in post-war austerity, continued food rationing and a severe housing shortage. At the same time welfare state reforms gave hope for the future and, perhaps more importantly, the cohort was established in the labour market (Marwick, 1982).

Work and fertility 1949-1988/1993

Male members of the cohort ended their phase of growth and development conscripted into compulsory national service in UK armed forces, with its physical fitness, calorie-rich diet and heavily subsidised tobacco smoking. Female members of the cohort worked in light industry rather than domestic service, as formerly, and married in unprecedented numbers, producing fewer children despite rudimentary contraception (Coleman, 2000). The cohort raised their children in residential circumstances that, initially, were poor, often crowded, unhygienic and cold. That improved slowly during the following two decades, by which time bathrooms, indoor toilets, separate bedrooms for adults and adolescents, refrigerators and kitchen cookers were becoming universal, with telephones and washing machines already widespread (Office for Population Censuses & Surveys, 1973).

The slow but steady improvement in the residential circumstances of the cohort was funded by full employment and a labour shortage that drove rising real wages and immigration from mainland Europe, Ireland, the Caribbean and the Indian sub-continent. The rise in real wages was accompanied by the abolition of Saturday morning working as part of the standard working week and the spread of paid holidays. The combination of better-equipped kitchens, new ideas from holiday experience and more disposable income made possible better nutrition. The later years of the cohort's working lives, when the risk of the onset of chronic disease increases, coincided with de-industrialisation and the 1980s economic recession – although the cohort was protected to some extent by long-service priority access to less physically demanding jobs and, for those who lost their jobs, by pension schemes which allowed early retirement on grounds of poor health and, for manual workers, disability benefits rather than unemployment (Schuller, 1987).

Retirement 1989/1994-2013

The cohort's retirement from paid employment coincided with the emergence of the idea of the Third Age as a new stage of the life course situated between the end of responsibility for work and children and the onset of physical dependency; functionally healthy and in receipt of occupational or private second pensions, such Third Agers are seen as free to pursue their own self-realisation and

pleasure (Laslett, 1989). Morris's research into the minimum income for healthy living for retired people (Morris, Wilkinson, Dangour, Deeming & Fletcher, 2007) shows that many in the cohort will have been denied such a Third Age, particularly those afflicted by chronic disease (Patsios, 2014). However the existence of the idea indicates that the cohort's retirement is being lived in new circumstances, which includes new knowledge about early old age in terms of the nutrition and physical exercise required to maintain functioning and the ability of social participation to confer resilience to the adversities of ageing.

Social Life Course

The life course is a social as well as a biological phenomenon, so the foregoing biological perspective needs to be complemented by its social equivalent.

Bartley, Blane and Montgomery (1997) identified a series of key social transitions that are faced by most people as part of current social organisation; such transitions can set a person on a long-term trajectory towards advantage or disadvantage, depending on whether the transition is completed successfully. The sites of such transitions include education, family, work and ageing; and each needs to be seen in its cohort-specific social and material context.

The move from primary to secondary school and school examinations

This transition would have had little relevance for those currently aged 85 years because they reached the then minimum school leaving age of 14 years in 1942, when perhaps 86 per cent left school with no qualifications (Stevenson, 1984). University study was rare among this cohort: 2.6 per cent at the 1951 decennial census (Carr-Saunders, Caradog Jones & Moser, 1958) and disrupted by national conscription in UK armed forces.

Leaving parental home, establishing own home, parenthood

By the mid-1950s when the cohort was making the transition to their own home and family, the necessary residential accommodation was in short supply and often lacked basic amenities. As a result, many families were started in an in-law's home, in consequently crowded circumstances, lacking privacy.

Job insecurity, change and loss

The cohort mostly entered the labour market during the full employment of World War II and benefitted from the later labour shortage in terms of secure and rising incomes and the ease of finding alternative employment.

Onset of chronic illness and labour market exit

The cohort reached the age where chronic disease starts to become more prevalent during the high unemployment and de-industrialisation of the 1980s, when premature labour market exit was possible through early retirement on an occupational pension or, for those without an occupational pension, through permanent sickness on disability benefit.

In each case, those from an advantaged social class were more likely to complete successfully the transition faced, but for the cohort as a whole the later challenges occurred in more favourable circumstances than the earlier ones.

Discussion

The biological and social life courses point in the same direction: namely, that those currently aged 85 years in UK mostly did not have a particularly advantaged childhood and adolescence, while their adulthood and early old age were marked by steadily improving social and financial circumstances. These findings suggest that life course research might question its emphasis on early life, give more attention to adult circumstances and look at the continuities between these stages of life.

At least three objections to this line of reasoning need to be addressed. First, can these ideas be tested; can positive health be defined more precisely and can it be measured? Second, the increase in life expectancy at middle age has continued beyond the *golden cohort*, in circumstances where the balance between early and later life may be different. Third, the increase in life expectancy at middle age is a worldwide phenomenon; can a worldwide phenomenon be explained by events in one country (UK)?

Each of these objections suggests a new line of enquiry. The measurement of some aspects of positive health is long established, particularly in relation to the phase of growth and development. Formerly in the UK, the school medical service measured height and weight during childhood; the

national educational test measured cognitive function at age 11 years; and the army medical corps measured various aspects of the physical and psychological functioning of those conscripted into the armed forces at the end of adolescence. Apart from special surveys of population samples, comparable measures during the phase of functional decline are rare, particularly during its early stages, before overt morbidity; routine screening by occupational health departments and private health insurance companies are the main exceptions. Most research has concentrated on specific measures such as coronary heart disease risk, although measures of positive health more generally have been proposed, such as the concept of allostatic load (McEwen & Seeman, 1999) and its current development (Kelly-Irving et al., 2014). New initiatives in the area of positive health would be timely because of the wealth of biomedical data becoming available in large, representative social surveys, such as the Constances cohort (Zins et al., 2010) and the UK Household Longitudinal Study (Benzeval, Devillas, Kumari & Lynn, 2014).

The second and third objections require international comparative research to identify countries whose demographic and social history differs from those of the UK. Are there countries where the proportionate fall in mortality from the prevalent causes of death differed from that in England & Wales; and if so, what were the reasons for this difference? Are there countries where the increase in life expectancy at middle age started earlier or later than in Britain; and if so, do they show the same gender differences? Are there countries whose history reversed the UK life course sequence of childhood hardship followed by growing adult affluence; and if so, what was the associated change in life expectancy at middle age? Once again, these research questions are timely because of the creation of international demographic databases, such as that of Max Planck Institute in Rostock, collaborating with Rand Corporation in USA, and international bio-social surveys, such as the USA National Institute of Aging portfolio studies of ageing.

In summary, the present discussion paper has argued that: studies of longevity risk could usefully include the idea of positive health; that the life course perspective offers a way of doing so which is biologically and socially plausible; that it is instructive to set these life course stages in their cohort-specific social history context; and that doing so suggests a timely and progressive programme of research.

Acknowledgements

We owe a debt of gratitude to Madhavi Bajekal, Rosalind Raine and the members of the Institute and Faculty of Actuaries, particularly Joseph Lu, Brian Ridsdale and Richard Willetts, for raising our interest in longevity risk; and to UK Economic and Social Research Council who funded (Award No: ES-J019119/1) the *International Centre for Life Course Studies in Society and Health* (ICLS) of whose scientific programme the present paper is a part.

References

Akinwale, B., Lynch, K., Wiggins, R., Harding, S., Bartley, M., & Blane, D. (2011). Work, permanent sickness and mortality risk: a prospective cohort study of England and Wales, 1971-2006. *Journal of Epidemiology and Community Health*, ;*65*, 786-792. http://dx.doi.org/10.1136/jech.2009.099325

Bartley, M., Blane, D., & Montgomery, S. (1997). Health and the life course: why safety nets matter. *British Medical Journal, 314*, 1194-1196. http://dx.doi.org/10.1136/bmj.314.7088.1194

Bajekal, M., Scholes, S., O'Flaherty, M., Raine, R., Norman, P., & Capewell, S. (2013). Unequal trends in coronary heart disease mortality by socioeconomic circumstances, England & Wales 1982-2006. *PLoS One*,8:e59608. http://dx.doi.org/10.1371/journal.pone.0059608

Benzeval, M., Devillas, A., Kumari, M., & Lynn, P. (2014). Understanding Society – the UK Household Longitudinal Study: biomarker user guide & glossary. *University of Essex, Institute of Social and Economic Research*.

Bergh, C., Udumyan, R., Fall, K., Nilsagard, Y., Appelros, P., & Montgomery, S. (2014). Stress resilience in male adolescents and subsequent stroke risk: cohort study. *Journal of Neurology, Neurosurgery and Psychiatry*, *85*, 1331-1336. http://dx.doi.org/10.1136/jnnp-2013-307485

Berney, L., Blane, D., Davey Smith, G., Gunnell, D., Holland, P., & Montgomery, S. (2000). Socioeconomic measures in early old age as indicators of previous lifetime exposure to environmental health hazards. *Sociology of Health and Illness*, *22*, 415-430. http://dx.doi.org/10.1111/1467-9566.00212

Bianconi, E., Piovesan, A., Facchin, F., Beraudi, A., Casadei, R., Frabetti, F., Vitale, L., Pelleri, M.C., Tassani, S., Piva, F., Perez-Amodio, S., Strippoli, P. & Canaider, S. (2013). An estimation of the number of cells in the human body. *Annals of Human Biology*, *40*(6), 463-471. http://dx.doi.org/10.3109/03014460.2013.807878

Blane, D., Kelly-Irving, M., d'Errico, A., Bartley, M., & Montgomery, S. (2013). Social-biological transitions: how does the social become biological? *Longitudinal and Life Course Studies, 4,* 136-146.

Carr-Saunders, A., Caradog Jones, D., & Moser, C. (1958). *A survey of social conditions in England and Wale* (p. 58). Oxford: Clarendon Press.

Coleman, D. (2000). Population and family. In A. Halsey, & J. Webb (Eds.), *Twentieth century British social trends* (pp.27-93). London: Macmillan.

Costa, G., & d'Errico, A. (2006). Inequalities in health: do occupational risks matter? *European Journal of Public Health 26* (2). http://dx.doi.org/10.1093/eurpub/ckl112

Erikson, R., & Goldthorpe, J. (1993). *The constant flux.* Oxford: Clarendon Press.

Goldthorpe, J., Llewellyn, C., & Payne, C. (1980). *Social mobility and class structure in modern Britain.* Oxford: Clarendon Press.

Gunnell, D. (1996). *Food, death and Income – a follow-up study based on a survey of family diet and health in pre-war Britain (1937-39).* University of Bristol, Doctoral Thesis.

Harvey, D. (1955). *Family diet and health in pre-war Britain: dietary and clinical survey* (Report to the Carnegie United Kingdom Trust from the Rowett Research Institute). Dunfermline: Carnegie United Kingdom Trust.

Holland, P., Berney, L., Blane, D., Davey Smith, G., Gunnell, D., & Montgomery, S. (2000) Life course accumulation of disadvantage. *Social Science and Medicine*, *50*, 1285-1295. http://dx.doi.org/10.1016/S0277-9536(99)00375-5

Human Mortality Database website. Data accessed as follows. Data: Zipped Data Files; Period Data: Death Rates; *enter* user name & password; *select* M_x 1x10; *select* GBRTENW.

Kelly-Irving, M., Barbosa-Solis, C., Fantin, R., Lamy, S., Lang, T., & Delpierre, C. (2014). Adverse childhood experiences and allostatic load in mid-life: pathways between early life experience and adult health decline. *European Journal of Public Health, 26* (1).

Laslett, P. (1989). *A fresh map of life: the emergence of the Third Age.* London: Weidenfeld and Nicolson.

Marwick, A. (1982). *British society since 1945.* London: Penguin.

Maynard, M., Gunnell, D., Abraham, L., Ness, A., Bates, C., & Blane, D. (2006). What influences diet at older ages? Prospective and cross-sectional analyses of the Boyd Orr cohort. *European Journal of Public Health*, *16*, 315-323. http://dx.doi.org/10.1093/eurpub/cki167

McEwen, B., & Seeman, T. (1999). Protective and damaging effects of mediators of stress: elaborating and testing the concepts of allostasis and allostatic load. *Annals of the New York Academy of Sciences*, *896*, 30-47. http://dx.doi.org/10.1111/j.1749-6632.1999.tb08103.x

McKeown, T., & Lowe, C. (1966). *An introduction to social medicine.* Oxford: Blackwell.

McKeown, T. (1979). *The role of medicine.* Oxford: Blackwell.

Morris, J.N., Wilkinson, P., Dangour, A., Deeming, C., & Fletcher, A. (2007) Defining a minimum income for healthy living (MIHL): older age, England. *International Journal of Epidemiology*, *36*, 1300-1307. http://dx.doi.org/10.1093/ije/dym129

Office for National Statistics website. Data accessed as follows: Themes: Population. Deaths: Mortality Rates. Vital Statistics: Population and Health Reference Tables. *select* current & past editions. Spring 2011. *select* Reference Tables. *open* Zip file. *select* Table 6.1 xls.

Office for Population Censuses and Surveys (1973). *General household survey 1971* (and subsequently each year). London: HMSO.

Patsios, D. (2014). Pensioner poverty and social exclusion. www.poverty.ac.uk.

Raine, R., Wong, W., Ambler, G., Hardoon, S., Petersen, I., Morris, R., Bartley, M., & Blane, D. (2009). Socio-demographic variations in the contribution of secondary drug prevention to stroke survival at middle and older ages: cohort study. *British Medical Journal*, 338, b1279. http://dx.doi.org/10.1136/bmj.b1279

Rathbone, E. (1924). *The disinherited family.* London: Edward Arnold.

Schuller, T. (1987). Second adolescence? The transition from paid employment. *Work, Employment and Society*, *1*, 352-370. http://dx.doi.org/10.1177/0950017087001003005

Strachan, D., & Sheikh, A. (2004). A life course approach to respiratory and allergic diseases. In D. Kuh, & Y. Ben-Shlomo (Eds.) *A life course approach to chronic disease epidemiology* (2nd Edition) (pp.240-259). Oxford: Oxford University Press..

Stevenson, J. (1984). *British society 1914-45.* London: Penguin.

Sundin, P., Udumyan, R., Sjostrom, P., & Montgomery, S. (2014). Predictors in adolescence of ESRD in middle-aged men. *American Journal of Kidney Disease*, *64*, 723-729. http://dx.doi.org/10.1053/j.ajkd.2014.06.019

Unal, B., Critchley, J., & Capewell, S. (2005). Modelling the decline in coronary heart disease deaths in England & Wales, 1981-2000. *British Medical Journal*, *331*, 614-615. http://dx.doi.org/10.1136/bmj.38561.633345.8F

Willets, R. (2004). *The cohort effect: insights & explanations.* Cambridge: Cambridge University Press

Willets, R., Gallop, A., Leandro, P., Lu, J., Macdonald, A., Miller, K., Richards, S., Robjohns, N., Ryan, J., & Waters, H. (2004). *Longevity in the 21st century.* London: Institute of Actuaries & Faculty of Actuaries.

World Health Organisation (2008). : *Closing the gap in a generation*. Commission on Social Determinants of Health, Geneva: World Health Organisation.

Zins, M., Bonenfant, S., Carton, M., Coeuret-Pellicer, M., Gueguen, A., Gourmelen, J., Nachtigal, M., Ozguler, A., Quesnot, A., Ribet, C., Rodrigues, G., Serrano, A., Sitta, R., Brigand, A., Henny, J., & Goldberg, M. (2010). The CONSTANCES cohort: an open epidemiological laboratory. *Public Health*, *10*, 479-487. http://dx.doi.org/10.1186/1471-2458-10-479

Commentary by **Hans-Werner Wahl** Heidelberg University, Germany
h.w.wahl@psychologie.uni-heidelberg.de

Life-span developmental psychology and social-behavioural aging science: need for better liaisons with life course epidemiology in the future

Life-span developmental psychology and life course research in the sociology of ageing (see below for differences) have been established meta-perspectives in social-behavioural ageing science for some decades. However, such 'old' meta-perspectives face permanent challenges to re-invent themselves as a result of the continuing development of new theories and the emergence of new longitudinal data, as well as synergies arising from the interchange with other disciplinary views. I will use the Blane, Akinwale, Landy, Matthews, and Wahrendorf article (2016) as a springboard to take a closer look at what life-span developmental psychology and life course research has achieved so far, particularly in empirical but also in conceptual terms. At the same time, I will refer to this material to take a critical look at the Blane et al. (2016) work.

A glance at the history of life-span / life course views in social and behavioural ageing research

The insight that it might not be a good idea to split the human life course and concentrate, for example, only on early childhood or on old age is not new in developmental science. Groffman (1970) has provided a comprehensive account of European historical roots of life-span thinking in philosophy, culture and fictional literature. Examples of influential philosophical perspectives on ageing include: Francis Bacon in England (1561-1626; 'History of Life and Death'), Michel de Montaigne (1533-1592; 'Life Wisdom's Final End') and Johannes Nikolaus Tetens in Germany (1736 – 1807; 'Philosophical Treatise on Human Nature and its Development'). One should also mention Belgian mathematician and statistician Adolphe Quetelet (1835), who argued for the need to detect the laws of life-long development in his two-volume treatise 'Sur l'homme et le développement de ses facultés' ('On man and the development of his capabilities'), and Francis Galton from England, who undertook one of the first cognitive performance studies across a wide age span – from infancy to old age – during the International Health Exhibition held in London in 1885. Life-span oriented research also received a strong push by Austrian developmental psychologist Charlotte Bühler's (1933) widely acknowledged monograph 'Der menschliche Lebenslauf als psychologisches Problem' ('Human Life Course as a Psychological Problem').

More recently, particularly after gerontology's instalment as a science shortly after World War II, two separated traditions, operating with different names, have evolved in the sociology and the psychology of ageing. In sociology, the term *life course* has mostly been used and a central argument always has been that social forces largely determine the flow of life and define expectations about what should happen in a 'normal' life at a certain age (e.g., Settersten, 2003). Psychology preferred the term *life-span development* and predominantly concentrated on proximal and distal influences of a range of factors such as personality, cognitive functioning, or childhood trauma, in order to understand the dynamics of life-long, developmentally relevant processes as well as to predict late-life outcomes (e.g., Baltes et al., 2006). These two lines of research converged at times, but also searched to define themselves from each other across the decades (e.g., life-span researchers also use the cohort concept to understand historical changes in late-life cognitive functioning; sociologist have a tendency to accuse life-span researchers of under-rating the role of socioeconomic status (SES) across full lives). More recently, health research has significantly added to both life course as well as life-span research and it seems that epidemiology increasingly searches for the inclusion of distal antecedent factors, when it comes to the predictions of a range of endpoints such as diseases and functional limitations (e.g., Ben-Shlomo & Kuh, 2002; Kuh et al., 2014).

In conclusion, a life course / life-span view has existed for some time, when it comes to social-behavioural research on ageing and, to some extent, also in the area of health and aging research. I therefore find the framework proposed by Blane et al. to be less innovative when seen from

the perspective of social-behavioural aging science. I was also surprised that the relationship to the life course approach in the health and epidemiology area, e.g., as suggested by Kuh and colleagues (e.g., Kuh et al., 2014), was not described.

Important data and findings of life-span and life course research: a selective and exemplary view with a focus on health-related outcomes

Setting aside the more historically relevant distinction between life-span and life course research, a number of findings with importance for late-life health issues emerged in social-behavioural ageing research and some of the prototypical ones will be mentioned in what follows. First, in the emerging area of the critical role that differences in *cognitive functioning* seem to play for late-life outcomes ('cognitive epidemiology'; see Calvin et al., 2011), work by intelligence researcher Deary at al. has shown that cognitive functioning as measured in 11-year-old children reveals a very strong relationship with intelligence assessed 70 years later (Deary et al., 2004). In addition, Deary and colleagues (2004) also found, in line with a number of other studies (see also Schaefer et al., 2015), that being higher in intelligence in childhood not only predicts living longer even after controlling for a number of confounders, but also type 2 diabetes, heart disease, and dementia in late life.

Second, the linkage between *personality and late-life health outcomes* is complex but well established. In particular, being a high scorer in neuroticism seems to predict follow-up health events and longevity rather well (e.g., Mroczek et al, 2006). Importantly, inter-individual differences in personality traits tend to be stable after young adulthood until the end of life (Roberts & DelVeccio, 2000) and thus unfold their health-related impact on the full remaining life course.

Third, Blane et al. already consider the critical role of adverse childhood conditions for very late health-related outcomes to some extent in the article. However, there is much more. Caspi and colleagues in the UK have shown, in a range of studies, how important early childhood experiences are for later-life outcomes via abnormal adolescent behaviour which in reverse may impact on the rest of life, e.g., via depressed mood or reduced educational pathways (e.g., Caspi et al., 2002). His research also underscores significant interactions between expression of specific genes and early-life traumatic experiences, leading to different mental health outcomes including abnormal behaviours, which again may dramatically shape the remaining life course. Going further, Schafer and Ferraro (2012) have shown with data from the US targeting early-life conditions based on rather objectively assessed retrospective information, that early-life economic conditions do show substantial associations with successful versus less successful ('positive health') lifespan developmental trajectories including wellbeing in old age. Brandt et al. (2012) show similar findings based on data from a number of European countries. Emerging findings from other research teams also found similar relationships between adverse childhood contexts and late-life functional ability impairment, multimorbidity, and mortality (Pavela & Latham, 2015; van den Berg et al., 2006, 2009). Most of these associations remained statistically meaningful even after controlling for proximal health and SES conditions.

Fourth, the existence of *early health risk factors* seems to impact on the full rest of the life span. A relatively large and fairly consistent body of evidence from epidemiological studies now demonstrates that being overweight in childhood and adolescence has adverse consequences on premature mortality and physical morbidity in adulthood (Reilly & Kelly, 2011). Additionally, the clear majority of depressive illnesses have emerged before the age of 25 years; hence, and particularly given the resistance to treatment of depressive illness at large, late-life depression is to a large extent connected with depressive episodes that already appeared earlier in the life-span (Kessler et al., 2014). Similarly, low educational input, low physical activity level, cognitive inactivity, midlife overweight, diabetes, smoking and depression earlier in life show relatively strong associations with late-life dementia-related disorders (Barnes & Yaffe, 2011).

Fifth, two simple subjective evaluations assessed earlier in life (e.g., in midlife), i.e., *subjective health* and *subjective age*, show important relations with late-life health-related endpoints. Subjective health assessed in early life has been found to predict late-life morbidity and mortality even when objective health is controlled (Jylhä, 2009). Also, feeling younger and having a more positive attitude

towards own aging, when assessed in midlife, can predict late-life cardio-vascular disease, functional ability, dementia-related physiological changes in the brain, and mortality (e.g., Levy et al., 2002; see also meta-analysis by Westerhof et al., 2014). It may be argued here that feeling healthier as well as feeling younger may represent a rather powerful ways to resist the ageing process and thus indicate efficient forms of resilience as people age, starting its operation rather early in the life-span.

In summary, it seems rather clear that differences appearing in late-life health outcomes including longevity are, to a considerable extent, influenced by differences earlier and even very early in life – including in childhood. It is interesting too that Blane et al. do not feature this body of work, mostly coming from the social and behavioural aging science area, very much in their article. I interpret this as an indication that life-span / life course approaches still operate too much in silos, with each unaware of what has already been done in different disciplinary areas. This cross-disciplinary problem needs to be overcome, because the concepts focused on in the empirical work outlined above are all able to speak to the concept of positive health – a core construct that Blane et al. are using in their article.

Concept of positive health

The argument made by Blane et al. that traditional gero-epidemiology research targeting longevity (mortality) is too much focused on a disease and disease-risks perspective is important. Blane et al. (2016) rightly state: "positive health, in the sense of growth and development, functional capacity, vitality and resilience, was largely ignored." (p. 167). Later in their work, they also address issues of definition and assessment in the context of positive health. Indeed, it seems that disease-specific mortality rates are on the decline due to on-going medical progress and positive health may increasingly take over as a driving force of longevity in decades to come.

However, in social-behavioural ageing research, the term positive health would be unlikely to find much resonance and the immediate association would be the concept of *successful ageing*. Three influential concepts of successful ageing may be distinguished. First, Rowe and Kahn (1997), a geriatrician and a social psychologist, have suggested a concept of successful ageing based on three components: (1) low risk of disease and related disability; (2) high cognitive and physical functioning, and; (3) continued active engagement in life. All three of these components are substantially related to longevity and all have, as argued above, major sources in earlier life conditions. They indeed also have considerable overlap with the concept of positive health as described by Blane et al.

Second, the so-called *well-being paradox* has gained much attention in social-behavioural ageing research and we now know that ageing people have a full tool box at their disposal allowing them to maintain high levels of wellbeing, even in highly adverse conditions. Two such mechanisms are also echoed in the data as mentioned above, i.e. feeling subjectively healthy even when faced with severe morbidity and feeling younger even beyond the age of 80 years. In a sense, such processes may resemble what Blane et al. had in mind, when they referred to growth and development as well as vitality in their conceptualisation of positive health.

Third, resilience, also explicitly addressed by Blane et al., has generated much interest in social-behavioural ageing science since the 1990's (Staudinger & Greve, in press). As Staudinger and Greve (in press) argue, resilience should be seen as a ubiquitous phenomenon of ageing and not as the rare exception, although personality characteristics for example (see also data mentioned above) are likely of importance to foster resilience.

In the light of such conceptual ideas as well as the empirical work I have compiled in the previous section, I feel that the term 'positive health' has remained too vague in the Blane et al. article. We need a robust conceptual model that addresses what positive health may mean and issues such as (childhood) intelligence, psychological resilience, attitudes toward own aging, as well as personality traits (e.g., low neuroticism, but also high conscientiousness) must all be considered in such a model. There is also a strong need to develop such a model in historic-dynamic terms; hence, ongoing cohort changes, as just mentioned, must become part of such a conceptual approach. It even seems that using 'positive health' is too narrow a term, because important factors related to longevity risk seem not to belong in the health sphere.

Outlook

Both the life course orientation as well as the emphasis put on positive health in the work by Blane et al., suggest that great synergies would unfold if life course epidemiology and life-span / life course research in social-behavioural ageing research would move closer together. First, better links and more cooperation between these areas may widen the range of constructs to be considered to better understand longevity risk. An important part of such widening would, in my view, be the insight that factors beyond health play a significant role when it comes to efficient prediction models of longevity. Second, better connections may greatly enhance our empirical understanding of which kinds of mechanisms are operating and linking early and late-life outcomes. Third, the expected conceptual and empirical progress based on better links and more co-operation may lead to better targeting of critical conditions early in life with the potential / risk to have 'long-term' impact on the remaining life course and thus become relevant for for intervention and early preventive efforts.

In conclusion, the concept of positive health, enriched and differentiated with now empirically proven concepts anchored in social and behavioural aging science, may further the needed *Gestalt Switch* from a traditionally mostly disease-related view of longevity to a view that integrates health / disease and social-behavioural parameters important for human long-term development. In an optimistic scenario, this may also open our eyes to new public health and preventive approaches that, to a large extent, may operate early in life, for example in kindergarten and the early school years. Hence, it may become increasingly true in the future that old age outcomes as well as end of life dynamics are linked with occurrences early in life and possibly even at the pre-natal stage of development.

References

Baltes, P. B., Lindenberger, U., & Staudinger, U. M. (2006). Life-span theory in developmental psychology. In W. Damon & R. M. Lerner (Eds.), *Handbook of child psychology* (6th ed., Vol. 1: Theoretical models of human development, pp. 569-664). New York: Wiley.

Blane, D., Akinwale, B., Landy, R., Mathews, K. & Wahrendorf, M. (2016). What can the life course approach contribute to an understanding of longevity risk? *Longitudinal and Life Course Studies 7*(2)

Barnes, D. E., & Yaffe, K. (2011). The projected effect of risk factor reduction on Alzheimer's disease prevalence. *The Lancet Neurology*, *10*, 819-828. http://dx.doi.org/10.1016/S1474-4422(11)70072-2

Ben-Shlomo, Y., & Kuh, D. (2002). A life course approach to chronic disease epidemiology: conceptual models, empirical challenges and interdisciplinary perspectives. *International Journal of Epidemiology*, *31*, 285-293. http://dx.doi.org/10.1093/ije/31.2.285

Brandt, M., Deindl, C., & Hank, K. (2012). Tracing the origins of successful aging: the role of childhood conditions and social inequality in explaining later life health. *Social Science & Medicine*, *74*, 1418-1425. http://dx.doi.org/10.1016/j.socscimed.2012.01.004

Bühler, C. (1933). *Der menschliche Lebenslauf als psychologisches Problem* [The Human Life Course a Psychological Problem]. Leipzig: Hirzel.

Calvin, C. M., Deary, I. J., Fenton, C., Roberts, B. A., Leckenby, G., & Batty, G. D. (2011). Intelligence in youth and all-cause mortality: systematic review with meta-analysis. *International Journal of Epidemiology*, *40*, 626-640. http://dx.doi.org/10.1093/ije/dyq190

Caspi, A., McClay, J., Moffitt, T., Mill, J., Martin, J., Craig, I. W., … & Poulton, R. (2002). Role of genotype in the cycle of violence in maltreated children. *Science*, *297*, 851-854. http://dx.doi.org/10.1126/science.1072290

Deary, I. J., Whiteman, M. C., Starr, J. M., Whalley, L. J., & Fox, H. C. (2004). The impact of childhood intelligence on later life: Following up the Scottish mental surveys of 1932 and 1947. *Journal of Personality and Social Psychology*, *86*, 130-147. http://dx.doi.org/10.1037/0022-3514.86.1.130

Groffmann, K. J. (1970). Life-span developmental psychology in Europe: past and present. In L. R. Goulet & P. B. Baltes (Eds.), *Life-span developmental psychology: Research and theory* (pp. 53-68). New York: Academic Press. http://dx.doi.org/10.1016/B978-0-12-293850-4.50009-1

Jylhä, M. (2009). What is self-rated health and why does it predict mortality? Towards a unified conceptual model. *Social Science & Medicine*, *69*, 307–316. http://dx.doi.org/10.1016/j.socscimed.2009.05.013

Hülür, G., Drewelies, J., Eibich, P., Düzel, S., Demuth, I., Ghisletta, P., Steinhagen-Thiessen, E., Wagner, G. G., Lindenberger, U., & Gerstorf, D. (in press). Cohort differences in psychosocial function over 20 years: Current older adults feel less lonely and less dependent on external circumstances. *Gerontology*.

Kessler, E.-M., Kruse, A., & Wahl, H.-W. (2014). Clinical gero-psychology: A lifespan perspective. In N. A. Pachana & K. Laidlaw (Eds.), *The Oxford Handbook of Clinical Geropsychology* (pp. 3-25). Oxford University Press.

Kuh, D., Karunananthan, S., Bergman, H., & Cooper, R. (2014). A life-course approach to healthy ageing: maintaining physical capability. *Proc Nutr Soc*, *73*, 237-248. http://dx.doi.org/10.1017/S0029665113003923

Levy, B. R., Slade, M. D., Kunkel, S. R., & Kasl, S. V. (2002). Longevity increased by positive self-perceptions of aging. *Journal of Personality and Social Psychology, 83*, 261-270. http://dx.doi.org/10.1037/0022-3514.83.2.261

Mroczek, D. K., Spiro III, A., & Griffin, P. W. (2006). Personality and aging. In J. E. Birren & K. W. Schaie (Eds.), *Handbook of the psychology of aging* (6th ed.; pp. 363-378). Burlington: Elsevier Academic Press. http://dx.doi.org/10.1016/B978-012101264-9/50019-7

Quêtelet, A. (1835). *Sur l'homme et le développement de ses facultés [A Treatise on Man and the Development of his Faculties]*. Paris: Bachelier.

Pavela, G., & Latham, K. (2015). Childhood conditions and multimorbidity among older adults. *Journals of Gerontology: Psychological Sciences and Social Sciences*. Online published. http://dx.doi.org/10.1093/geronb/gbv028

Reilly, J. J., & Kelly, J. (2011). Long-term impact of overweight and obesity in childhood and adolescence on morbidity and premature mortality in adulthood: systemic review. *International Journal of Obesity*, *35*, 891-898. http://dx.doi.org/10.1038/ijo.2010.222

Roberts, B. W., & DelVecchio, W. F. (2000). The rank-order consistency of personality traits from childhood to old age: A quantitative review of longitudinal studies. *Psychological Bulletin*, *126*, 3-25. http://dx.doi.org/10.1037/0033-2909.126.1.3

Rowe, J. W., & Kahn, R. L. (1997). Successful aging. *The Gerontologist*, *37*, 433-440. http://dx.doi.org/10.1093/geront/37.4.433

Schaefer, J. D., Caspi, A., Belsky, D. W., Harrington, H., Houts, R., Israel, S. …Moffitt, T. E., (2015). Early-life intelligence predicts midlife biological age. *Journal of Gerontology: Psychological Sciences and Social Sciences*. Online Published. http://dx.doi.org/10.1093/geronb/gbv035

Schafer, M. H., & Ferraro, K. F. (2012). Childhood misfortune as a threat to successful aging: Avoiding disease. *The Gerontologist*, *52*, 111-120. http://dx.doi.org/10.1093/geront/gnr071

Settersten, R. A. (2003). Propositions and controversies in life-course scholarship. In R. A. Settersten (Ed.), *Invitation to the life course: toward new understandings of later life* (pp. 15-45). Amityville, NY: Baywood.

Staudinger, U. M., & Greve, W. (in press). Resilience and aging. In N. Pachana (Ed.), *Encyclopedia of geropsychology*. New York: Springer. http://dx.doi.org/10.1007/978-981-287-080-3_122-1

Van den Berg, G.J., Lindeboom, M. & Portrait, F. (2006). Economic conditions early in life and individual mortality. *American Economic Review*, *96*, 290-302. http://dx.doi.org/10.1257/000282806776157740

Van den Berg, G. J., Doblhammer, G., & Christensen, K. (2009). Exogenous determinants of early-life conditions, and mortality later in life. *Social Science & Medicine*, *68*, 1591-1598. http://dx.doi.org/10.1016/j.socscimed.2009.02.007

Westerhof, G., Miche, M., Bothers, A., Barrett, A., Diehl, M., Montepare, J., Wahl, H.-W. & Wurm, S., (2014). The influence of subjective aging on health and longevity: A meta-analysis of longitudinal data. *Psychology and Aging*, *29*, 793-802. http://dx.doi.org/10.1037/a0038016

Commentary by **Mark D. Hayward** University of Texas at Austin, USA
mhayward@prc.utexas.edu

The paper by Blane, Akinwale, Landy, Matthews and Wahrendorf provides a thoughtful and nuanced discussion of the value of the life course framework for understanding the origins of adult health and mortality. Most highly-prevalent adult health problems in the UK and other high income countries are a long time in the making and reflect exposures stretching from the prenatal environment and childhood, to adolescence, and adulthood. Because the social conditions, institutions, and stratification systems of societies are powerful forces that shape the nature of individuals' life courses, adult health is fundamentally a reflection of these *lifetime* social forces.

As Blane and his colleagues observe in their review of the historical conditions surrounding the life course of the UK's *golden cohort*, social conditions, institutions and stratification systems are far from static. Over the course of the 20th century, for example, the social capacity for health in many countries, particularly high income countries, has dramatically improved through technological innovation, dramatic growth in biomedical knowledge and improvements in social institutional resources (Easterlin, 1997). These societal forces have had rippling consequences for changes in the nature and timing of life course experiences for cohorts born at different points in history. In turn, changes in the nature and timing of life course experiences have led to a host of changes in population health. Conditions once important in defining the health of the population have waned (e.g., the long-run decline in heart disease or the near eradication of polio in most high income countries), while other conditions have become more prevalent (e.g., some cancers). The concept of the birth cohort is critical in understanding these trends, due to cohort differences in the nature and timing of exposures. For example, given the role of childhood vaccinations in improving child health and survival in the 20th century in the United States (Centers for Disease Control and Prevention, 1999; Andre et al., 2008), combined with the dramatic decline in adult smoking (Fenelon and Preston, 2012), more recent American birth cohorts have experienced fewer and less exposure to *lifetime* health risks than earlier cohorts, contributing in important ways to historical declines in US adult mortality (Yang, 2008). Thus, the health of birth cohorts, often reflected in age-specific trends in health, may change due to fundamental shifts in the nature and timing of life course experiences. A key issue that is implicit in the discussion by Blane and colleagues is that life course influences on adult health are largely endogenous to the historical context. I suggest that we are only at the initial stages of understanding how life course influences on health are being transformed by changes in the social capacity for health. Their call for comparative research is an important component in furthering this agenda.

Despite growing agreement over this conceptual framework, Blane and his colleagues alert us to the fact that applying this framework to adult health outcomes comes with important challenges. Three major challenges that I discuss below are the following. First, how ought researchers to define health? I argue that we should consider a 'portfolio' of health outcomes encompassing biological risk, morbidity, functioning and disability, and mortality. A second challenge is that conceptual frameworks of social factors influencing health are often not biologically informed. I agree with Blane and colleagues that it is critical to integrate biological and social life course frameworks in order to understand how life course exposures from childhood into adulthood shape health trends and disparities through both developmental and aging processes. Finally, Blane and colleagues argue for the importance of incorporating historical context in understanding trends and differences in the life course pathways leading to adult health problems. Dramatic changes have occurred across current birth cohorts represented in the adult population in high-income countries in their prenatal, childhood and adult exposures, yet these changes are rarely central in life course studies of health. The development of conceptual models requires sensitivity to the fact that stratification systems, institutions, social conditions, technology, and even the epidemiological environment are changing and

differ across countries, all of which have implications for tackling a comparative research agenda.

Challenge one

Only recently have researchers begun to take a more integrative view of adult health and examined how life course experiences influence multiple facets of health (e.g., how life course factors influence the interplay of functioning and mortality to determine healthy life expectancy (Montez & Hayward, 2014)). Research rarely explicitly addresses the idea that exposures may give rise to a cascade of adult health conditions starting, say, from morbidity, to disability, and then to mortality – or not. All too often, research assumes that such a cascade exists, it gives rise to more 'endogenous' health outcomes such as disability and mortality, and is unidirectional – despite strong cautions about these assumptions (Verbrugge & Jette, 1994).

Health at the population level is a multidimensional concept. Increasingly, definitions of health acknowledge the core domains of physiological dysregulation (e.g., metabolic functioning), conditions (e.g., disease conditions such as diabetes), functioning (e.g., physical and cognitive deficits) and important facets of wellbeing and health potential (e.g., ability to live independently). The measurement of these domains is complex as are the relationships among these domains. Physiological dysregulation, disease conditions, functioning loss, and frailty are all parts of the process of health change that can – *but need not* -- precede death (Crimmins, Kim & Vasunilashorn, 2010; Martin, Schoeni & Andreski, 2010; Crimmins & Beltrán-Sánchez, 2011). The importance of understanding these connections stems from the fact that trends in these domains need not move in the same direction, and social group differences may vary, depending on the domain of interest.

Given these associations between health domains, life course factors need not affect all parts of the process in the same way. Some life course influences may be germane only to certain parts of the process of health change. For example, it is plausible that some childhood health problems (e.g., infectious conditions that heighten inflammation) give rise to adult morbidity conditions (e.g., coronary heart disease) that results in a cascade of increased risks of functional problems and mortality from cardiovascular disease (CVD). In this hypothetical example, childhood health problems' association with CVD-related mortality stems primarily from increasing disease incidence. In contrast, other life course factors may come into play throughout the process. Educational attainment, for example, not only is associated with a lower risk of heart disease but potentially it also comes into play in differentiating the risks of functional problems and mortality *among* persons with heart disease through human agency and financial resources (Mirowsky & Ross, 2003). In this example, a major social resource acquired relatively early in life – educational attainment – may accentuate disparities throughout the process of health change (Manton, Stallard & Corder, 1997; Merkin, Karlamangla, Crimmins, Hayward, & Seeman, 2009).

Challenge two

Blane and colleagues offer a biological, developmental framework of life course health (see figure 2 in their article). The core idea is that processes of the major biological systems (e.g., endocrine, immune, neurological, respiratory) display a similar pattern of development – a steady curvilinear growth in functional capacity during childhood followed by maintenance and eventually some decline in adulthood (Halfon & Hochstein, 2002). Figure 2's conceptual framework conveys a number of important ideas to keep in mind when considering the factors that come into play in understanding differences/disparities in adult health. First, differences in capacity begin as early as *in utero* and are evident at birth. This speaks to the seminal work by Barker and his colleagues (Barker, 1997; Barker, 1998; Barker, 1999; Barker, 2004). Second, childhood is a period of growth in capacity, and differences in capacity widen because of differences in inputs throughout childhood (e.g., SES, diet, family relationships). This is also the period in which cohort morbidity phenotypes (e.g., lifelong health risks that accrue through early life exposures such as infection and inflammation) are established (Finch & Crimmins, 2004; Crimmins & Finch, 2006). Although Blane and colleagues note that the maximum level of growth is a product of the level of inputs, I would add that the period of growth (and different peak

ages of capacity) might also be highly dependent on the level of inputs. In this sense, both the length and degree of development are highly malleable to inputs (Finch & Crimmins, 2004). Third, declines in capacity can start at different ages and exhibit varying rates of decline. Resources such as quality jobs, marriages and the avoidance of disease result in slow rates of decline, while the lack of resources and risk factors (e.g., smoking) contribute to relatively accelerated rates of decline. Indeed, it is possible that despite early life developmental advantages, adult risk factors and adverse conditions can result in rates of decline that negate earlier advantage. The combination of lifetime gains and losses results in growing heterogeneity of capacity in the population across most of the adult life course – the period of life where losses occur in capacity.

This biologically informed conceptual work of life course health presented by Blane and colleagues points to the need for researchers to attend to the combinations of lifetime exposures that put adults at greater or lesser risk of various health outcomes. In addition, this idea suggests that, depending on the inputs over a lifetime, the *balance* of childhood and adult influences on health disparities can change. This is a very important idea in that the developmental 'origins' of adult health are highly dynamic and mutable to a variety of inputs across the lifetime. No phase is inherently more important than another in terms of influencing adult health disparities. That said, as Blane and colleagues aptly note, life course stratification processes often reinforce childhood advantages and disadvantages in adulthood, compounding the effects of childhood. There is no 'lottery' after childhood that randomly assigns persons to adult trajectories of resources and risks. Moreover, some combinations of life course exposures are likely to be relatively common while others are quite rare due to life course stratification processes and social change. The malleability of life course trajectories in capacity has significant implications for understanding social group differences and trends in the life course origins of adult health – see *Challenge three* below.

Challenge three

Not surprisingly given the constraints of available data, much of the research on the life course influences on adult health has occurred in the context of single birth cohorts or a relatively narrow band of birth cohorts, e.g., the UK *golden cohort* described by Blane and colleagues, the British cohort studies and the US Health and Retirement Study. Thus, much of the empirical evidence about the life course origins of adult health is necessarily framed by the experiences of individuals in these studies. With the explosion of international studies built on the life course framework of the Health and Retirement Study (including the Study on Global Ageing and Health (SAGE)), we now have the opportunity to respond to Blane and colleagues' call for comparative research – and on a global scale.

Blane and his colleagues make a strong case that researchers need to be highly sensitive to the specific historical conditions that characterised the cohorts' experiences at particular ages in the life course. Stratification systems (and their metrics) may change across cohorts (and differ across countries). For example, occupation was more strongly tied to resources that garnered health advantages in the early part of the 20th century in the US compared to educational attainment (Preston & Haines, 1991; Hayward & Gorman, 2004). However, educational attainment, particularly advanced education, has grown in importance for reducing mortality in the US in the last half of the 20th century (Montez, Hummer, Hayward, Woo & Rogers, 2011; Masters, Hummer & Powers, 2012; Hayward, Hummer & Sasson, 2015). The 20th century in the United States also was a period of large reductions in infectious disease exposure and rising obesity. This period was characterised first by massive increases in post-secondary educational institutions and the prevalence of post-secondary education after World War II. This trend was followed in the later part of the century by the stalling of post-secondary attainment and the rise in student load debt. These are only a few examples but they raise important questions about how researchers should measure key concepts relating to the types of inputs over cohorts' lifetimes (e.g., childhood health, socioeconomic resources), and they point to some of the difficulties of carrying out a comparative research agenda.

Ryder noted 50 years ago that "the principal motor of contemporary social change is technological innovation" (Ryder, 1965).

Technological change is fundamentally important for the level of social capacity for population health (Easterlin, 1997). It is embedded in social institutions and defines the stock of knowledge and institutional resources that individuals in the population have access to and can act on to garner health advantages. The idea is similar to Fogel's concept of techno-physio evolution (Fogel & Costa, 1997; Fogel, 2004) which reflects the synergistic association between technological and physiological improvements in the modern era. Although technological change is sometimes thought to be felt most strongly by persons about to make 'lifelong' choices (Ryder, 1965), the developmental trajectories shown in Blane et al.'s figure 2 illustrate that technological change may have implications for changes in capacity at all stages of the life course. The pace of technological change is an issue that is rarely considered in life course studies of heath, yet this phenomenon has enormous implications for understanding how the inputs to the growth and decline in capacity ultimately influence adult health (Goldin & Katz, 2009; Palloni & Souza, 2013; McEniry, 2014). The pace of technological change in combination with early life exposures relates strongly to the heterogeneity of lifetime inputs to the gain and loss of physical capacity shown in figure 2.

An important tenet in life course conceptual frameworks is the importance of historical context. Here, I have argued that the historical context is not only relevant to a given cohort but it matters a great deal for the pace and nature of changes in the social capacity for health. In addition, current surviving birth cohorts in high-income countries are likely to differ in important ways in their lifetime exposures to important features of the social capacity for population health. The types of exposures and the pace of change in social capacity necessarily will shape how birth cohorts' capacities are changed over the lifetimes, ultimately influencing trends and disparities in the major domains of population health. The importance of broader societal forces for health can thus best be appreciated through studies that include a range of cohorts and that analyse the data with sensitivity to between-cohort differences.

Conclusions

The article by Blane and his colleagues adds to a burgeoning literature on the importance of life course conceptual frameworks for understanding adult health and mortality. As is evident in their discussion, a life course approach is fundamentally interdisciplinary and encompasses disciplines that are key in understanding how health is shaped from 'cells to society'. Epidemiology, biology, sociology, economics, genetics, psychology, history, …, – all these fields and more are part of a growing understanding of the life course origins of adult health and mortality. The emergence of this highly interdisciplinary approach reflects the enormously complex web of forces by which population health is shaped and changed.

References

Andre, F., Booy, R., Bock, H., Clemens, J., Datta, S., John, T., Lee, B., Lolekha, S., Peltola, H., Ruff, T., Santosham, M., & Schmitt, H. (2008). Vaccination greatly reduces disease, disability, death and inequity worldwide. *Bulletin of the World Health Organization, 86*, 140-146. http://dx.doi.org/10.2471/BLT.07.040089

Barker, D. (1999). Early growth and cardiovascular disease. *Archives of Disease in Childhood, 80*(4), 305. http://dx.doi.org/10.1136/adc.80.4.305

Barker, D.J.P. (1997). *Maternal nutrition, fetal nutrition, and disease in later life. Nutrition, 13*(9),807-813. http://dx.doi.org/10.1016/S0899-9007(97)00193-7

Barker, D.J.P.. 1998. *Mothers, babies, and health in later life*. London: Churchill Livingstone.

Barker, D.J.P. (2004). The developmental origins of well-being. *Philosophical Transactions: Biological Sciences, 359*(1449),1359-1366. http://dx.doi.org/10.1098/rstb.2004.1518

Centers for Disease Control and Prevention. (1999). CDC on infectious diseases in the United States: 1900-99. *Population and Development Review, 25*(3), 635-640. http://dx.doi.org/10.1111/j.1728-4457.1999.00635.x

Crimmins, E., & Finch, C. (2006). Infection, inflammation, height, and longevity. *Proceedings of the National Academy of Sciences, 103*(2), 498-503. http://dx.doi.org/10.1073/pnas.0501470103

Crimmins, E., Kim, J.K., & Vasunilashorn S. (2010). Biodemography: new approaches to understanding trends and differences in population health and mortality. *Demography, 47 Supplement,* S41-S64. http://dx.doi.org/10.1353/dem.2010.0005

Crimmins, E.M., & Beltrán-Sánchez, H. (2011). Mortality and morbidity trends: is there compression of morbidity? *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences, 66B*(1), 75-86. http://dx.doi.org/10.1093/geronb/gbq088

Easterlin, R.A. (1997). *Growth triumphant, the twenty-first century in historical perspective*. Ann Arbor: The University of Michigan Press.

Fenelon, A., & Preston, S. (2012). Estimating smoking-attributable mortality in the United States. *Demography, 49*(3), 797-818. http://dx.doi.org/10.1007/s13524-012-0108-x

Finch, C.E., & Crimmins, E.M. (2004). Inflammatory exposure and historical changes in human life-spans. *Science, 305*(5691), 1736-1739. http://dx.doi.org/10.1126/science.1092556

Fogel, R.W. (2004). *The escape from hunger and premature death, 1700-2100*. New York, NY: Cambridge University Press. http://dx.doi.org/10.1017/CBO9780511817649

Fogel, R.W., & Costa, D.L. (1997). A theory of technophysio evolution, with some implications for forecasting population, health care costs, and pension costs. *Demography, 34*(1), 49. http://dx.doi.org/10.2307/2061659

Goldin, C.D., & Katz L.F. (2009). *The race between education and technology*. Boston, MA: Harvard University Press.

Halfon, N., & Hochstein, M. (2002). Life course health development: an integrated framework for developing health, policy, and research. *Milbank Quarterly, 80*(3), 433-479. http://dx.doi.org/10.1111/1468-0009.00019

Hayward, M.D., & Gorman, B. (2004). The long arm of childhood: the influence of early life conditions on men's mortality. *Demography, 41*, 87-107. http://dx.doi.org/10.1353/dem.2004.0005

Hayward, M.D., Hummer, R.A., & Sasson, I. (2015). Trends and group differences in the association between educational attainment and U.S. adult mortality: implications for understanding education's causal influence. *Social Science & Medicine*, *127*, 8-18. http://dx.doi.org/10.1016/j.socscimed.2014.11.024

Manton, K.G., & Stallard, E., & Corder, L. (1997). Education-specific estimates of life expectancy and age-specific disability in the U.S. elderly population 1982 to 1991. *Journal of Aging and Health, 9*(4), 419-450. http://dx.doi.org/10.1177/089826439700900401

Martin, L.G., Schoeni, R.F., & Andreski, P.M. (2010). Trends in health of older adults in the United States: past, present, future. *Demography, 47 Supplement*, S17-S40. http://dx.doi.org/10.1353/dem.2010.0003

Masters, R.K., Hummer, R.A., & Powers, D. A. (2012). Educational differences in U.S. adult mortality: a cohort perspective. *American Sociological Review, 77*(4), 548-572. http://dx.doi.org/10.1177/0003122412451019

McEniry, M. (2014). *Early life conditions and rapid demographic changes in the developing world*. Netherlands: Springer. http://dx.doi.org/10.1007/978-94-007-6979-3

Merkin, S.S., Karlamangla, A., Crimmins, E., Hayward, M., & Seeman, T. (2009). Education differentials by race in the diagnosis and management of hypercholesterolemia. *International Journal of Public Health, 54*(3), S1-S1.

Mirowsky, J., & Ross, C.E. (2003). *Education, social status, and health*. New York: Aldine De Gruyter.

Montez, J.K., & Hayward, M.D. (2014). Cumulative childhood adversity, education, and active life expectancy among U.S. adults. *Demography, 51*, 415-435. http://dx.doi.org/10.1007/s13524-013-0261-x

Montez, J.K., Hummer, R.A., Hayward, M.D., Woo, H., & Rogers, R.G. (2011). Trends in the educational gradient of U.S. adult mortality from 1986 to 2006 by race, gender, and age group. *Research on Aging, 33*(2), 145-171. http://dx.doi.org/10.1177/0164027510392388

Palloni, A., & Souza, L. (2013). The fragility of the future and the tug of the past: longevity in Latin America and the Caribbean. *Demographic Research, 29*(21), 543-578. http://dx.doi.org/10.4054/DemRes.2013.29.21

Preston, S.H., & Haines, M.R. (1991). *Fatal years: child mortality in late nineteenth century America*. Princeton: Princeton University Press. http://dx.doi.org/10.1515/9781400861897

Ryder, N.B. (1965). The cohort as a concept in the study of social change. *American Sociological Review, 30*(6), 843-861. http://dx.doi.org/10.2307/2090964

Verbrugge, L.M., & Jette, A.M. (1994). The disablement process. *Social Science & Medicine, 38*(1), 1-14. http://dx.doi.org/10.1016/0277-9536(94)90294-1

Yang, Y. (2008). Trends in U.S. adult chronic disease mortality, 1960–1999: age, period, and cohort variations. *Demography, 45*, 387-416. http://dx.doi.org/10.1353/dem.0.0000

Commentary by **Aart C. Liefbroer** Netherlands Interdisciplinary Demographic Institute, University Medical Center Groningen and Vrije Universiteit Amsterdam, Netherlands

What can the life course approach contribute to an understanding of longevity risk? – a demographer's comment

The paper by Blane et al. makes a strong case for more attention to the life-course perspective in order to better understand seminal trends in mortality and longevity. Given my own background in the sociology and demography of the life course, it is hard to disagree with the authors on this issue, so I will restrict myself to providing some brief reflections on a few issues of key demographic or sociological importance.

The paper starts with the notion of 'longevity risk'. This is terminology that 'only' actuaries can use, as the costs to insurance companies go up if people live longer than expected. Most people would not want to view longevity mainly as a risk, but rather as an accomplishment. It also conflicts with the terminology of demographers, who speak of risk (or 'rate') as the chance that an event will happen (rather than the event not happening), and view increased longevity as the outcome of a process in which mortality risks (at specific ages, for specific cohorts, in specific periods) have fallen.

A key issue in the Blane et al. paper is how to understand the strong increase in longevity. Female life expectancy has increased by three months per year for more than a century (Oepen & Vaupel, 2002). In 2012 female life expectancy at birth was highest in Japan at 87 years, and male life expectancy at birth was highest in Iceland at 82 years (World Health Organisation, 2014). Blane et al. argue that this is not just the result of improvements in treating specific diseases, but largely of general health improvements. They illustrate this with period figures (the trend in mortality rates among 65-year-old men and women) and with a description of the *golden cohort* (born in 1928). But it is clear that health and mortality differences between age groups in a population, or across time among the same age group, could depend on one of three factors. They could be age-related, with increasing mortality rates as people grow older. They could be cohort-related, with decreasing mortality rates among younger cohorts. Or they could be period related with lower mortality rates for all cohorts and at all ages in more recent years. Often, it will be mix of these three factors. However, given that the three elements of this classic APC (Age-Period-Cohort) dilemma are dependent (someone's current age equals current period minus his or her birth cohort), it is hard to disentangle these elements and to determine whether changes in any outcome are influenced by age, period, cohort, or a combination of them. Statistical models are developed that try to solve this dilemma, but without a consensus about the best approach (Bell & Jones, 2014). An interesting contribution from demography to understand this issue is the so-called Lexis-surface. Recently, Minton (2014) provided a useful illustration of its application to mortality, shown here in figure 1. It shows mortality rates of Norwegian males, with year (period) on the X-axis and age on the Y-axis. Birth cohort can be followed drawing a 45-degree diagonal from lower left to upper right. Different colours signify different levels of mortality. Age effects are evident from the increase in mortality rates across the Y-axis. Period shifts are visible as mortality rates go up or down if one advances along the X-axis. Clear, 'pure' period effects can, for instance, be observed during the first and second world wars. A cohort shift is evident, if mortality rates to the left of a cohort diagonal would strongly differ from those to the right. In the example, we see a strong decrease in mortality rates from the 1930s onwards (briefly interspersed by World War II). The contour lines of all mortality levels retreat to higher ages, the closer we get to the current period. In the more recent period these lines have an upward incline, suggesting that they are a mix of period effects (affecting virtually all age groups) and cohort effects (with some cohorts profiting more than others). Thus, the Lexis-surface can be a useful tool to understand the dynamics of mortality decline and longevity increase, which could lead to hypotheses that could be more formally tested in a next step.

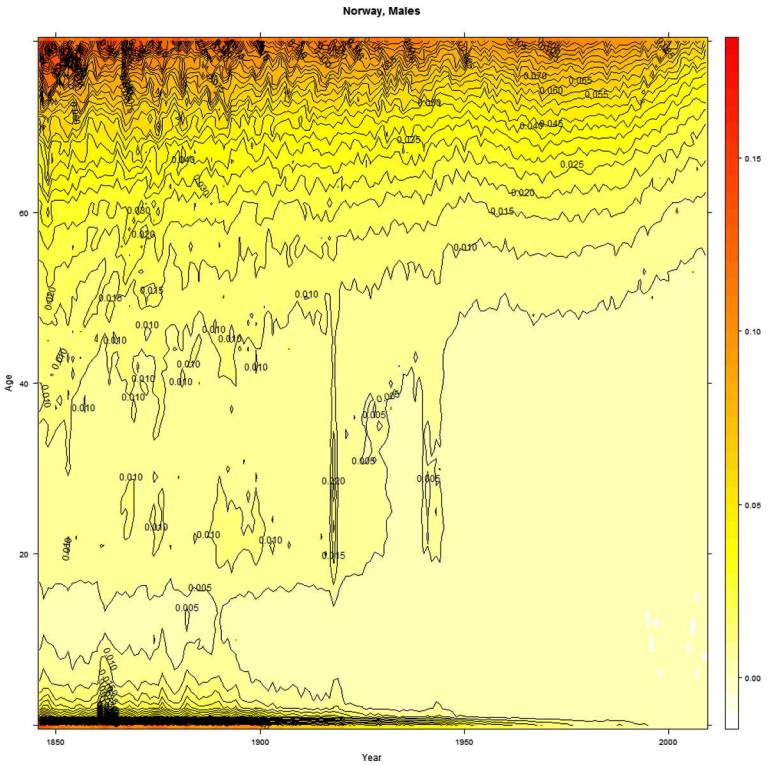


Figure 1. Shaded contour plot of mortality surface, Norway, males (Minton, 2014, Figure 7)

In order to understand the changes in 'positive' health, Blane et al. emphasise the importance of examining the long-term consequences of earlier life events for health later in life. This is not a new suggestion, as David Barker (1990, 1995) has already alerted epidemiologists to the relevance of studying conditions during pregnancy for later development. What is important in the paper by Blane et al., is their emphasis on multiple critical periods in people's lives that could influence their later development. This starts with early childhood where establishing secure attachment with key caregivers is of utmost importance (Bowlby, 1988). But Blane et al. suggest other critical periods later in life, such as the transition from youth to adulthood and retirement, as well. Fortunately, the basic ideas of such a life course approach already have strong supporters within epidemiology (Power, Kuh, & Morton, 2013). A key challenge, however, is to understand what aspects of life course change matter. What are the key life domains to take into account? Is it the experience of certain events, the time at which these events are experienced, or their ordering that matters? And how do events in different life domains interact? An important recent development in demographic and sociological applications of the life course approach, in this respect, is the growing popularity of sequence analysis (Abbott & Tsay, 2000; Elzinga & Liefbroer, 2007; Aisenbrey & Fasang, 2010). Within sequence analysis, a holistic approach to understanding the life course is advocated in which the effects of occurrence, timing and sequencing of events are all taken into account to develop a typology of life course trajectories that optimally takes the heterogeneity in people's life courses into account. The resulting typology can be used both to study the precursors (including health related ones) of specific life course patterns, and to study the consequences (again, including health related ones) of these patterns. For the promise of a life course approach to be realised, though, it is imperative that data collections within epidemiology pay more attention to life course trajectories in the health domain, as well as to those in the family and career domains. For this to come about, closer collaborations between epidemiologists and other health researchers on the one hand, and social scientists (in the broadest sense) on the other hand, have to be established.

A final plea made by Blane et al. is for more comparative research. I could not agree more.

Comparison is the essence of science. Often we compare social groups or categories within a specific spatial location (usually a specific nation state). But country comparisons could help us test whether our results are location specific (and thus conditional on the environment) or not. In addition, it can alert us to factors that might explain these spatial differences. Unfortunately, many cross-national social surveys only include relatively crude health related measures, whereas international medical data collections are not only very rare, but often have very little information on social aspects. However, there are a few exceptions (or at least examples to follow-up). The GGS (Generations & Gender Survey – a panel survey among the whole adult population with data collected in nineteen countries) includes a number of general questions on physical and mental health (see www.ggp-i.org). SHARE (Survey of Health, Ageing and Retirement in Europe – a panel survey among the population aged 50 years and over with data being collected in 20 countries) also includes health related questions and has even moved into collecting biomarkers (see www.share-project.org). These studies are designed by social scientists, but could certainly profit from collaboration with and involvement from epidemiologists and other health scientists.

To conclude, I fully agree with the plea by Blane et al. for more attention to the life course paradigm to better understand developments in longevity and in health more generally. What it takes, though, is better data, but, above all, collaboration between specialists from different fields. Only in that way can we turn our search for understanding the social underpinning of health risks into a truly interdisciplinary endeavour.

References

Abbott, A., & Tsay, A. (2000). Sequence analysis and optimal matching methods in sociology. *Sociological Methods & Research, 29*(1), 3-33. http://dx.doi.org/10.1177/0049124100029001001

Aisenbrey, S., & Fasang, A. E. (2010). New life for old ideas: the "second wave" of sequence analysis bringing the "course" back into the life course. *Sociological Methods & Research, 38*(3), 420-462. http://dx.doi.org/10.1177/0049124109357532

Barker, D. J. P. (1990). The fetal and infant origins of adult disease. *British Medical Journal, 301*, 1111. http://dx.doi.org/10.1136/bmj.301.6761.1111

Barker, D. J. P. (1995). Fetal origins of coronary heart disease. *British Medical Journal, 311*, 171-174. http://dx.doi.org/10.1136/bmj.311.6998.171

Bell, A., & Jones, K. (2014). Another 'futile quest'? A simulation study of Yang and Land's hierarchical age-period-cohort model. *Demographic Research, 30*(11), 333-360. http://dx.doi.org/10.4054/DemRes.2014.30.11

Bowlby, J. (1988). *A secure base: parent-child attachment and healthy human development*. New York, NY, US: Basic Books.

Elzinga, C. H., & Liefbroer, A. C. (2007). De-standardization of family-life trajectories of young adults: a cross-national comparison using sequence analysis. *European Journal of Population, 23*(3-4), 225-250. http://dx.doi.org/10.1007/s10680-007-9133-7

Minton, J. (2014). Real geographies and virtual landscapes: exploring the influence on place and space on mortality Lexis surfaces using shaded contour maps. *Spatial and Spatio-temporal Epidemiology, 10*, 49-66. http://dx.doi.org/10.1016/j.sste.2014.04.003

Oepen, J., & Vaupel, J. W. (2002). Broken limits to life expectancy. *Science, 296*, 1029-1031. http://dx.doi.org/10.1126/science.1069675

Power, C., Kuh, D., & Morton, S. (2013). From developmental origins of adult disease to life course research on adult disease and aging: insights from birth cohort studies. *Annual Review of Public Health, 34*(1), 7-28. http://dx.doi.org/10.1146/annurev-publhealth-031912-114423

World Health Organisation (2014). *World health statistics*. Geneva: World Health Organisation.

Commentary by **Gita D. Mishra** University of Queensland, Australia
g.mishra@uq.edu.au
Isabel Ferreira University of Queensland, Australia
Ilona Koupil Stockholm University and Karolinska Institutet, Sweden

Longevity risk describes the phenomenon of living longer than predicted (Willets et al., 2004). As Blane and colleagues explain, the concept was developed by the actuarial profession as a response to the unexpected decline in middle age mortality during the late 20th century that placed sudden financial strain on insurance and pension funds in the UK and elsewhere. It may also illustrate what is known as the *black swan event:* a surprise, with a major impact, that is rationalised by hindsight as if it had been expected (Taleb, 2007). Blane and colleagues posit that to find the key driving factor for this increased life expectancy at middle age, one needs to look beyond changes in disease risk factors, morbidity, and medical innovations to improvements in *positive health* in the sense of "growth and development, functional capacity, vitality and resilience". Second, they then draw on the UK social history of a *golden cohort,* men and women currently aged 85 years, to argue that a life course approach is needed to identify plausible biological and social pathways that lead to these changes in positive health.

We agree that positive health appears a largely neglected concept in actuarial and epidemiological research. Seligman et al. (2015) is one of the few to set out a detailed description of positive health as "well-being beyond the mere absence of disease" and as the study of empirically measured *health assets* and their configuration in an individual. In this sense, a health asset refers to a factor that "produces longer life, lower morbidity, lower health care expenditure, better prognosis when illness does strike, and/or higher quality of life" (Seligman et al., 2015). This concept is similar to that for mental health whereby it is no longer considered the same as the absence of mental illness, but consists of a "measurable configuration of positive emotions, engagement, good relationships, meaning, and accomplishment" (Seligman, 2011).

In contrast, life course epidemiology is a well-established approach and defined as "the study of long term effects on later health or disease risk of physical or social exposures during gestation, childhood, adolescence, young adulthood, and later adult life" (Kuh, Ben-Shlomo, Lynch, Hallqvist & Power, 2003). Its aim "is to elucidate the biological, behavioural, and psychosocial processes that operate across an individual's life course, or across generations, to influence the development of disease risk" (Kuh et al., 2003). Thus, at the heart of life course research there is an emphasis on statistical models that reflect basic hypotheses on the role of timing or duration of exposures (Mishra et al., 2009; Mishra, Chiesa, Goodman, De Stavola & Koupil, 2013).

Blane and colleagues draw on two examples of evidence to support the additional role of positive health, beyond that just from a reduction in risk factors and medical innovations. Here we focus on their second example: time series data for the mortality at age 65 years in the UK that shows a near linear decline for women since 1900. By comparison, mortality for men at age 65 years is higher than for women but has a slightly larger overall decline over the same time period. It includes a plateau in mortality rates for the three decades after about 1930 that were followed by a steeper 'catch-up' decline since about 1960. The authors highlight that the near linear decline in mortality rates for women at age 65 years fails to exhibit signs of "the introduction of antibiotics, the start of the National Health Service, or the changing prevalence of tobacco smoking". Instead, they ascribe the decline to "a cumulative process driven by rising living standards" and thereby consequent improvements in positive health. Improvement in living standards, however, may act as a proxy or may cause changes in a range of public health related exposures, including improvements in childhood nutrition and environmental exposures such as air quality. Therefore we should not expect too much from aggregated statistics for mortality rates in later life to reveal signals that unravel or distinguish various mechanisms that may be operating across the life course.

The integration of both social and biological pathways provides new insights into aetiology of health and disease but brings about new challenges in our views on generalisability of findings across

historical time, geographical regions or social strata of a society. Although findings demonstrating a large degree of consistency in early life determinants of social trajectories and later health have recently emerged, for example, from research on several generations of Swedish men and women (Goodman, Gisselmann & Koupil, 2010), the interpretation of these effects within societies that dramatically change over time is not straightforward. Would consistency in social pathways indicate a failure of our social and public health policies to break the chains of social and biological risks that affect subsequent generations? Or would it perhaps indicate a change in the main underlying pathophysiological (biological) mechanisms?

In spite of the dramatic changes experienced across the life course by the *golden generation*, it is their uniqueness in terms of biological and social history that arguably limits their explanatory role here. The timespan covered by the decline in mortality rates at 65 years applies to people born many decades both prior and after that generation. Each of these other cohorts, especially younger men and women born in the decades since 1940, would need to have an equivalent biological and social history with additional benefits on positive health in each decade. Further, longevity risk appears to have been an international phenomenon, so explanations are needed both over time and across populations. Yet without data from longitudinal studies, such accounts – including those from the context of UK social history provided by Blane and colleagues on the *golden generation* – would still be prone to ecological fallacies because they do not rely on empirical data of biological and social variables obtained at the individual level throughout the years.

Since its inception, the Newcastle 85+ study used by Blane and colleagues to illustrate the *golden generation,* has provided valuable information about their physical, metabolic, immune and cognitive function phenotypes (Collerton et al., 2007; Harrison et al., 2015; Motta et al., 2005; Terry, Sebastiani, Andersen & Perls, 2008; Vacante et al., 2012; Willcox et al., 2008). Yet by their design, this and numerous other studies conducted worldwide among the oldest old are limited in their contribution to the understanding of the life course trajectories that explain the longevity of their participants. Not only their validity may be compromised due to survival bias, but also any information on past exposures and experiences, either objective or subjective, can mostly, by definition be obtained retrospectively, with all the well-known limitations of that method. Current longitudinal and life course data analysis methodologies provide a means to handle the problem of the survival bias (e.g., inverse probability of attrition weights) (Weuve et al., 2012) but no such remedies can be developed to overcome the problems of retrospective data collection.

It remains, however, that healthy octogenarians and even more so healthy centenarians or even 'supercentenarians', can be seen as living proof of successful ageing (Motta et al., 2005; Terry et al., 2008; Vacante et al., 2012; Willcox et al., 2008), and positive health may prove to be a valuable framework to understand the explanatory factors at work. Attempts have been made to understand which life course trajectories led to the observed exceptional longevity, for instance, using the '*compression of morbidity*' hypothesis, that posits that in order to achieve extreme old age individuals markedly *delay* or even *escape* diseases that would otherwise be lethal at younger ages (Evert, Lawler, Bogan & Perls, 2003). Based on retrospective lifetime data on diagnoses of 10 major illnesses (i.e., hypertension, heart disease, diabetes, stroke, non-skin cancer, osteoporosis, thyroid condition, Parkinson's disease, and chronic obstructive disease) and one ocular disease (cataracts) collected by means of health questionnaires completed by >400 centenarians (or their proxies), the authors reported that three morbidity profiles fitted their study population: *survivors*, *delayers* and *escapers (*Evert et al., 2003). Interestingly, the identification of these distinct phenotypes led them to conclude that the exceptional longevity of centenarians may be achieved by multiple pathways and that there may be sex differences in these.

Blane and colleagues acknowledge the need to look for evidence with other direct indicators of positive health. Seligman et al., (2015) specifically suggest a re-analysis of existing longitudinal datasets shifting from the traditional focus on '*what goes wrong in life*' to the study of *health assets*, including subjective ones, as the main instruments to operationalise *positive health.* Some examples of biological markers of positive health as proposed by

Seligman et al. (2015) are low blood pressure (BP), low body mass index (BMI) and high cardiorespiratory fitness (VO_2max). Some on-going longitudinal studies have examined these variables throughout the life course of individuals. For instance, using a life course approach of repeated data obtained between the ages of 12 and 36 years (8 repeated measures), the Amsterdam Growth and Health Longitudinal Study (AGAHLS) has shown that 36-year olds with a healthy arterial ageing phenotype (i.e., younger than that that could be expected on the basis of their chronological age) (Ferreira & van de Laar, 2015) and metabolic profiles (Ferreira, Twisk, van Mechelen, Kemper & Stehouwer, 2005) were characterised by less steep increases in BP, BMI and VO_2max from adolescence to adulthood, with levels of BP and BMI never exceeding those cut-off values conventionally placing individuals at higher risk for metabolic and cardiovascular diseases (Ferreira, van de Laar, Prins, Twisk & Stehouwer, 2012). In addition, the AGHALS has pin-pointed adolescence and transition from adolescence to young adulthood as critical periods when increases in the levels of BP and BMI or decreases in VO_2max may no longer be reversible in some individuals.

The development of life course epidemiology and the increasing interest in potential critical or sensitive periods have also stimulated a wider use of developmental and growth indicators for monitoring of health at younger ages (Maggi, Irwin, Siddiqi & Hertzman, 2010) and ideally, one could use these as indicators of positive health early in life to construct more continuous life course trajectories of positive health, rather than rely on measurements taken at later stages of the life course which would be already influenced by a rate of decline.

Aspects of self-reported health such as SF-36 physical functioning scores, may provide another measure of positive health (Seligman et al., 2015; Ware, Snow, Kosinski & Gandek, 1993). With progressive improvements in positive health, one might expect higher scores at the same age with each subsequent generation, and each with its own distinct trajectory. The Australian Longitudinal Study on Women's Health has studied over 45,000 women in three age cohorts (born in 1921-26, 1946-51, and 1973-78) and has been running since 1996 (Dobson et al., 2015). Although the age ranges do not yet overlap to provide a definitive answer, each cohort does show a higher set of scores for physical functioning for younger generations (figure 1), but the overall impression can still be interpreted as a consistent connected trajectory across life (and across these generations of women), rather than three distinct and progressively higher trajectories. With further data in coming years the character of this life course trajectory will be more clearly resolved.

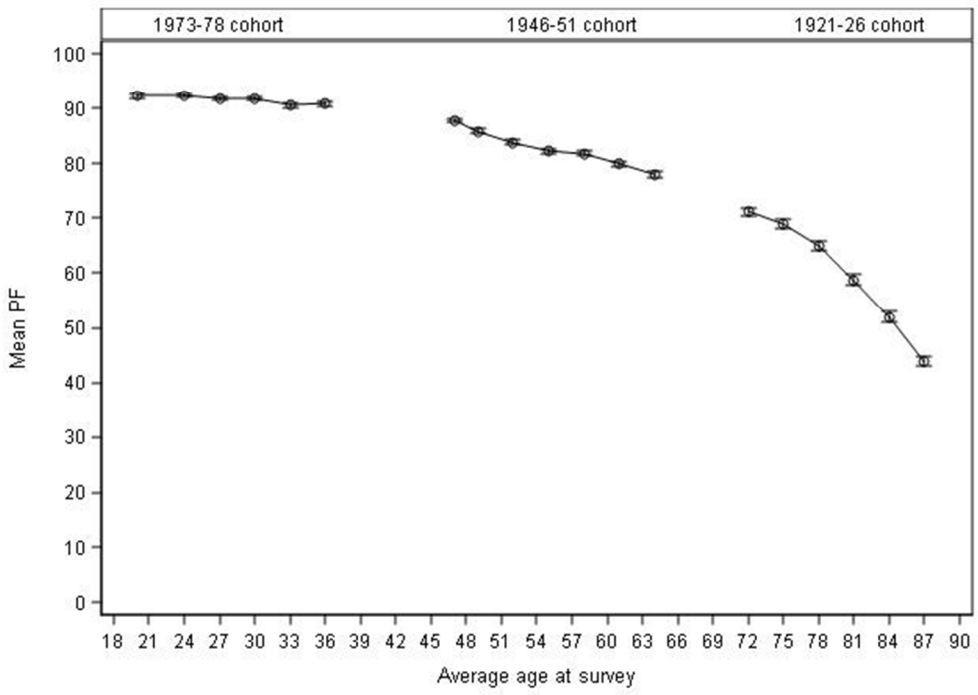


Figure 1. SF-36 physical functioning scores (means with 95% confidence limits) by age and cohort for all women who provided survey data in the Australian Longitudinal Study on Women's Health at the specified age.

In summary, Blane and colleagues present intriguing evidence to support the case for an additional role of positive health as an explanation for longevity risk. To identify the specific mechanisms operating across life and evident in the biological and social history of each cohort, they acknowledge the next step needed is to move beyond aggregated statistics for disease prevalence and mortality, to evidence from direct measures of health assets and across multiple cohorts and populations. Yet for more detailed investigation in future research, interpretation of results from cross-cohort comparisons can be problematic as it may not be obvious whether one would interpret heterogeneity across cohorts as (i) evidence against universal biological effects or (ii) evidence for contextual effects and effect modification. Nevertheless, on-going longitudinal studies are already applying the life course approach to the better understanding of disease, health, and positive health, and hold the promise that it will not be too long until more definitive evidence to explain longevity risk can be identified – sufficient follow-up time just needs to accrue. It may still be a decade or more, but what are decades when trying to understand the factors operating over 100-year timescales that led to this *black swan event?*

References

Collerton, J., Barrass, K., Bond, J., Eccles, M., Jagger, C., James, O., Martin-Ruiz, C., Robinson, L., von Zglinicki, T., & Kirkwood, T. (2007). The Newcastle 85+ study: biological, clinical and psychosocial factors associated with healthy ageing: study protocol. *BMC Geriatrics*, *7*(14). http://dx.doi.org/10.1186/1471-2318-7-14

Dobson, A., Hockey, R., Brown, W., Byles, J., Loxton, D., McLaughlin, D., Tooth, L., & Mishra, G.D. (2015). Cohort profile update: Australian Longitudinal Study on Women's Health. *International Journal of Epidemiology* 44 (5),1547-1547f. http://dx.doi.org/10.1093/ije/dyv110

Evert, J., Lawler, E., Bogan, H., & Perls, T. (2003). Morbidity profiles of centenarians: survivors, delayers, and escapers. *Journals of Gerontology. Series A, Biological Sciences and Medical Sciences, 58*(3), 232-237. 58(3), 232-237. http://dx.doi.org/10.1093/gerona/58.3.M232

Ferreira, I., Twisk, J.W., van Mechelen, W., Kemper, H.C., & Stehouwer, C.D. (2005). Development of fatness, fitness, and lifestyle from adolescence to the age of 36 years: determinants of the metabolic syndrome in young adults: the Amsterdam Growth and Health Longitudinal Study. *Archives of Internal Medicine, 165*(1), 42-48. http://dx.doi.org/10.1001/archinte.165.1.42

Ferreira, I., & van de Laar, R.J. (2015). Lessons from the Amsterdam Growth and Health Longitudinal Study. In P.M. Nilsson, S. Laurent & M. H. Olsen (Eds.), *Early Vascular Ageing – new directions in cardiovascular protection* (pp. 33-44). Amsterdam: Elsevier Academic Press. http://dx.doi.org/10.1016/b978-0-12-801387-8.00005-3

Ferreira, I., van de Laar, R.J., Prins, M. H., Twisk, J.W., & Stehouwer, C.D. (2012). Carotid stiffness in young adults: a life-course analysis of its early determinants: the Amsterdam Growth and Health Longitudinal Study. *Hypertension*, *59*(1), 54-61. http://dx.doi.org/10.1161/HYPERTENSIONAHA.110.156109

Goodman, A., Gisselmann, M.D., & Koupil, I. (2010). Birth characteristics and early-life social characteristics predict unequal educational outcomes across the life course and across generations. Data from a Swedish cohort born 1915-1929 and their grandchildren born 1973-1980. *Longitudinal and Life Course Studies*, *1*(4), 317-338.

Harrison, S.L., Stephan, B.C., Siervo, M., Granic, A., Davies, K., Wesnes, K.A., Kirkwood, T.B., Robinson, L., & Jagger, C. (2015). Is there an association between metabolic syndrome and cognitive function in very old adults? The Newcastle 85+ Study. *Journal of the American Geriatric Society*, *63*(4), 667-675. http://dx.doi.org/10.1111/jgs.13358

Kuh, D., Ben-Shlomo, Y., Lynch, J., Hallqvist, J., & Power, C. (2003). Life course epidemiology. *Journal of Epidemiology and Community Health*, *57*(10), 778-83. http://dx.doi.org/10.1136/jech.57.10.778

Maggi, S., Irwin, L.J., Siddiqi, A., & Hertzman, C. (2010). The social determinants of early child development: an overview. *Journal of Paediatrics and Child Health*, *46*(11), 627-35. http://dx.doi.org/10.1111/j.1440-1754.2010.01817.x

Mishra, G., Nitsch, D., Black, S., De Stavola, B., Kuh, D., & Hardy, R. (2009). A structured approach to modelling the effects of binary exposure variables over the life course. *International Journal of Epidemiology*, *38*(2), 528-37. http://dx.doi.org/10.1093/ije/dyn229

Mishra, G.D., Chiesa, F., Goodman, A., De Stavola, B., & Koupil, I. (2013). Socio-economic position over the life course and all-cause, and circulatory diseases mortality at age 50-87 years: results from a Swedish birth cohort. *European Journal of Epidemiology*, *28*(2), 139-47. http://dx.doi.org/10.1007/s10654-013-9777-z

Motta, M., Bennati, E., Ferlito, L., Malaguarnera, M., Motta, L., & Italian Multicenter Study on, Centenarians. (2005%0. Successful aging in centenarians: myths and reality. *Archives of Gerontology and Geriatrics*, *40*(3), 241-251.

Seligman, M.E., Peterson, C., Barsky, A.J., Boehm, J.K., Kubzansky, L.D., Park, N., & Labarthe, D. (2015). Positive Health and Health Assets: Re-analysis of Longitudinal Datasets. Whitepaper. Retrieved 1 October 2015, 2015, from http://positivehealthresearch.org/content/positive-health-and-health-assets-re-analysis-longitudinal-datasets

Seligman, M.E.P. (2011). *Flourish.* New York: Free Press.

Taleb, N,N. (2007), *The black swan: the impact of the highly improbable*. New York: Random House.

Terry, D.F., Sebastiani, P., Andersen, S. L., & Perls, T.T. (2008). Disentangling the roles of disability and morbidity in survival to exceptional old age. *Archives of Internal Medicine, 168*(3), 277-283. http://dx.doi.org/10.1001/archinternmed.2007.75

Vacante, M., D'Agata, V., Motta, M., Malaguarnera, G., Biondi, A., Basile, F., Malaguarnera, M., Gagliano, C., Drago, F., & Salamone, S. (2012). Centenarians and supercentenarians: a black swan. Emerging social, medical and surgical problems. *BMC Surgery, 12 Suppl 1*, S36. http://dx.doi.org/10.1186/1471-2482-12-S1-S36

Ware, J. E., Snow, K.K., Kosinski, M., & Gandek, B. (1993). SF- 36 Health survey manual and interpretation guide. Boston: The Health Institute, New England Medical Center.

Weuve, J., Tchetgen Tchetgen, E.J,, Glymour, M.M., Beck, T.L., Aggarwal, N.T., Wilson, R.S., Evans, D.A., & Mendes de Leon, C.F. (2012). Accounting for bias due to selective attrition: the example of smoking and cognitive decline. *Epidemiology, 23*(1), 119-128. http://dx.doi.org/10.1097/EDE.0b013e318230e861

Willcox, D.C., Willcox, B.J., Wang, N-C., He, Q., Rosenbaum, M., & Suzuki, M. (2008). Life at the extreme limit: phenotypic characteristics of supercentenarians in Okinawa. *Journal of Gerontology: Medical Sciences, 63*(11), 1201-1208. http://dx.doi.org/10.1093/gerona/63.11.1201

Willets, R., Gallop, A., Leandro, P., Lu, J., Macdonald, A., Miller, K., Richards, S., Robjohns, N., Ryan, J., Waters, H. (2004). *Longevity in the 21st century.* London: Institute of Actuaries & Faculty of Actuaries.

Response by **David Blane** ESRC International Centre for Life Course Studies in Society Health and University College London, UK
d.blane@imperial.ac.uk

Bola Akinwale ESRC International Centre for Life Course Studies in Society and Health and Imperial College London, UK

Rebecca Landy ESRC International Centre for Life Course Studies in Society and Health and Queen Mary College London, UK

Katey Matthews ESRC International Centre for Life Course Studies in Society and Health and University of Manchester, UK

Morten Wahrendorf ESRC International Centre for Life Course Studies in Society and Health and University of Duesseldorf, Germany

The authors thank their six colleagues for thoughtful comments. These come from psychology (Hans-Werner Wahl), sociology (Mark Hayward), demography (Aart Liefbroer) and epidemiology (Gita Mishra, Isabel Ferreira, Ilona Koupil). It is heartening to see the level of agreement between them about required future developments in life course research, particularly the need for inter-disciplinarity, international comparative research and new studies to collect combined high quality social and biological measurements; as pioneered, we add, by Richard Suzman's legacy of the USA National Institute of Aging's international portfolio of studies of ageing (in relation to the inclusion of biological measurements, particularly the English Longitudinal Study of Ageing and, it is intended, the Survey of Health, Ageing and Retirement in Europe).

While celebrating this consensus, we regret the lack of comment from biology and actuarial science; and note that none of our commentators engaged fully with either the biological or the social historical parts of the ideas we presented. For us, it is important that data collection and analysis should be guided explicitly by social and biological plausibility; so, for example, while agreeing that "… important factors related to longevity risk seem not to belong to the health sphere", we nevertheless consider that death is inescapably a biological event and that social influences can produce death only through biological processes. Similarly, we feel that knowledge of social-historical context complements, rather than replaces, formal analysis of age-period-cohort effects. In other words, a commitment to social and biological plausibility can help to move us along the road from statistical association (…*related to*...) towards causation and the social challenge of longevity risk.

When reading the commentaries on our piece, we realised that we should say a few more words about the Strachan-Sheikh model and our idea of positive health.

The Strachan-Sheikh model

We use the word *model* in the sense of a theoretical description of the way a system or process works; or, if preferred, a way of thinking about reality. We accept readily the comments that the different components of the anatomical-physiological-biochemical system, which comprise the human body, grow and develop and lose capacity and atrophy at varying rates. Nevertheless, we find the generalised Strachan-Sheikh model useful for two reasons. First, it reminds us that humans are both social and biological beings who, biologically, start as a single cell which sub-divides and replicates many times, to each person's own achieved peak capacity which subsequently attenuates at varying speeds to death. Second, it reminds us that these rates of growth and atrophy are influenced by social circumstances, material and emotional, producing variation in life expectancy and mean height and age at puberty which vary by country, social class and historical period. It is this sensitivity of biology to social context which makes social history important to life course research, because it can inform us about who was likely to have been exposed to what during which phase of their development, with some exposures being beneficial and others noxious and the biological impact of specific exposures varying, to some extent, depending on whether the person was in the stage of growth or decline.

In relation to the decline phase of the Strachan-Sheikh model, it is worth mentioning a recent study of healthy, athletic people aged 55-79 years who spent two days completing a battery of physiological measurements, of which only six measures showed an inverse association with age (Pollock et al., 2015). These six involved mainly tissue repair (ILGF-1, pelvic bone density) and lung function (FEV_1, VO_{2max}, VT), which could be seen as components of intrinsic ageing or as signs of pre-clinical morbidity. In either case, the main implication of this small scale, cross-sectional study is that the biological path of decline to death is mainly via disease, rather than intrinsic ageing. If replicated, these findings argue for greater attention to variation in the rates of decline due to the living and working conditions of adult life.

Positive health

The financial consequences of the recent and, particularly among men, unanticipated increase in life expectancy at middle age, and its knock-on effects at later ages, have led to efforts to understand its causes. Actuaries are responsible for predicting future changes in life expectancy, which they are doing primarily in terms of anticipated change in disease risk factors and therapeutic innovations, to which our piece suggested the addition of a third factor, namely, changes to positive health.

We were led to the idea of positive health by two features of the present phenomenon and by the previous occurrence of something similar. For us, it is unlikely to be a coincidence that the mortality rates of the main causes of men's death have declined by proportionately similar amounts during the same period of time (see table 1 of our piece). Medical innovation, in our view, is unlikely to be the cause of this phenomenon, because its effectiveness varies greatly by disease – moderate to high in the case of ischaemic heart disease; low for carcinoma of the stomach. Similarly for risk factor change, where the most effective change (tobacco smoking cessation) impacts variably on different causes of death: high for lung cancer; low for accidents & violence.

The difficulty of explaining the present phenomenon solely in terms of medical innovation and risk factor change reminded us of the late nineteenth and early twentieth century when the mortality rates of the most prevalent infectious diseases of childhood (scarlet fever, measles, diphtheria, whooping cough, diarrhoea & vomiting) fell at the same time by proportionately similar amounts. Medical innovation (diphtheria anti-toxin) and the public health sanitary reforms (water & fly-borne infections) contributed to this change, but so did increased host resistance primarily due to better nutrition (the difference in host resistance contributes to high child mortality due to measles in refugees camps compared with lower mortality from the same virus in adequately nourished children). Our idea of positive health is that it is the equivalent of host resistance for chronic, non-communicable diseases.

Positive health in the sense of the body's ability to neutralise or mitigate the effect of environmental insults may also underlie the secular increase in the population's mean height and the fall in its mean age at the onset of puberty. And, we suggest in our piece, that the more or less linear fall across the twentieth century in the mortality rate of 65 year old women (see our figure 1) may be a further manifestation, due to cumulative improvements in the conditions of life, to which public health undoubtedly contributed, alongside technical-scientific innovation, democratic competition for power and self-organisation in trade unions, pressure groups and so forth. This suggestion raises two interesting questions in relation to historical change in mortality at age 65 years. Why did mortality rates at age 65 remain largely stable for both men and women from the 1840s to 1900? And why did the fall in men's mortality rate at 65 plateau during the 1940s, '50s and '60s? Amartya Sen's aphorism that "*There's never been a famine in a democracy*" (Sen, 1994) may be relevant to the former question, because the cohort who were aged 65 years in 1900, when mortality among 65 year olds started to fall, were born in 1835, which was one year after the start of the reform of the UK parliamentary electoral franchise, and so were the first cohort of 65 year olds to have lived their lives in an expanding democracy. To suggest an answer to the second question, we need to ask how the lives of men who were aged 65 years during the 1940s-60s differed from women of the same age. Both were born during the latter part of the nineteenth century, so the men were the right age to have fought in the first world war; perhaps their later mortality

plateau was an unrecognised long-term effect of their experiences during that war.

In summary, we welcome the enthusiasm of our commentators for what we regard as the right direction in which life course research should develop, although we give perhaps greater emphasis than they do to the inclusion of biologists in our inter-disciplinary efforts and the value of social-biological plausibility as a means of moving from correlation to causation.

Acknowledgements

MW is supported by funding from the German Research Foundation (Deutsche Forschungemeinschaft), project number WA 3065/3-1;DB is supported by UK Economic and Social Research Council award number ES/J019119/1

References

Pollock, R., Carter, S., Vellose, C., Duggal, N., Lord, J., Lazarus, N., & Harridge, S. (2015). An investigation into the relationship between age and physiological function in highly active older adults. *Journal of Physiology*, *593*, 657-680. http://dx.doi.org/10.1113/jphysiol.2014.282863

Sen, A. (1994). Freedoms and needs. *The New Republic*, 10th January 1994, pp. 31-37.

Referencing

The debate should be referenced as:

Blane, D., Akinwale, B., Landy, R., Matthews, K., Wahrendorf, M., Wahl, H., Hayward, M.D, Liefbroer, A.C., Mishra, G., Ferreira, I., & Koupil, I. (2016). What can the life course approach contribute to an understanding of longevity risk? *Longitudinal and Life Course Studies, 7, 165 – 196.* http://dx.doi.org/10.14301/llcs.v7i2.343

AUTHOR GUIDELINES SUMMARY

Submission of Papers

All papers, written in the English language, should be submitted via the *LLCS* website as a Microsoft Word file. If there is a good reason why this is not possible, authors are requested to contact crandall@slls.org.uk **before** submitting the paper. All subsequent processes involving the author are carried out electronically via the website.

Preparation of Texts

Length. The paper should normally be **approximately 5,000 words**, with longer papers also accepted up to a maximum of 7,000 words. This word count excludes tables, figures and bibliography.

Font and line spacing. Please use Calibri (or similar sans serif) font, 12pt, with 1.5 line spacing in all main text, single space in figure or table captions.

Page layout. All text should be justified to the left hand margin (all margins of at least 2.5cm) with no indents at the start of paragraphs and a line space separating paragraphs. All headings and sub-headings used within the body of the paper should also be left justified. Please do **NOT** use automatic text formatting.

Weblinks. To help our readers to look up cited references or other information available on the web, authors should ensure that all such references are activated.

DOIs. Do NOT include DOIs in the bibliography – they are added during editing as resolvable URLs.

Ensuring an anonymous (blind) review. Please submit papers with a full detailed title page. Once a paper has been submitted to *LLCS* via the website, it will be 'anonymised' by the removal of all author name(s) and institution names on the title page, and any identifying electronic document properties will also be removed. Authors do not need to remove their name(s) from the main text or references but any reference to their work or themselves should be expressed in the third person.

Abstract. The abstract (no subheads or paragraphs) should be no more than 250 words (not part of the main word count).

Keywords. These should be included just below the author list (minimum 3 maximum 10).

Abbreviations. Words to be abbreviated should be spelt out in full the first time they appear in the text with the abbreviations in brackets. Thereafter the abbreviation should be used.

References. Please use the APA 6th edition and refer to examples in the full Guidelines.

Authors not complying with these reference guidelines will be asked to make all the necessary alterations themselves, if their paper is accepted for publication.

Notes. As a general rule, supplementary notes should be avoided, but if thought to be essential, they should *not* appear on the page as Footnotes, but instead, be included as Endnotes.

Supplementary material. Supplementary material may be uploaded with the submission, and if the paper is published, will be visible to the reader via a link on the RHS of the screen.

Submissions containing graphs, tables, illustrations or mathematics. All graphs, tables and illustrations should be embedded in the submitted text, and have clear, self-explanatory titles and captions. Mathematical expressions should be created in Word 2003 (or a compatible package) with equation editor 3.0, unless the author has good reason to use other software, in which case please contact crandall@slls.org.uk. All biological measures should be reported in SI units, as appropriate, followed, in the text, by traditional units in parentheses.

Author citation. If the paper is accepted for publication, a version of the paper with all authors cited in full on the title page will be used. Only individuals who have contributed substantially to the production of the paper should be included.

Copy editing. All accepted manuscripts are subject to copy editing, with reference back to author with suggested edits and queries for response.

Proofs. The corresponding author will be asked to view a layout proof of the article on the website and respond with final amendments within three days.

(Full Author Guidelines at: http://www.llcsjournal.org/index.php/llcs/about/submissions#authorGuidelines**)**

Open Journal System

The ***LLCS*** journal is produced using the Open Journal System, which is part of the Public Knowledge Project. OJS is open source software made freely available to journals worldwide, for the purpose of making open access publishing a viable option for more journals. Already, more than 8,000 journals around the world use this software.

INTRODUCTION

PAPERS

COMMENT AND DEBATE

LLCS Journal can be accessed online at: www.llcsjournal.org

Published by
The Society for Longitudinal and Life Course Studies
Institute of Education, 20 Bedford Way, London, WC1H 0AL

info@slls.org.uk http://www.slls.org.uk