



SCIENTIFIC CASE FOR A NEW BIRTH COHORT STUDY

**Report to the Research Resources Board of the
Economic and Social Research Council**

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Authorship

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Executive Summary

Background

1. As part of the contribution to the development of national strategy for longitudinal data resources, ESRC commissioned Longview to undertake a scoping study to evaluate the case for establishing a new cohort as the latest in a series of cohort studies beginning in 1946, 1958, 1970 and 2000. Subsequently MRC contributed additional support for the study, which extended to: providing advice on alternative options for design, including those in use in prominent overseas studies; to consult sceptics as well as advocates of such studies; and to assess in depth the scientific case for the collection of biomedical data in any new study.
2. The work involved, collection of evidence from key individuals across the range of disciplinary perspectives in longitudinal research, through meetings with 55 experts in Britain and overseas, including France, Sweden and the US. A preliminary report was considered at a consultative conference involving 46 experts in longitudinal study and final conclusions were drawn.

Foundations of the case

3. Building on its unique history in establishing national birth cohort studies, each comprising many thousands of births, UK Social and Health Scientists have consistently demonstrated the great value of birth cohort study research resources to scientific enquiry and to the evidence base for policy. The case for the new study rests on the need to build the new knowledge required to address major challenges facing society in the current era and to establish continuities and discontinuities in past findings.

Scientific programme

4. The major challenges comprise child poverty, health and wellbeing, changing demography, especially the ageing population, globalisation, including the transformation of economies brought about by technological change, and immigration, including the growth of large minority populations in host countries such as Britain.
5. The scientific programme that follows embraces the range of factors that impact on a child's development from conception onwards and outcomes in a number of life domains, including most prominently, cognitive development and education, physical health and development and emotional, behavioural development and well-being.
6. The over arching theoretical framework to inform the programme is broadly described as the *lifecourse perspective*, which conceptualises development in terms of transitions in the different (interacting) domains of life at different levels (family, community and society) and the effects changing societies and different cultures have on these. Also of central importance to the understanding of these processes is the work of geneticists on gene expression

through interaction with the environment. Important extensions to the programme include cross cohort comparisons to establish the effects of secular change on lifecourse processes, intergenerational studies to assess the transfer of economic, human, social, cultural and psychological resources across the generations and cross national studies to assess systemic and cultural differences. Cross national comparability of data collected also offers the opportunity of data pooling, of particular importance in relation to the large data sets needed for the investigation of gene-environment interaction.

Design options

7. The scientific programme suggested promises to yield rich rewards in terms of knowledge and understanding, much enhanced by theoretical and methodological advances that in the current era have taken place since the earlier studies. The options for design follow directly from the programme as specified, identifying key features for attention. These include: the need for a large representative population sample to produce population estimates and maintain continuity with the earlier birth cohort studies, ecologically rich samples to support studies of interactional contexts at a number of levels, family, school, community, region, that affect the development and identity of the growing infant. Such samples can be built into the design of the population sample through clustering based on such catchment areas as ante natal clinics, primary schools or GP practices. Alternatively they can follow the ALSPAC model of a large scale area study of all pregnancies over a given period, replicated in contrasting geographical areas, including the four countries of the United Kingdom and areas defined by the different geographies within them.

8. Another option considered was to recruit for the new study the babies born to the new 40,000 UK Household Longitudinal Survey as opposed to establishing a new cohort. The conclusion is that the different scientific foci and the problem of respondent burden in the UKHLS would rule out this substitution. However there is much to be gained from building in complementarity between the two sources of data on children, especially with respect to harmonisation of data collection procedures and measures.

9. The focus on genetic environment inter-action points to the need for large samples, both in the sample as a whole and ideally within areas to embrace the range of possible interactions involved.

10. Other design features include the need to begin the study earlier than previously, i.e. as close to conception as possible, with biomedical and personal data collection through the period of pregnancy as well as post natally. Subsequently, data needs to be collected at the frequency to match the rate of change in development with frequent contact during the early years. Extensive use of administrative data (including medical records) will fill gaps in the record and relieve respondent burden and will be a major feature of the study. Much improved quality and linkage can be expected by the time the study begins.

11. Other design issues are concerned with the organisation of data collection the main message from which points to as long as possible a period for preparation of the study for optimum returns from it. This would include ideally a pilot embracing at least two waves of data collection to test the administrative procedures, including data linkage, measurement protocols and

ethical clearance that will be needed. Research funding availability may dictate a more contracted period with 2012/13 emerging as the earliest feasible starting date. Other organisational issues extend to: the recruitment and training of interviewers, especially for the area studies; the maintenance of data protection and confidentiality; recruitment and retention of cohort members.

Final considerations and conclusions

12. Although the case for the new study is convincing on a number of grounds: scientific, policy relevance and methodological. The main objection that comes especially from biomedical science is that the understanding of lifecourse processes and the mechanisms involved in the generation of particular conditions in later life can already be fully addressed through data collected in existing studies such as ALSPAC or the Millennium Cohort Study. Investing in a new cohort study diverts effort away from the top priority of exploiting more fully existing data. Other objections reside in preferences for other forms of research design including, especially, the randomised controlled trial and in depth qualitative studies of organisations such as hospitals or schools.

13. The team takes the view that alternative designs should be seen as complementary to the new birth cohort study, which addresses scientific questions in a way that no other research vehicle can match. The major scientific challenges in the study of the lifecourse in the current era can only be addressed adequately through a new birth cohort study.

14. High costs, capacity, feasibility and motivation point to more practical difficulties in launching a new study. The cost of a new birth cohort study cannot be seen in isolation from the cost of the continuation of all the others. There are questions whether academic capacity in Britain is adequate yet to meet the demands of the more elaborate research designs. Capacity building is therefore an essential complement to the scientific programme. Feasibility reflects concerns by survey researchers generally about falling response rates and problems in retaining respondents in longitudinal surveys.

15. Coupled with concerns about data protection and disclosure control much careful planning is needed to ensure that optimum procedures are put in place to ensure the study's success on all fronts, including the linkage to the best sources of administrative data locally and nationally. Finally the work needed to maintain and develop longitudinal surveys is not recognised in universities dominated by Research Assessment Exercise (RAE) as valuable in its own right. Without such recognition it may be difficult both to motivate young researchers to work on a new study and to analyse its results.

Conclusion

16. The scoping study has demonstrated strong support in the research community for investment in the scientific vehicle for research that the new birth cohort study would become. Developing the design of the study in innovative directions is likely to attract a wider constituency of interest in the work and this itself may encourage investment in the capacity building that is needed to take the best advantage of it.

17. Without the new study the continuity of what is a unique and world renowned series would be irrevocably broken. Other countries are increasingly recognising the value of such data sources in connection with understanding life course processes in their own societies and are establishing birth cohort studies of their own. The regard with which they hold the British cohort study enterprise extending over 60 years is more than enough justification for Britain to develop a new birth cohort study that will be best equipped to match modern needs.

Preface

1. The impact of accelerating technological change, demographic transformation and rising inequalities demand continuous monitoring of population movement and much enhanced understanding of the life course processes connecting origins to destinations. The data sources supplying the evidence base for building the knowledge that is needed are recognised as a responsibility running across the research councils, government and the major charitable foundations in which the Economic and Social Research Council (in conjunction with more recently the Medical Research Council) has taken the lead. The UK Data Forum now provides the means of sharing information between the major users about data sources and their development between the major users and prioritising data needs.
2. The National Data Strategy is the main product of the forum's work to date, supplying a set of principles and means of implementing them that will guide policy for the production of social, economic and medical data for many years to come¹. In recognition of the national significance of the Forum's work, eligibility was given for the first time in 2006 for support from the UK Science Large Scale Facilities fund to establish the facilities that would help meet the country's social data needs.
3. Central to the strategy is the need for longitudinal data in which Britain has a world lead. In connection with the strategy, ESRC commissioned Longview² to undertake a strategic review of panel and cohort studies, similarly with a view to determining where investment in them would yield the best returns³. The review concluded that there was a powerful case for establishing a new household panel study eight times the size of the existing one (the British Household Panel Study, BHPS). A bid was put to the Large Scale Facilities fund for such an expansion which was successful. The 40,000 household UK Longitudinal Household (UKHLS), following an 'Innovation' pilot panel in 2008, begins in 2009.
4. The review also argued for investment in the continuation of the series of birth cohort studies starting with the National Survey of Health and Development in 1946, followed by subsequent cohort studies based on a single weeks births in 1958 (National Child Development Study, NCDS) and 1970 (1970 British Cohort Study, BCS70) and the most recent one, following a 30 year gap, in 2000 (Millennium Cohort Study, MCS). In the intervening years the closest to a comparable study was the Avon Longitudinal Study of Parents and Children based in the county of Avon (ALSPAC), which began in 1992.
5. The Strategic Review concluded that "A new cohort study should be started in around 2012 to restore the twelve year interval series."

¹ National Strategy for Data Resources for the Social Sciences, Economic and Social Research Council, 2006

² Longview is Charity devoted to promoting longitudinal research and improving the quality of longitudinal data. The Longview team comprised Jean Martin, University of Oxford, John Bynner, Longview, Graham Kalton, Westat (USA), Harvey Goldstein, University of Bristol, Paul Boyle, St Andrews University, Vernon Gayle, Stirling University, Samantha Parsons, Institute of Education, Andrea Piesse, Westat

³ Strategic Review of Panel and Cohort Studies, 2006, www.longviewuk.com

6. ESRC Research Resources Board decided to establish the scientific case for investing in such a study, with a view to making a further bid for support to the Large Scale Facilities fund. An invitation to tender for the work was issued, and a team again established by Longview was commissioned to undertake the work⁴. The brief required the Longview team to examine the scientific arguments for the new study and to advise on alternative options for its design, including sample design and coverage (including biomedical data) and the timing of the new study. Subsequently the brief was extended further in the light of Medical Research Council interest in the work to assess innovative research designs including prominent overseas studies, to consult sceptics as well as advocates of cohort studies and to assess in depth the scientific case for the collection of biomedical data. Subsequently following a successful consultative conference in Oxford. The Wellcome Foundation also expressed interest in supporting the case for the study.
7. The team established by Longview spanned a range of experience in the design and use of cohort study research across the perspectives of social, behavioural and health sciences and statistics. This included one team member from a survey organisation with much experience of longitudinal data collection and another team member based in the US with much experience of running longitudinal surveys.
8. The review was based on the collection of evidence from key individuals across the range of disciplinary perspectives in longitudinal research (Appendix 1a) and from expert meetings, including one with the new French longitudinal study of children due to begin in 2009 (ELFE⁵) and commissioned papers (Appendix 2). Longitudinal study experts in Sweden were also consulted⁶. US experience was tapped through the team's US member, particularly through his involvement in the design work for 100,000 strong US National Children's Study beginning in 2008 and through expert interviews⁷. This first draft of the report was supplied to ESRC to support the developing case for the study within ESRC. It also supplied the basis for a highly successful consultative conference, held In St Catherine's college, Oxford, attended by 46 cohort studies experts across the range of social and health sciences, research funders and government (Appendix 1b). The final report brings together all these different sources of evidence in drawing together final conclusions.

⁴ The team comprised John Bynner (Longview Director), Michael Wadsworth (Longview), Harvey Goldstein (University of Bristol), Barbara Maughan (Institute of Psychiatry), Susan Purdon National Centre for Social Research, Robert Michael (Harris School for Public Policy Studies, University of Chicago

⁵ *Etude Longitudinale Française depuis l'Enfance*, https://www.elfe.ined.fr/Institution/hist_indexA.htm

⁶ Jansson C-G(ed) *Seven Swedish Longitudinal Studies in the Behavioural Sciences*, Swedish Council Planning and Coordination of Research, 2000

⁷ *National Children's Study, Health Growth and Environment*, <http://www.nationalchildrensstudy.gov/>

1. Foundations of the Case

(a) Introduction

- 1.1. Britain has an unrivalled history in the establishment of national birth cohort studies for scientific investigations of developmental processes and their outcomes throughout life in social, educational, economic, psychological and health spheres. They are also used extensively for policy development drawing on the evidence base that the cohort studies produce. Spanning the period from 1946 to the present day, the studies chart the changing nature of the life course in Britain, in relation to changing economic and political circumstances. Continuities and discontinuities can be identified and the reasons sought, as a result of the longitudinal nature of these studies, offering ‘quasi experimental opportunities’.⁸
- 1.2. The birth cohort study is a powerful instrument for unravelling in detail the course of development and the influences that shape it under prevailing conditions in the social and physical environment. The extensive changes that have taken place in the demographic, economic, political and technological context of development make each of the British studies not only the means of monitoring their effects but the means of supplying a vital source of evidence about the processes of growing up in the current era.
- 1.3. The national birth cohort studies were set up to tackle a range of policy and scientific questions arising initially from conditions prevailing after the Second World War, including the introduction of the National Health Service and the 1944 Education Act and their consequences for the health, education and well being of children. Topics included:
 - The risk of perinatal death and the socio-economic and geographic variation in that risk and in the provision of expert health care; inter-cohort comparisons were to show how far these risks and their distribution changed
 - The prevalence and socio-economic variation in infant feeding and health, and of health care for infants and mothers
 - Showing how efficiently and equitably the fund of talent at school was drawn on for further and higher education
 - Showing the impact on children’s lives and opportunities of socio-economic change in terms of, e.g. parental separation, employment of mothers, birth to a young mother
 - Showing that there are pathways from early life growth, health and development to lifetime trajectories in psychological and health function (e.g. cognitive function, respiratory function, and blood pressure), illness risk (e.g. schizophrenia, type2 diabetes, pre-menopausal breast cancer), to socio-economic status and labour market engagement, and to social and political participation
 - Showing that across recent cohorts there has been widening polarization of life chances in which family education and income differentials are critical factors⁹

⁸ Shadish, W., Cook, T.D. and Campbell D(2001) *Experiments and Quasi-Experiments for Generalised Causal Inference*, Houghton-Mittlin, Boston (MA)

⁹ Hansen, K. and Joshi, H, (2007) Millennium Cohort study Second survey: *A User’s Guide to Initial Findings*, Centre for Longitudinal Studies, Institute of Education

- 1.4. The results of this work can be seen in findings ranging from the risk of smoking in pregnancy to the economic and social returns to education, with significant contributions to understanding child development and its later outcomes. The studies provide unparalleled opportunities for analysis of life histories in nationally representative samples, and statistical modeling of developmental processes. When extended across the generations, longitudinal studies give insights into cycles of deprivation and achievement, and the intergenerational transfer of resources. They are the best if not the only means of unraveling the long-term effects of childhood experiences on the dynamics of inequality, ageing and health in the human life course.
- 1.5. The strengths of the British studies are recognised by the numerous government enquiries and policy developments for which they have been a major source of evidence. The Platt Committee on the Welfare of Children in Hospital (1959), the Plowden Committee on Primary Education (1967), the Warnock Committee on Special Educational Needs (1978), the Finer Committee on One Parent Families (1966-1974), the Acheson Independent Enquiry on Health Inequalities (1998) and the Moser Committee on Adult Basic Skills (1997-1999) all drew heavily on the longitudinal data that the cohort studies produced. Similarly, numerous policy initiatives from *Sure Start* to the *Child Poverty* initiative have relied on cohort study data to aid policy development and to help to assess its effects.
- 1.6. The model has been adopted in other countries originally mainly for epidemiological enquiries¹⁰, but the range of data collected within a multi-disciplinary framework on the British scale is a fairly recent development. Prominent examples include the North Finnish Birth Cohorts of 1966 and 1986, and more recently, the US National Children's Study (NCS) due to start in 'vanguard' form in 2008, which comprises the follow-up of 100,000 babies located in 105 US areas¹¹. The focus of the US study is on child health with particular emphasis on the effects, harmful and helpful, of exposures in children's environments – chemical, physical, biological and psychosocial – from conception to adulthood. The new French national study, ELFE, comprising follow up of up to 35,000 infants from birth, has a broader remit with a wide range of socioeconomic, behavioural and health data collected alongside biomedical data and measures of the physical and social environment to meet the goals of a range of scientific programmes supported by that study¹².
- 1.7. This report considers whether there is a case for establishing a new UK national birth cohort study. A part of that case is the outstanding contribution the prior four British Birth Cohort Studies have made to our understanding of the well-being of children and the determinants of their healthy development over a lifetime. The most recent renewal of the foundations of this unique knowledge base comes from the first findings from the Millennium Cohort Study (MCS), which demonstrate new challenges to child wellbeing¹³. Within a few years, the Studies will have no children as a focus and renewing that focus with a new birth cohort has great value in the light of the productivity of all four earlier cohort studies. In this chapter we consider the role a new birth cohort study would have in addressing major policy concerns and as the appropriate vehicle for building further the scientific evidence base.

¹⁰ Bynner, J. and Joshi, H. (2007) Building the Evidence Base from Longitudinal Data: the aims content and achievements of the British Birth Cohort Studies, *Innovation*, 20, (2), 159-179.

¹¹ *National children's Study, Health Growth and Environment*, www.nationalchildrensstudy.gov

¹² *Étude Longitudinale Française depuis l'Enfance (ELFE)*, www.elfe.ined.fr/institution/hist_indexA.htm

¹³ Hansen, K and Joshi, H (eds.) (2007) *Millennium Cohort Study Second Survey: A User's Guide to Initial Findings*, Centre for Longitudinal Studies, Institute of Education.

(b) Would a new national birth cohort study contribute usefully to addressing major policy concerns?

1.8. Identification of significant challenges facing society in the coming years has been the subject of expert groups in governments across the world and in international organisations. In the UK such prioritising has taken place in government (the Coordination of Research and Analysis Group, CRAG) and in the ESRC through the work undertaken for the *ESRC Strategic Plan 2005 – 2010*¹⁴. Research priorities are also central to the *National Data Strategy* and to the *Strategic Review*. The National Data Strategy's four top priorities encompass problems traditionally addressed by the social sciences that are also of concern to the health sciences:

- a) Child development: its long term effects on health, socio-economic well-being, and social behaviour
- b) The ageing population: its implications for employment, service provision and dependency
- c) Globalisation: embracing technological transformation of the labour market and the consequences for education and skills and growing economic inequalities
- d) Migration within and between countries: its consequences for social cohesion

(i) Child development

1.9. Study of the long term effects of child development is central to consideration of the case for a new study. The other priorities say more about the context of development and, in the case of the ageing population, the long-term returns to early development. Other priorities identified in the strategic review are likely to become increasingly prominent on the research agenda. In particular they include climate change and what has been described as the 'biotechnical revolution' including the patenting of new life forms. Their longer term economic and social consequences need to be kept continually under review.

1.10. National concerns about childhood include those influences that are shaping the developing individual:

- a) the changing forms and effectiveness of parenting
- b) the effects of the economic circumstances of the family and 'learning culture' of the home on readiness for learning, skills formation and later educational attainment and behaviour
- c) children's social behaviour in relation to the social capital of the neighbourhood
- d) service provision in health, preschool and school education and social welfare
- e) the physical environment and, in particular, evidence of increased exposure to toxicity
- f) health related habits of nutrition and exercise

1.11. The negative consequences of adverse experience in developmental problems to which policy is directed are exemplified by such disabling conditions as obesity, the prevalence of which is increasing. 23% of the MCS infants at age 3 were overweight, including 5% who were obese and latest projections suggest that in 25 years half the

¹⁴ www.esrcsocietytoday.ac.uk/ESRCInfoCentre/Images/Strategic_Plan_2005-10_tcm6-12995.pdf

population will be obese. Such difficulties also underpin later economic and educational disadvantage associated with impeded skills acquisition, with challenging variations between different ethnic groups and between the countries of the UK¹⁵. Increasing interest in prenatal influences, gene expression and gene-environment interaction in developmental processes argues for examining the impact of these environmental exposures at the very earliest stages of life. Long-term life-span studies embracing all life domains of environmental influence are needed to identify the risk and protective processes to which the individual is subjected, the potential effects of which will remain with them throughout their lives.¹⁶

1.12. In summary a new birth cohort study design would be informative about all these topics, because each requires follow-up of individuals, each concerns a situation which is changing rapidly, each lays down an aspect of the foundations of later life, and in each area the theoretical frameworks for understanding the processes of differentiation and associated research programmes are changing. At the same time scientific technologies for the collection, management and analysis of relevant data are being transformed greatly enhancing research potential.

(ii) Demographic change

1.13. The age profile of the national population is changing. The 2001 Census showed that for the first time the number of people age 60 and over was greater than the number aged under 16. By 2050 it is estimated that the proportion of the population aged over 65 will have risen to 20% compared with 7% in 2000. In the year to mid 2006 the largest percentage growth in population was at ages 85 and over with the number in this age group standing at a record 1,243,000. The number beyond retirement age was 11,344,000, while at the same time the number aged under 16 decreased by 0.4 percent to 11,537,000¹⁷

1.14. Although the new birth cohort study would not contribute in the short term to the study of ageing, the point was stressed by experts in this field that information concerning changes in early developmental patterns from previous cohorts will provide vital clues to conditions at older ages. There are certain to be concerns about whole life course relationships in 60-70 years time, just as the 1946 cohort (currently age 61) is now beginning to supply the present generation of scientists working on ageing with invaluable information. New evidence would be a timely complement to such studies as the English Longitudinal Study of Ageing (ELSA) and the UKHLS, because new methods of measurement of growth, psychological and physical development and genetic endowment have been established since the earlier birth cohort studies began. So the new study would help elucidate the genetic and environmental effects on the developmental processes known to be associated with ageing.

1.15. Other features of demographic change present challenges of a different kind. Thus the number of married people in the population over the age of 16 has been steadily declining from, for example, 350,000 in 1980 to 250,000 in 2005 while the population

¹⁵ Parsons, S and Bynner, J. (in press) *Illuminating Disadvantage: Entry Level Literacy and Numeracy over the life course, evidence from the 1970 Birth Cohort Study*. Institute of Education, National Research and Development Centre for Adult Literacy and Numeracy

¹⁶ e.g see Schoon, I. *Risk and Resilience: Adaptations in Changing Times*, Cambridge University Press, 2006.

¹⁷ Office of National Statistics www.statistics.gov.uk/CCL/nugget.asp?ID=6

was steadily increasing rising by 349,000 from mid 2005 to mid 2006, to over 60.6 million. Of particular significance in relation to the ageing population is the postponement of marriage and parenthood to later ages. Since 1995 the mean age of marriage has increased by just over 3 years for men and just under 3 years for women, reaching in 2005, 36.2 years for men and 33.6 years for women. At the same time the average age at first birth among women has increased by 3 years since 2001 reaching 29.2 years in 2006, with potentially greater risk of social exclusion of those who give birth much earlier. Family structure is also changing with over 40% of children born outside marriage in 2004 (15% to single parents) and 20% to mothers born outside the UK compared with 12% in 1997.¹⁸ A new national birth cohort study could contribute greatly to understanding the impact of such changes on styles of child rearing and care, on preparation of children for school, and on aspirations for children's future.

(iii) Globalisation

1.16. Globalisation is changing the socio-demographic environment in ways that interact with those just considered, affecting fundamentally the shape and trajectories of the life course in Britain. For instance the information technology (IT) revolution and the growth of the knowledge economy has had a massive impact on employment and employability, including the increased demand for qualifications, the extension of education, and the creation of global labour markets. Inward investment and GNP have increased steadily over the last 40 years across most of the countries of the developing world, while the prices of ICT and global travel have fallen. The enormously increased accessibility of knowledge through the internet and the ability to communicate socially via peer group sites can be expected to have important effects on children's learning and behaviour and a new birth cohort will be well placed to explore this. Literacy levels have risen in response motivating the desire to migrate and making it possible to do so. Rising educational standards and better access to improved individual and public health care have also had a strong impact.¹⁹ As the demand for human capital increases, and the necessary period of education extends, long term commitments tend to be postponed. In the 1970 cohort study only 27% of men were fathers by age 30, compared with 49% in the 1958 cohort study and over 80% in the 1946 cohort study.²⁰

1.17. As the counterpart to the extension of the transition from education to work, there is economic dependency for many more years beyond adolescence. There is also a high risk of marginalisation and social exclusion of those who have little or no family resources to take advantage of extended educational opportunities. In terms of the proportion of the population in this position the UK (and the US) fair badly, compared with other OECD countries.²¹ In 2006, one sixth of the UK child population in Britain were below the poverty line compared with one 50th in Denmark.²² *Every Child Matters* and *Sure Start* in the UK and *No Child Left Behind* and *Early Head Start* in the US, are among the policy responses directed at eliminating child poverty and optimising life chances from the earliest age back to conception²³. The record of achievement toward the goals of these public policy initiatives requires continuous

¹⁸ *Birth Statistics 2004* Series FM1 no.33 www.statistics.gov.uk/statbase/Product.asp?vlnk=5768

¹⁹ Masson, P. 'Globalization: Facts and Figures', IMF Discussion Paper, 2001

²⁰ *Changing Britain, Changing Lives*

²¹ Bradshaw, J (ed.), *Poverty the Outcomes for Children*, Family Policy Studies Centre, 2001

²² *An Overview of child well-being in rich countries*, Unicef Innocenti Research Centre Report Card 7 2007

²³ e.g. Bradford Bamfield, L. 'Born unequal: Why we need a progressive pre-birth agenda', Fabian Society Policy report 61, 2007;

replenishing of the evidence base from a new birth cohort as the circumstances of birth and infancy change.

(iv) Migration

1.18. Global labour markets generate population movements as local economies grow or contract in the light of changing investment policies and capital shifts. Disparities in economic and physical well-being and political restructuring, such as the collapse of the Soviet Union and the creation of the European Community, add to the pressures for migration, and the UK is seen as offering attractive opportunities. An estimated 223,000 more people came to the UK in 2004 than left to live overseas (120,000) – a figure that was up 72,000 over the previous year and the highest net migration since the present count began in 1991. Arrivals of Commonwealth residents increased by 45% between 2003 and 2004, with arrivals from Pakistan rising from 9,000 to 25,000 and from Bangladesh, India and Sri Lanka from 38,000 to 54,000. 345,000 migrants from Eastern Europe have registered to work in Britain since the expansion of the European Union in May 2004.

1.19. The challenges of immigration relate to temporary statuses - a potential source of inequality and stress - and identity conflicts in relation to the countries of destination. The transmission of these through families is another focus of research attention. Intermingling of cultures can have the positive consequences of enterprise, cross-fertilization and revitalisation. It can also be the source of conflict in the competition for resources, such as jobs and housing, in places where these are in short supply. Differing cultural assumptions about clothing, lifestyle, values and religion may also fuel prejudice and hostility. The violent response fuelled by extremist ideology casts a deep shadow over the ideal of cohesive community and is likely to be a dominant feature of the political landscape in the coming years.

(v) Other inequalities and social exclusion

1.20. Within the indigenous population, other forms of inequality defined by such factors as gender, ethnicity, age and disability, are apparent. Social mores shift and aspirations rise for some sections of the population while others are left behind. The transformation of women's participation in the labour market and its ramifications for family formation and functioning is a realisation of aspiration matched by new opportunities with provisions such as part-time and home-working employment.

1.21. But taking advantage of new opportunities is not evenly distributed. Poor school performance encourages early exit from education and accelerated transition to partnership and parenthood, giving the UK the highest teenage pregnancy rate in Europe. At the same time graduate women postpone childbearing to ever later ages: in the age 33 follow-up of NCDS in 1991 half had yet to have a child and in the 1970 cohort the percentage was even higher. Thus as the gender gap reduces in terms of earnings and career prospects, polarisation of expectations and experience among women increases²⁴.

1.22. Age is another source of differentiation posing further challenges. The 'generation gap' takes on a new form in the world of global media and widening inequality. The use of electronic media has become the prerogative of the young through which their

²⁴ Ferri, E., Bynner, J. and Wadsworth, M. (eds) (2003) *Changing Britain, changing lives: three generations at the turn of the century*, London: Institute of Education

own culture is expressed, thus reversing the traditional transfer of capability from the old to the new generation. Gangs and violence, as a response to alienation and exclusion from the mainstream routes to adulthood through education and the labour market, are another challenge to social cohesion.

1.23. The longitudinal database that a new cohort study would provide will supply vital evidence about these *trajectories of disadvantage*. We need to understand not only differentiation and alienation in the teenage years, but experiences from the beginning of life that lie behind it. The previous cohort studies have identified some of the factors that produce the ‘turning points’ at home and at school underpinning the “escape from disadvantage”²⁵ A new study would build the comprehensive evidence base on which effective policy can be founded.

(c) What contribution could a new national birth cohort study make to building the scientific evidence base

1.24. The existing studies have made, and continue to make, substantial contributions to the social, developmental and health sciences. As each study ages, the scientific opportunities offered multiply. The value of a new study would reside in the contribution it is able to make to scientific knowledge through the application of new thinking about early childhood and methodological enhancement. Within the framework of interdisciplinary enquiry, which the birth cohort study supports, significant scientific advance could be expected.

(i) *Scientific programme*

1.25. Social science thinking about the life course increasingly focuses on the kinds of capital resources – cognitive, social, cultural and psychological – that underlie the development of capability, identity, and social cohesion and the obstacles in the family and the community that lie in the way of acquiring them. There is much interest in the pathways from early life to adult outcomes ranging from civic participation to happiness and well-being. Because of its repeated measurement design the birth cohort study has been valuable in the study of the origins, of and life-time influences on, trajectories of earnings, occupation and benefits and the returns to public investment in them at different ages and life stages. In all of these areas the extensive social and demographic change currently taking place will influence the formation of individual attributes, such as capability, and the nature of social cohesion. What past studies have lacked is the detailed information on the early conditions of life that support strong causal inference about the life course processes involved. There is growing interest in the role of social ecology (social relations and contexts) and of personal agency in trajectory formation. Taking advantage of new thinking about sample design and measurement in the family and community that address these issues would offer the prospect of significant scientific returns.

(ii) *Cognitive development, skills and educational outcomes*

1.26. The cognitive development of the child is of paramount interest among scientists in many disciplines. Developmental psychologists have developed excellent measures of various attributes of cognitive capability and show linkages from one life stage to another. Sociologists have

²⁵ Pilling, D. *Escape from Disadvantage*, The Falmer Press, London, 1990

provided important evidence of how family, schools, and peers influence the motivation and efforts made by children in acquiring skills. Economists have tracked the returns to investments in education at various stages of schooling and shown that there is payoff, as well, from human and other forms of capital investments. Recent research has shown how important family support for children is in facilitating the capacity to learn at later ages, and have hence shown how critical it is to document and to understand better, the factors that lead to successful early learning at the pre-school stage. This early evidence of learning and of parental encouragement of habits of inquisitiveness and motivation to learn implies that it is essential to study the child from the very earliest ages, even pre-birth, ideally. Life-long learning, also, has become a topic of substantial interest in the study of the life course. So the continuation of the series of birth cohorts, tracing the antecedents of study habits throughout life under changing circumstances has great value for this purpose as well.

(iii) Physical health and development

1.27. Although the earlier birth cohort studies measured physical growth, they did so, inevitably, using the concepts and methods of their time. There is currently great advance in this field, and it is now evident that in order to understand why and how early life growth influences health throughout life, detailed studies of growth from the earliest time in life, ideally from conception, are required. New measures would be concerned not only with pre and postnatal skeletal growth but also with growth of the major organs, including the brain. The genetic contribution to such processes can now be measured. Better measures of environmental effects and nutrition are possible. Biochemical measurement can be undertaken from very small samples of blood and tissue. Using these methods a new birth cohort study would greatly and uniquely advance knowledge in this field. Such a study could deliver new knowledge about some costly conditions that are of particular concern. These include premature birth, childhood obesity and its associated long-term risks, and the effects of exposures to suspected toxins on growth and sensory development.

(iv) Emotional and behavioural development and well-being

1.28. Longitudinal studies have convincingly shown that early experience plays an important role in psychological development. The effects begin from the very point of conception through interactions between the foetus/child and the environment. The potential to include genetic characteristics of the child and the parents in studying mental illness would greatly enhance understanding of this growing problem, especially in the adolescent and young adult population. There have been major advances in the study of prenatal influences, gene expression and gene-environment interaction and the development and maintenance of psychological well-being. Pre and post natal environments are changing rapidly as maternal characteristics (e.g. age at birth, diet, smoking, drinking, exercise, drug use, occupational and educational attainment) and the infant environment (e.g. diet, exercise, care), change. Some adverse trends in early outcomes (e.g. prevalence of premature birth, childhood obesity, allergies, the beginnings of anti-social behaviour and 'attention deficit hyperactivity disorder' (ADHD) will become better understood through the contribution to theory and measurement that the new cohort study would make. New data may also help to illuminate why, for example, Britain scores lower than many other wealthy countries on indicators of child well-being.²⁶

²⁶ UNICEF(2007) *An Overview of Well-being in Rich Countries*, Innocenti Research Centre Report Card 7

(v) Intergenerational and cross-national extension

- 1.29.** To understand the changing life course it is necessary to chart the course of development in large population samples of individuals of the kind the cohort studies provide, monitored individually across an extended time and born in different periods. Such research also extends across the generations. Providing the requisite age-equivalent measures (or proxies for them) are available, we can determine the extent of, and changes in, intergenerational transfer of material, cognitive and social resources and what part it plays in the social exclusion of particular individuals and groups²⁷.
- 1.30.** Locating such studies within the framework of international comparison - now possible through the launch of birth cohort studies in many other countries - offers the opportunity to bring systemic effects into the equation. How do different countries and their distinctive welfare systems affect early developmental and longer-term life course processes and the distribution of their outcomes in socio-economic and health functioning? In cases where hypotheses are confirmed across countries ruling out a 'nation effect' the data can be pooled thus greatly enhancing the potential of the study of gene-to-gene and gene-to-environment interactions where large sample numbers are needed to maintain statistical power²⁸. When hypotheses fail to be supported further investigation is stimulated to determine the reasons why.

(vi) Enhanced data collection opportunity

- 1.31.** A new cohort study will need to repeat some measures made in the previous studies and to improve their quality as well as range. That will be particularly necessary for studies of gene/environment/development interactions. Rapid technological advance in the collection and storage of biomedical samples and in laboratory processing is likely to increase greatly the range of home-based measures that can be made from small biological samples (e.g. saliva, blood). Expanding facilities for clinic-based assessment will also bring a large proportion of the population within reach of the most advanced and sophisticated measurement. Besides the projected improvements in measurement, the form of the survey interview itself is also likely to be very different by the time a new birth cohort study is initiated. 'Adaptive' survey interview programmes are developing in the US to a point where rather than an interviewer administering questions in accordance with a standardized schedule, the interview will mimic more closely a normal conversation. Web-based interviewing is also becoming increasingly common. Such developments offer opportunities for the fast and efficient collection of much richer data on experience than has been possible in the past while at the same time presenting problems for later data retrieval and analysis. Finally, enhanced computer linkage capacity will enable a new study to draw on huge banks of previously untapped administrative and clinical data, which themselves are undergoing quality scrutiny and improvement. Properly planned from the outset of a new study, such new resources supply the means of filling gaps in the longitudinal record, reducing respondent burden and extending further the scope of scientific investigation.

²⁷ Fox, J. and Fogelman, K. (1989) 'New Possibilities for Longitudinal Studies of Intergenerational Factors in Child Health and Development', in Magnusson, D. and Bergman, L. R. (1990) *Data Quality in Longitudinal Research*, Cambridge: Cambridge University Press.

²⁸ Burkhauser, R.V. and Lillard, D.R. (2006) The Contribution and Potential of Data Harmonization for Cross-National Comparative Research, *Journal of Comparative Policy Analysis*, 7, 313-330.

(d) Design implications for a new national birth cohort study

1.32. The major considerations about design include sampling, first contact, size and timing of a new study.

(i) Sample design

1.33. The first three birth cohort studies chose as their samples babies born in a single week. This reflected the largely medical-developmental model on which they were based of individual response to environmental exposures. To encompass the wider social science and modern developmental perspectives, sample design needs to embrace the geographical and ecological context (social and physical) in which development takes place. Many of our informants urged highly innovative approaches which we describe in chapter 6. Several new data sets exemplify this trend. For example, the U.S. *Fragile Families* study comprises children born to unmarried parents based in 20 US cities, with a thousand babies in each of the randomly sampled cities in order to focus upon variation in the social environments in those cities. The U.S. National Children's Study focuses on physical and chemical environment exposures, among others, and so it too is highly clustered, but using a nationally representative sampling frame, allows generalization to the whole U.S. population of children born during the period of recruitment.

(ii) Sample size

1.34. From the 1958 cohort study onwards the birth cohort studies adopted comparatively large samples to support study of relatively rare population groups. To gain the full advantage of advances in the study of gene-environment interactions as well many of our informants argued that substantially large samples are needed. Sampling ecological variation requiring sampling of places as well as individuals within a multilevel framework as urged by many of our informants puts added pressure on sample size.

(iii) First contact

1.35. The options for making first contact with the cohort member families can be at pregnancy, as in ALSPAC, or at some time close to the birth. To enable the critical early stages of development to be investigated there is strong interest in following the precedent of other studies such as the US National Children's Study by starting data collection as early as possible after conception.

(iv) Timing of a new study

1.36. A starting date for the new study, of 2012, would retain the original twelve year interval in the 1946, 1958, 1970 birth cohort study series. A number of our informants argued, however that the timing of the new study should be tied to major legislative changes in relation to the welfare of children or decided on the basis of a coherent scientific or policy principle. The principle of *generation renewal* was suggested pointing to something in the order of a 12 to fifteen year interval between cohort studies. However as others, pointed out as more important is the time needed, with adequate piloting, to put an effective study in place, i.e. development period of three to four years. For a cohort study team to begin work in 2009 this would imply a start

date for the new study between 2012-2015, and possibly extending recruitment over two or three years rather than the traditional single week, or one year, 'sweep'. Exigencies of funding profiles and the need for results will also be a critical factor in deciding the optimum date.

(e) Conclusions

1.37. Although a few of our informants offered arguments against investment in a new birth cohort study, which we consider at the end of the report, the overwhelming response was one of enthusiasm for the scientific opportunities such a study would offer. In some ways the most convincing appraisal came from our overseas informants who view the existing British birth cohort series as a unique and hugely important scientific achievement²⁹. No other country has comparable social science and medical research resources for understanding the development of the human life course, under changing socio-economic conditions. The policy response to the dominant challenges of 21st century will be greatly informed by the new knowledge that the cohort study can provide. In the words of one of our US informants failure to continue the cohort studies series would be 'mad' if not monumentally short-sighted.

1.38. We therefore conclude that there is a very strong case to be made for a new national birth cohort study. Our evidence points to two major questions that the new study could enable social and health scientists to address:

How do the major changes in society – globalization and the premium on technical skills for the workforce, the ageing population of the UK and the changes in traditional family structures, migration and the growing cultural diversity, and growing economic inequality and child poverty – impact on the social, psychological, and physical development of children in the UK and their skills, health and behaviours throughout their lives?

Which of these societal changes complement or thwart the on-going efforts by family, social institutions (i.e. schools), communities and government to nurture well-being, and in what ways?

1.39. The chapters that follow consider the main features of the research programme the new study would support and examine the design requirements and constraints that would need to be met to answer these questions and maximise the new study's scientific returns. The final chapter returns to the main case, supplying an overall appraisal, including the case against, and reaches final conclusions.

²⁹ e.g. Clark, L. *et al*, "Interim Report on Seminal Approaches to the Study of Children's Trajectories.." Department of Sociology, University of Toronto, 2003

2. Introduction to the Scientific Programme

2.1. As outlined in Chapter 1, the scientific case for a new birth cohort study rests on four main planks:

- a) the rapid pace of social and demographic change in the environment of childhood, and its implications for the health and development of the next generation of British children
- b) compelling evidence that influences very early in life play a key role in shaping developmental trajectories throughout the life course
- c) continuing advances in our knowledge of the factors that shape individual development
- d) methodological improvements in both the social and the biological sciences that enable us to track key aspects of development and the influences on it in increasingly sophisticated and reliable ways

In this and the following chapters we set out these arguments in more detail, and, building from them, sketch in some of the key questions that a new birth cohort study is needed to address.

(a) The changing environment of childhood

2.2. As chapter 1 showed, recent decades have seen major changes in the demographic structure of the UK population, and in the lives of succeeding generations of British children: these are continuing trends. Table 1 sets out in more detail some headline markers of these trends and some projections forward to the era of the new study. The changing *population structure* (projected to continue at least through the early decades of the new millennium) marks a major shift towards an ageing population, and raises a plethora of policy issues for a society in which - for the first time ever - older adults will outnumber the new generations of children. Trends in the drivers of *population change* highlight other issues: natural change (births and deaths within the existing population) was by far the main contributor to population growth up to the 1980s; continuing growth over coming decades is projected to owe at least as much to migration. These changes - coupled with the young age structure of many existing minority groups in the UK - mean that the next generations of British children will encompass unprecedented levels of cultural and ethnic diversity.

Table 1. The Changing Face of Childhood

						Projected	
	1971	1981	1991	2001	2005	2011	2021
<i>Population structure</i>							
% population under 16	25.5	22.3	20.3	20.1	19.3	18.1	17.6
% population age 65 and older	13.2	15.0	15.8	15.9	16.1	16.9	19.7
<i>Live births</i> (thousands, annual averages)	962	736	757	731	692	702	716
<i>Population change</i>							
Net natural change (thousands, annual averages)	324	69	103	100	92	121	139
Net migration and other (thousands, annual averages)	-12	-27	5	68	182	160	145
<i>Fertility</i>							
Total fertility rate	2.41	1.82	1.82	1.63	1.79		
Mean maternal age at 1 st birth	23.7	24.8	25.6	26.6	27.3		
% births outside marriage		12	30	40	43		

						Projected	
	1971	1981	1991	2001	2005	2011	2021
<i>Multiple births (per 1,000)</i>	9.9 (1975)				14.9		
<i>% Smoking in pregnancy</i>		30 (1985)	28 (1990)	20 (2000)	17 (2005)		
<i>% Drinking in pregnancy</i>			66	61	54		
<i>% Breast feeding</i>				69 (2000)	78		
<i>Households: % couples with dependent children</i>	52	47	53	39	37 (2006)		
<i>Dependent children:</i>							
% in couple families with 3+ children	41 (1972)	29	25 (1997)	24	22 (2006)		
% in lone parent families	7 (1972)	12	21 (1997)	22	24 (2006)		
<i>Children aged <16 of divorced couples (thousands - approx)</i>	82	155	155	148	135		
% under 16 year-olds	5.8	12.4	13.2	12.5	11.6		
<i>Maternal employment: % mothers returning to work, child under 1 year</i>		20	36	49 (1999)			

- 2.3. Table 1 also lists recent trends in a range of other indicators. Total fertility rates have remained below replacement level (2.1 children per woman) since the 1980s, and trends for later ages at child-bearing have continued, reflecting women's increasing involvement in education and the labour market. Rates of smoking and drinking in pregnancy have fallen, but remain of concern; rates of breast feeding - which carry benefits for both mothers and babies - have risen overall, but like many of the other indicators discussed here still show marked variations both by region and by socio-economic group. More than 50% of mothers now return to full- or part-time work before their child's first birthday; alongside formal child care arrangements, grandparents and other informal care-givers are playing an increasingly important role in the care of young children. Perhaps the most dramatic shifts have been in the size and structure of children's family units, and their stability over time. Latest figures suggest, for example, that almost a quarter of children now spend at least some time in a lone parent family - a doubling of the rate in the last 25 years. In couple families, average family size has dropped - but increasing use of assisted fertilization has led to a rapid increase in rates of twinning and other multiple births, - a potentially special target for the study. While most children are born to married couples, Britain now has one of the highest levels of births outside marriage in the EU-25 (43% in 2005), and parental separation and/or divorce is now likely to affect one in four UK children. For many children, parental separation will be just the first step in a sequence of family changes, with periods in lone parent households followed by the formation of new family groups: in Britain in 2005 more than 10% of families with dependent children were step-families.
- 2.4. The substantial rise in lone parenting imposes stress on both the parents and the children, creating greater pressure on social programs for children. But while *half* of all households had a child in 1970, now only about *one-third* do so reflecting also the continual postponement of parenthood especially among the most educated. The demographic shift towards an older childless population may, in the longer term, reduce the political commitment to the welfare of children: though currently children's needs are high on the list of government priorities, with policies such as *Sure Start* and *Every Child Matters* targeting the twin issues of child poverty and well being.
- 2.5. Many of these demographic shifts have known associations - some positive, others negative - with child health and well-being, and with aspects of children's social and cognitive development. Future trends with respect to these parameters cannot be predicted with certainty; what does seem clear, however, is that even in terms of these 'headline' indicators such as family poverty or obesity, new generations of British children will differ from their predecessors in numerous and important ways. In addition, new generations will face new challenges which, though less easy to quantify, will undoubtedly be powerful in their effects: globalization, environmental change, insecurity in the face of community conflict and global terrorism, changing patterns of social cohesion and trust, and the accumulation of risk associated with life in disadvantaged neighbourhoods. Tracing the impact of these changes on the unfolding of individual lives constitutes a major impetus for establishing a new British birth cohort.

(b) Early life influences on the development of capabilities, health and behaviour

2.6. Our understanding of the life course has progressed with the scientific work undertaken over the past decades and now it is generally acknowledged that early life experiences inform and affect subsequent development, for good and for ill. Pathways develop and while they are informative, a child can also move from one pathway to another; understanding how and when and why is one of the motivating intellectual issues that a new birth cohort study should address. The social and health science disciplines use different terminology and emphasize different aspects of the development process; they also focus on different determinants of well-being; but all emphasize common elements of human development: these include (1) the progress of development with early exposures molding later capabilities, (2) the complex range of influences some direct, close-in, and immediate, others more distal, indirect, and delayed in their effects, (3) accumulation of capabilities and consequently the form of personal skills, knowledge, habits, emotional and social skills, and (4) the interconnections among the domains of physical, psychological, economic and social well-being. These elements imply that there are interdependencies across the domains of interest and there is great complexity in the formation of any of the developmental outcomes in terms of human, social, cultural and psychological capital. Correspondingly, these realities imply that no single set of theoretical models and no single set of statistical methods can address all the domains of interest and no single “outcome” can adequately be studied in isolation. This is the key contribution to understanding that, large-scale multidisciplinary social / medical / social policy longitudinal surveys can make to the knowledge base on which effective policy is founded.

(i) Pre-natal influences

2.7. There is now strong evidence that processes very early in development shape outcomes throughout the life course. We elaborate this evidence in more detail in relation to specific outcomes in later chapters. In brief, however, building from Barker’s³⁰ seminal work on foetal programming in the physical health arena, it is now clear, for example, that maternal stress in pregnancy is associated with increased risks of behavioural difficulties and language delay in children³¹; that mothers’ diet in pregnancy is associated with variations in children’s verbal IQ and social communication skills³²; and that maternal smoking in pregnancy is associated with long-term risk for offspring of antisocial behaviour and crime³³. In many instances the precise processes involved in these effects remain to be

³⁰ Barker, DJP. (1992). *Foetal and infant origins of adult disease*. London: BMJ Publications.

³¹ Talge, N.M., Neal, C. & Glover V. (2007). Antenatal maternal stress and long-term effects on child neurodevelopment: how and why? *Journal of Child Psychology and Psychiatry* 48, 245-261.

³² Hibbeln JR, Davis JM, Steer C, Emmett P, Rogers I, Williams C, Golding J. (2007). Maternal seafood consumption in pregnancy and neurodevelopmental outcomes in childhood (ALSPAC study): an observational cohort study. *Lancet* 369, 578-585.

³³ Wakschlag LS, Pickett KE, Cook E, Benowitz NL, Leventhal BL. (2002). Maternal smoking during pregnancy and severe antisocial behavior in offspring: A review. *American Journal of Public Health* 92, 966-974.

elucidated. What existing findings do make clear, however, is that the impact of later experiences can only be properly understood in the light of knowledge of these early influences, and that retrospective reports of pre-natal exposures, though adequate for some purposes, are generally far from ideal. Instead, contemporaneous measures taken during pregnancy - including both assessments of maternal characteristics and life-styles and measures of key aspects of foetal development - now constitute the gold-standard in this area. A new birth cohort study beginning in pregnancy laying the ground prospectively for the study of development to follow would play a major role in our growing knowledge of these key early processes and their implications for development across the life course.

(ii) Gene-environment interplay

2.8. Advances in genetic research are also revolutionizing our understanding of the processes of human development. The vast majority of human characteristics are now thought to reflect a complex interplay of heritable and environmental influences³⁴, with genetic variations contributing to individual differences in vulnerability to disease and environmental adversity, and also to selection into more and less favourable environments. The ease with which it is now possible to collect DNA in large population samples, along with the rapid progress in identifying genes associated with health and functioning, thus promise extensive new insights not only into biological processes but also into the ways that social and environmental adversity impact on individual development. There is already, of course, major scientific investment in DNA resource in the UK large cohort studies including the 1946 birth cohort study (NSHD), the Avon Longitudinal Study of Parents & Children (ALSPAC), Biobank, the English Longitudinal Study of Ageing (ELSA) and the 1958 national birth cohort study (NCDS). Biobank and ELSA (both beginning with adult samples) have genetic and environmental data in relation to ageing, but are dependent on inference, record data and recollection for information about the developing years. NSHD, NCDS, and more especially ALSPAC, have rich data on childhood environments (including, in the case of ALSPAC, key data on prenatal exposures), but are to varying extents constrained by the limited measures of early growth and development available when they were initiated. A new birth cohort study able to marry the rapid advances in genetic research with state-of-the-art measures of both the growing individual and key environmental influences would constitute a major new national resource. However, as we argue later, much larger numbers are required than in the previous cohort studies to pursue this possibility.

(iii) Conceptualizations of individual-environment interplay across development

2.9. In addition to these specific advances, existing longitudinal studies - including the British birth cohorts - have over time contributed to the emergence of conceptual models of development that can now be used to inform the design of new studies. Central among these is the life course perspective elaborated by Elder and others³⁵, detailing the influences on the *trajectories* through which an individual's

³⁴ Rutter M. (2007). Gene-environment interdependence. *Developmental Science* 10, 12-18.

³⁵ Elder GH, and Shanahan MJ (2006). The life course and human development. In: RM Lerner, ed. *Handbook of child psychology, Vol 1, 6th edn: Theoretical models of human development*. Wiley and Sons, New York, pp. 665-715. Kuh D, Ben Shlomo Y. ed. (2004) *A life course approach to chronic disease epidemiology*. 2nd ed. Oxford University Press, Oxford. Power C. (1994) Power C. (1994) The

life course is constructed in terms, for instance, of capabilities, occupation, income and health. Among these trajectories, the concept of *personal agency* has emerged as of key importance. From the very earliest stages of development children influence, as well as being influenced by, their environments, evoking different responses from parents, teachers and peers, and in so doing, contribute to the creation of their own social worlds. Bidirectional processes of this kind, played out with immediate interactional partners in the family, the school and later in the workplace, are now seen as among the key *proximal* influences on social development. Theoretical work in the tradition of Giddens and Beck³⁶ argues for concern with the development of individual agency and 'individualization', i.e. detachment from the socialisation processes of the past stemming from the family and the workplace; though others question whether such structural constraints as class and gender have truly broken down³⁷. Theorists in the tradition of Bronfenbrenner³⁸ also argue the need to view the proximal processes in the context of more *distal* effects: neighbourhood and community characteristics on the one hand, and broader social and cultural influences that go to shape attitudes, opportunity structures and social institutions on the other³⁹. Bronfenbrenner's unifying model of proximal and distal influences is shown in figure 1.

special role of longitudinal studies. In Pless IB (ed.) *The Epidemiology of Childhood Disorders*. Oxford University Press, New York 1994; 31-46

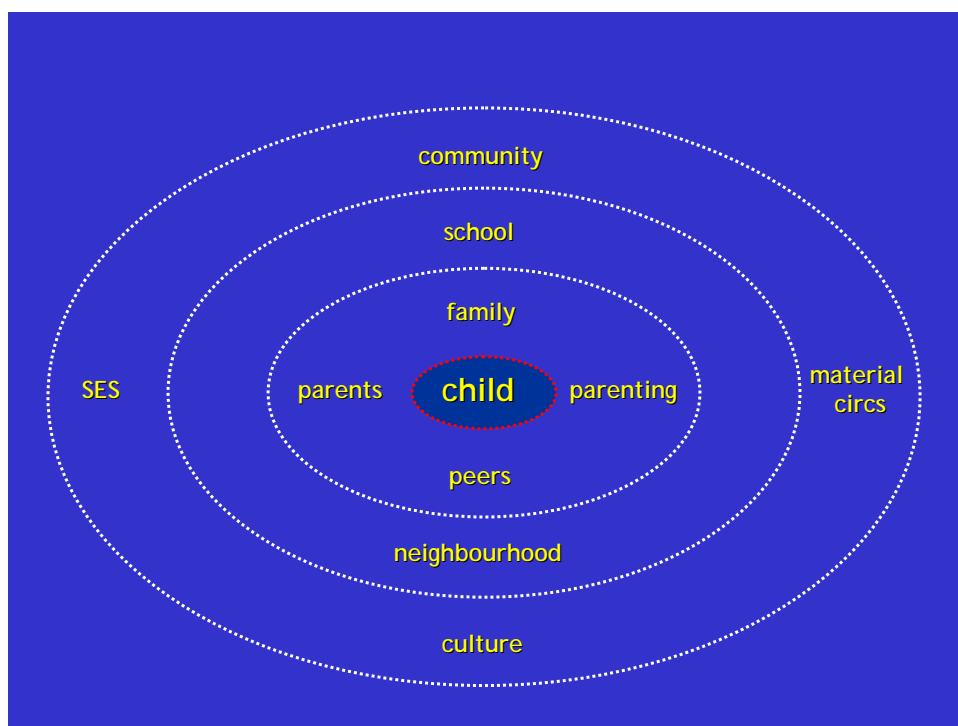
³⁶ Giddens A, Beck U, Lash S (1994) *Reflexive modernisation: politics, tradition and aesthetics*. Polity Press, Cambridge. Giddens A (1991) *Modernity and self identity*. Polity Press, Cambridge; Beck U (1986) *Risk Society*, Sage, London.

³⁷ Furlong, A. and Cartmel, F. (1997) *Young people and Social Change*. Buckingham: Open University Press.

³⁸ Bronfenbrenner U (1979). *The ecology of human development: experiments by nature and design*. Harvard University Press, Cambridge, MA.

³⁹ Putnam RD (2000) *Bowling alone*. Simon & Schuster, New York. Lerner RM, Benson PL (2003) *Developmental assets and asset-building communities*. Kluwer Academic/Plenum, New York.

Figure 1: Forces Influencing the Child's Development



Birth cohort studies have predominantly focused on mapping the most proximal levels of such influences - often implemented within an implicitly 'unidirectional' paradigm. These theoretical models - and the empirical evidence from which they derive - argue for the utility of key extensions to this model, within a new study explicitly designed to capture more fully the multi-layered nature of environmental effects. Foremost among the influences are those of the family.

(iv) Family influence

2.10. Family context, comprising resources, aspirations, and actions for, and interactions with, the developing child is the key arena for the proximal influences on child development and the key mediator of the more distal effects of community and society and therefore needs to be measured. Some of the family characteristics are biological contributions (e.g. diet) to the child's well-being, some are cultural, some affect the child's early social- emotional- and cognitive-capabilities and expressions and many have long-term influence on the child's psychological and social and subsequently economic capabilities, strengths and weaknesses. The structure of the family, in terms of size, composition, child's birth order and number of siblings, is also a significant part of the context, relating to the family's stability its mobility, and its connections to the extended family and to the community. The economic circumstances of the family – the levels and sources of income, the family's assets and debts, housing tenure, employment status, income and occupation – are also

important⁴⁰ operating through a variety of mechanisms. While evidence clearly points to family poverty as detrimental to children's healthy development in all domains, there is much variation in its impact on subsequent outcomes for children; there is also much movement in and out of disadvantaged statuses as well as their persistence in some families.

2.11. Nearly all the child's life in the formative early months are spent with family members or in circumstances chosen by the parent so the resources and capabilities of the parents as reflected in their own educational level, socio-economic position and values, have a great impact on the child's cognitive and socio-emotional development. There is growing evidence that these very early experiences and exposures have lasting influence on the child's later life. Documenting many of these family influences has been a strength of the earlier birth cohort studies, and so opportunities for inter-cohort comparison would be available.⁴¹

(v) Influences beyond the family

2.12. As figure 1 makes evident important influences beyond the family include the child's peers from the pre-school period onward. The nursery, the primary school, the neighbourhood, the community, all extend the potential range of friendship groupings and their consequent influence. The prevailing culture with its foundations in social class, ethnic, religious and language distinctions all play an important part in shaping identities and the pathways to adult life, as do teachers and the culture of the school more generally. Other significant adults outside the family may also supply role models, which may or may not provide re-enforcement for positive community and education values.

(c) How the environment of childhood influences development

(i) Human capital investments

2.13. The notion from micro-economics of investing in oneself – or in one's children – in the form of skills, knowledge, understanding, as well as less obvious human capital investments like migration, job search and signalling, lies at the core of the life course pathway and of the importance of family in the well-being of the child. People expend

⁴⁰; Desai, S., P. L. Chase-Lansdale, & R. T. Michael. 1989. "Mother or Market? Effects of Maternal Employment on the Intellectual Ability of 4-year-old Children". *Demography*, 26 (4; Nov.): 545-561; Waldfogel, Jane, Wen-Jui Han, & Jeanne Brooks-Gunn. 2002. "The Effects of Early Maternal Employment in Child Cognitive Development." *Demography* 39(2): 369-92.

⁴¹ Smith, J. R., J. Brooks-Gunn, & P. K. Klebanov. 1997. "Consequences of Living in Poverty for Young Children's Cognitive and Verbal Ability and Early School Achievement." in Duncan & Brooks-Gunn, (eds) *Consequences of Growing Up Poor*. NY:Russell Sage.; Aughinbaugh, Alison & Maury Gittleman. 2003. "Does Money Matter? A Comparison of the Effect of Income on Child Development in the United States and Great Britain." *Journal of Human Resources*. 38(Spring, 2):416-440.; "Children and Poverty" *The Future of Children*. 7 (2) Summer/Fall 1997;

resources of time and money and effort in the interest of acquiring skills and habits of mind that yield productive gains later when those skills are utilized in jobs, in the home, and in life generally. As we have noted they may also invest this capital in the achievements of their children. Documenting the processes involved is one of the key benefits of birth cohort studies⁴². Pivotal public policy issues surrounding this conception, include:

- access to funds for human capital investments as these may be too-dependent on family resources or ability-to-pay and may therefore inhibit intergenerational mobility
- the interplay of native ability and the return on investments in human capital and the corresponding remedial disposition for the “rents” associated with this distribution of success
- the psychological factor of willingness to defer gratification, and the role of different discount rates as a factor influencing willingness to invest in human capital
- the perverse incentives of job market discrimination against any race or culture as inhibiting the motivation for self-improvement through human capital investments

(ii) Health

2.14. In health studies the question of how exposure to environmental risks actually influence growth and the risk of illness are conceptualized primarily in terms of dietary effects, adverse emotional exposures over a long period, exposures to substances that have toxic effects (e.g. environmental chemicals found in food, household cleaning substances, or outdoor atmospheric pollution), and exposure to infection. The risk of long-term effects of such exposure is hypothesized to be the result of such adversity changing the pattern of growth and response during developmental plasticity.⁴³

(d) The longer term outcomes

2.15. While childhood is the central focus of research and attention in a new birth cohort study, the main scientific returns to the study in many respects come much later. This is when the child is an active adult, engaging in social and economic activity that impacts on the family, community and nation. While many important survey programs focus on these adult years, only those that began at a very young age can offer researchers the opportunity to control adequately for the ‘initial conditions that supply the foundations of later well-being at every

⁴² Becker, G.S. (1975) Human Capital. Washington D.C.: National Bureau of Economic Research.

⁴³ Rutter M, O'Connor TG, English & Romanian adoptees study team (2004) Are there biological programming effects for psychological development? *Developmental Psychology* 40, 81-94; Hertzman C (2007) Human development, life course, intervention and health. In Pickles A, Maugham B, Wadsworth MEJ (Eds) *Epidemiological methods in life course research*. Pp.111-136. Oxford University Press, Oxford.

subsequent stage through adolescence to old age. In outlining the case for a new cohort study chapter 1 emphasised the importance of the early years, as foci of public policy concern and research interest, while recognising that throughout the life course the possibility of changing tracks is ever-present. The longer the time interval over which data are collected the more the value of data on early life experience on these adult behaviours and capabilities becomes apparent.

- 2.16.** The thirty-year gap in the current British birth cohort series makes the point that we currently have no nationally representative sample from birth of men and women in their teens, in their twenties, or in their early thirties at the stage of life of forming long-term partnerships, having children, advancing in their careers and securing their first home and beginning to build up assets for later retirement. This stage is important as the choices made in this thirty-year interval sets in motion the developments that constitute the nature of our national work force, future fertility, and basic macro economic conditions of consumption, savings and investment. Civic life as well as economic life is dominated by this mid-life stage and knowing the precursors and prior investments and behaviours of adults in this interval has great value in understanding how our society responds to opportunities and threats. Again, while the immediate focus of a new birth cohort study, appropriately, is on children, the value of these data grows as these children age and the longer term consequences of their actions, investments, exposures are manifested.
- 2.17.** Such outcomes include educational level, occupational choices, employment and earnings. They also include family formation/dissolution and the quality of relationships, fertility, and migration, income and wealth, civic behaviours, and health status, health related behaviours such as smoking, drinking and drug abuse. From the information obtained as the cohort ages one can track both the cross-generational mobility in these indicators and their cross-lifetime transitions and volatility. These later data, of course, also permit comparisons with earlier cohorts providing the basis for understanding differences in well-being and life expectancy across the generations.

(e) Comparative studies

(i) Cross-cohort comparisons

- 2.18.** Both the nature and the inter-weaving of the differing levels of influence on development will vary with the individual's location in the social structure, with their stage of development, and with historical time: each generation, for example, will experience different economic cycles, and may be exposed to particular cataclysmic events - be they wars, terrorist atrocities, or natural disasters - that will impact on their experiences in very particular ways. In examining these historical effects the series of British birth cohorts constitutes a well-nigh unique resource. Although this is only now beginning to be fully exploited, it is already clear that comparisons, between cohorts born and developing through different historical eras, can constitute an exceptional tool to illuminate effects of both social and policy

change. Studies undertaken to date, for example, have addressed issues as varied as the implications of rapidly rising levels of parental divorce for child and young adult outcomes⁴⁴; the effects of increasing educational opportunity on gender wage differentials; and the effects of cohort differences in exposure to atmospheric pollution on the development of respiratory function⁴⁵. More consistent use of the existing series of studies is now being developed through an on-going study of inter-cohort differences in the development of cognitive capital, and plans for parallel studies of historical change in the influences that affect escape from poverty. With appropriate attention to 'backward compatibility' of measurement with existing studies, a new cohort would add importantly to the value of this existing series.

(ii) International comparisons

2.19. Britain's past tradition of birth cohort studies is unparalleled world-wide. More recently, however the US, Canada and a number of other European nations are planning or have already initiated birth cohort studies of their own. Though some of these are designed to address quite specific issues (so that, for example, the US National Children's Study is focusing centrally on risks for specific aspects of child health), many such as the French ELFE study would offer important complementarities with the issues proposed to us as central for a new British birth cohort. Emerging findings from these studies would thus constitute an additional resource on which plans for a new UK study could draw; in principle, these studies could also offer a rich basis for international comparisons. In the course of the scoping study we have held discussions with key members of the teams involved with the French, US and Swedish studies; all expressed their support for a new UK-based study, and were excited by the potential for collaboration.

(f) Methodological advances

2.20. The existing British cohort studies have used a range of approaches to data collection, typically centering on in-home interviews with key informants supplemented by cognitive testing, medical assessments and the measurement of some bio-markers. To match the new scientific aims outlined above, our informants highlighted a range of methodological developments that could greatly extend the scientific potential of a new birth cohort study.

(i) Record-linkage

2.21. Many informants stressed the major advantages to be gained from linkage with the rapidly expanding sources of individually-based administrative data now available in the health and educational fields. Linkage with death records has long been

⁴⁴ Ferri E, Bynner J, Wadsworth M (2003) eds. *Changing Britain, changing lives*. Institute of Education Press, London. Ely M, Richards MPM, Wadsworth MEJ, Elliott BJ. (1999). Secular changes in the association of parental divorce and children's educational attainment - Evidence from three British birth cohorts. *Journal of Social Policy* 28: 437-455. Chase-Lansdale PL, Kiernan K, Friedman RJ. eds. (2004) *Human development across lives and generations*. Cambridge University Press, Cambridge. Sigle-Rushton W, Hobcraft J, Kiernan K. (2005). Parental divorce and subsequent disadvantage: A cross-cohort comparison. *Demography* 42, 427-446.

⁴⁵ Orfei L, Strachan DP, Rudnicka AR, Wadsworth MEJ (in press) Early influences on adult lung function in two national British cohorts. *Archives of Disease in Childhood*.

standard practice in the existing cohort studies. More recently, both ALSPAC and the Millennium Cohort Study teams have sought family consent for linkage with birth, child health and education records and experience in dealing with both the technical and the ethical issues raised by such linkage is rapidly developing in the research community. In the future, linkage of research-based data with these and other administrative sources will allow for a major expansion of the information available on individuals while at the same time reducing respondent burden, and freeing time in research-based assessments for examination of other issues.

(ii) Data from clinical sources

2.22.Capitalizing on its local geographical base, ALSPAC has pioneered the use of study member visits to central research ‘clinics’ comparable with those used in the highly influential Dunedin longitudinal study in New Zealand. These visits allow for the collection of reliable data on a much wider range of bio-markers than is feasible in the home, and also provide better controlled conditions for psychometric assessments. In the future, the development of research facilities of this kind around the country (one of which, in the Wellcome Trust network of Clinical Research Facility Clinics, is being used in the current feasibility study of clinic data collection in the 1946 cohort), will greatly extend the potential of future studies to incorporate state-of-the-art measures of a wide range of aspects of development.

(iii) Other measurement advances:

2.23.More detailed innovations in the measurement of both individual growth and functioning and the key features of environmental exposures (e.g. through GIS coding) continue apace across both the social and the biological sciences. We highlight some of the most important of these in relation to specific topic areas in the chapters that follow. At a more general level, our informants also highlighted the advantages that are likely to accrue from the expansion of web-based assessments as a complement to face-to-face interviews, and the major advantages to be gained from incorporating into the cohort study model the multi-informant approaches now seen as central to reliable assessment in many disciplines.

(g) Conclusions

2.24.The great advances in theory, in empirically based knowledge, in measurement and in data collection techniques, come together to establish a major scientific programme, which only a new birth cohort study could supply the means of implementing. These advances also argue for building on, rather than sticking rigidly, to all features of the research designs that have been used effectively in the past. Rather they argue for developing the design to match new questions in the most efficient and productive way. The questions to be addressed and design options are considered in the chapters that follow.

3. Cognitive Development and Educational Outcomes

(a) Introduction

- 3.1.** Enhancing the cognitive abilities and educational attainment of children and young people is a concern shared by the sciences and society as a whole. The British cohort studies have added much to our understanding of cognitive development and their findings have already been useful in policy aimed at nurturing and educating the young. Studies such as these have shown that for the individual, the beginnings of the developmental pathways to cognitive skills, educational attainment, styles of response in personal and social relations, attitudes and values and personal identity are to be found in the characteristics of early life. Furthermore, society's substantial investment in education and the initiatives to raise educational standards are perceived to be key drivers of the knowledge economy. At the same time however, society itself changes; thus, *Changing Britain, Changing Lives* compared 30 year olds in the 1946, 1958 and 1970 cohort studies showing how these individuals' lives had changed over the 24 years spanning their births⁴⁶. Notable changes were in the rising levels of participation in education, the qualifications gained (especially by women), and the decline in marriage and parenthood (especially amongst the most educated). At the heart of the drive to increase educational capability is cognitive development because it underpins the core skills of literacy and numeracy. Despite this, research has demonstrated that within two years of birth, cognitive function varies according to socio-economic background with the gap subsequently widening to reach a substantial size by the time of school entry at age 5⁴⁷.
- 3.2.** The relationships between the development of cognitive (and non cognitive) skills, attainment in education and the role of society may be understood through Biosocial ecology Theory⁴⁸. As we have seen, this conceptualises the environment as shaping development at a number of interacting levels: biology, psychology, the family, the community, and society. The influences include 'risk' and 'protective' factors comprising the fixed and more malleable features of the child's personal, social, and physical environments to which policy such as Sure Start is principally directed. *Social* risk factors are exemplified by economic disadvantage, poor neighbourhoods, and inadequate parenting; conversely protective factors are exemplified by parents' effective caring behaviour through which positive development is nurtured⁴⁹ and community based

⁴⁶ Ferri et al *op cit*

⁴⁷ Feinstein, L. (2003) Inequality in the Early Cognitive Development of British Children in the 1970 Cohort. *Economica*, 70, 277, pp 73-98; Gregg, P, Harkness, S. and Machin S. (1999) *Child development and Family income*, Joseph Rowntree Foundation

⁴⁸ Bronfenbrenner, U (1979) *The Ecology of Human Development: Experiments by Nature and Design*. Harvard University Press, Cambridge Mass.

⁴⁹ Rutter, M (1990) Psychosocial resilience and protective mechanisms. In Rolf, J., Masten, A.S., Chicchetti, D., Nuechterlein, K.H. & Weintraub, S. (Eds.). *Risk and Protective factors in the development of psychopathology*. pp 181-214. Cambridge University Press, Cambridge

interventions promoting cognitive development and capability⁵⁰. The research literature shows that child poverty and social disadvantage, concentrated at the individual family and neighbourhood levels, is a growing national problem that is related to poor acquisition of the basic cognitive skills, followed by poor educational attainment, employment prospects and earnings, and lack of community involvement⁵¹. Following rising equality through the 1970s there has been rising inequality since⁵². Further consequences of the 'exclusion' processes involved in this inequality includes mental health problems, drug and alcohol abuse, violence, and crime⁵³.

(b) Capital resources

3.3. It is useful to conceptualise the effects of inequality and social disadvantage in terms of various kinds of *capital resources* through which families support their children and which children in turn have the opportunity to build. Most obviously family capital comprises financial resources available through income and savings⁵⁴. They also include the more intangible cognitive and non-cognitive resources needed for human functioning and where higher priority in relation to employability, for example, is increasingly being placed, including:

- *Human capital* (concerned with the cognitive and practical skills that are valued in the labour market)
- *Social capital* at the individual level (concerned with networks of association and trust)
- *Cultural capital* (concerned with the norms and values associated with achievement)
- *Psychological capital* (concerned with personal affect, attributes and styles)
- *Family capital* (concerned with collective family processes such as the home learning environment)

In aggregate, they form in the growing child what Côté describes as *identity capital*⁵⁵, supplying at the individual level, the foundations of capability and personal well-being and, at the local and societal levels, wealth creation and cohesion⁵⁶.

⁵⁰ Evangelou, M., Brooks, G., and Smith, S. (2007) The Birth to School Study: evidence on the effectiveness of PEEP, an early intervention for children at risk of educational under-achievement, *Oxford Review of Education*, 1-29

⁵¹ Hendry, L. and Kloep, M (2002) *Lifespan Development: Resources, Challenges and Risks*, Thompson Learning

⁵² Dorling, Rigby, et al (2007) *Poverty, wealth and place in Britain*, Joseph Rowntree Trust

⁵³ UK Social Exclusion Unit (1999) Bridging the Gap; Bynner, J. (2001) 'Childhood risks and protective factors in social exclusion', *Children and Society*, 15:285-301

⁵⁴ Ermisch, J.E. (2003) *An Economic Analysis of the Family*, Princeton University Press

⁵⁵ Côté, J.E., Levine, C.G. (2002) *Identity, Formation, Agency and Culture*, London: Lawrence Erlbaum.

⁵⁶ Sen, A. (1991) *Inequality re-examined*. Oxford University Press

(c) Life course perspective

- 3.4. Understanding development requires a *life course* perspective,⁵⁷ which would strongly benefit from a new cohort study that brings together the perspectives and findings of different disciplines. The intergenerational transfer of cognitive skills and educational attainment from one generation to the next is known to be influenced by “cycles of disadvantage (and advantage)”⁵⁸ such that continuities are evident in the effects of family background on educational attainment⁵⁹. Moreover, the risks themselves faced by one generation can also be passed on through processes that are often facilitated by parenting⁶⁰. Yet at the same time, and as cohort study research has shown from the 1946 cohorts study onwards, there is escape from such cycles which typically reflects high levels of family aspiration and teacher commitment to a child’s educational progress overriding adversity and risk; these are coupled with the effects of the child’s own agency such as their motivation to succeed⁶¹. Also by their strategic behaviour families purposively influence through the resources available to them the educational and other outcomes of their children and data are needed that will facilitate modelling the processes through which such choices are made. Therefore, disadvantage, adversity, and social risks might be mitigated by opportunities in all these levels outlined in bio-ecological theories: within the family, the school, and the community
- 3.5. However, the differences in the development of individual life pathways between generations are not well understood and reflect changing distributions of resources, opportunities, and the political consensus through which policy is formed. A new birth cohort study would provide information that would uniquely add to scientific understanding and to policy relevant to contemporary circumstances. Specifically, by investigating the *interactive* influences of genetic, prenatal, social, psychological, and socio-economic factors over time, it would be possible to address (in a novel way) the basic question of how far individuals are ‘selected’ into societal disadvantage/advantage. Additionally, how strongly would this selection be based on individual characteristics and developmental progress and how far is this selection the result of socio-economic and other contextual influences?

⁵⁷ Lerner, R.M. (1996) Relative plasticity, integration, temporality, and diversity in human development: A developmental contextual perspective about theory, process, and method. *Developmental Psychology*, 32, 781-786; Elder, G.H., Jr. (1999) *Children of the Great Depression. Social change in life experience*. (25th Anniversary Edition). Boulder, Co: Westview Press

⁵⁸ Rutter, M., and Madge, N. (1976). *Cycles of disadvantage: A review of research*. London: Heinemann Educational Books; Gregg, P, Harkness, S. and Machin S. (1999) *Child development and Family income*, Joseph Rowntree Foundation

⁵⁹ Ferri et al *op cit*

⁶⁰ Saltaris, C., Serbin, L. A., Stack, D. M., Karp, J. A., Schwartzman, A. E., & Ledingham, J. E. (2004). Nurturing cognitive competence in preschoolers: A longitudinal study of Intergenerational continuity and risk. *International Journal of Behavioral Development*, 28(2), 105-115.

⁶¹ Douglas, JWB *The Home and the School*. London: MacGibbon and Kee; Pilling, D (1990) *Escape from Disadvantage*, Falmer Press; Werner, E.E. & Smith, R.S. (1992). *Overcoming the Odds. High risk children from birth to adulthood*. Ithaca: Cornell University Press; Werner, E.E. (1989) Vulnerability and resiliency: a longitudinal perspective. In Brambing, M., Losel, F. and Skowronek, H. (eds.) *Children at Risk: Assessment, Longitudinal Research and Intervention*. Berlin: Walter de Gruyter.

(d) Prenatal influences

- 3.6.** The rapidity of brain development during the prenatal and early postnatal periods implies they are sensitive periods of unique opportunity having implications for the development of children's cognitive skills and abilities. The sensitivity of these periods means that children's future cognitive development is especially vulnerable to the effects of risk factors and environmental adversity. Among the potential risks include the drug and alcohol abuse that are consequences of rising social inequality⁶² as well as less direct effects that can stem from mothers experiencing stressful events whilst their children are *in utero*⁶³. Understanding the relative importance of these periods in relation to those of infancy and childhood (and their interaction) can only be successfully managed by a longitudinal study that features measures taken across all of these periods and across all the levels that can effect the development of cognitive abilities.

(e) Cognitive development in infancy and early childhood

- 3.7.** For the *individual*, the trajectories and pathways leading to social and developmental disadvantage have been shown to begin in infancy and involve: inconsistent acquisition of cognitive, behavioural and social skills; poor attitudes towards learning; propensity to display disruptive behaviour; poor emotional regulation; lack of school readiness. Associated with these are poor socio-economic conditions; prenatal growth; postnatal development; maternal mental health and parental life style; development and educational support; carer responsiveness and stimulation; aspirations. However, the consequences of the formation of such pathways during infancy and childhood affect not just the individual. Rather, the effects of social disadvantage, partly stemming from poor cognitive development and educational attainment, are pervasive and detrimental for the entire *family unit* and are in direct proportion to the severity of this disadvantage⁶⁴. Such effects underlie those observed in earlier cohort study analysis which has shown that social mobility, though differing marginally between countries (with Scandinavian countries showing the highest levels) also remains relatively impervious to the changing policy context, particularly in Britain⁶⁵.
- 3.8.** Recent research has identified the early home learning environment as a powerful influence on children's cognitive development⁶⁶ and developing

⁶² UK Social Exclusion Unit (1999) Bridging the Gap; Bynner, J. (2001) 'Childhood risks and protective factors in social exclusion', *Children and Society*, 15:285-301

⁶³ Anja C. Huizink, Pascale G. Robles de Medina, Eduard J.H. Mulder, Gerard H.A. Visser, Jan K. Buitelaar (2003) Stress during pregnancy is associated with developmental outcome in infancy *Journal of Child Psychology and Psychiatry* 44 (6), 810–818

⁶⁴ Walsh, F. (2002). A Family Resilience Framework: Innovative Practice Applications. *Family Relations*, 51, 130-137; Wood, D. (2003). Effect of Child and Family Poverty on Child Health in the United States. *Pediatrics*, 112, 707-711.

⁶⁵ Breen, R., and Goldthorpe, J.H. (2001). Class, mobility and merit: the experience of two British birth cohorts. *European Sociological Review*, 17, 81-101

⁶⁶ Sammons, P., Sylva, K., Melhuish, E., Siraj-Blatchford, I., Taggart, B., & Elliot, K. (2002). *EPPE Technical Paper 8a: Measuring the impact of Pre-school on Children's Cognitive Progress over the Pre-school Period*. London: DfES/Institute of Education

values including those underpinning the motivation to learn. Previous cohorts did not collect detailed information on the dynamics of family life, but a new cohort study would benefit from efficient interviews that measure everyday activities carried out by family members known to foster the development of both 'hard' cognitive skills (letter recognition) and 'soft' (task concentration) skills. A major goal of a new birth cohort study would be to describe processes within the family that protect or hinder children's development. These include the bi-directional influences in which the child's own agency affects the behaviour of parents and siblings as well as being influenced by them. Relevant factors also include the growing influences of the peer group as the child interacts with others in the pre-school play group and other settings. Electronic media, including the use of computers and the internet, will play an increasing role as the child develops and their influence is like to grow as the time for the new study approaches. All these socialization processes start in the early years and they continue throughout schooling.

3.9. The role of early years' education and care during the crucial period of infancy and the pre-school years has undergone detailed scrutiny by teams of researchers around the world, specifically by the EPPE project within Britain and the NICHD studies originating in the USA. Such research has demonstrated that early years' education can play an important part in protecting against social exclusion and promoting inclusion by offering disadvantaged children, in particular, a better start to primary school⁶⁷. For Britain, such findings directly influence the government's *Sure Start* policies, policies aimed at improving children's development and increasing school readiness. The source of these beneficial influences comes from both the *quality* (especially the relationships between carers and children) as well as the *quantity* of this education that children experience - effects that are independent of children's learning environments at home. In terms of protecting life course trajectories against the powerful influences of adversity, UNESCO⁶⁸ claims that early education can be a part of this protection by complementing the care and education children receive from their families and the wider community. However despite its importance, establishing the effects of early years' education on the life course trajectories of those who 'rise above' adversity is an area of study that could benefit greatly from longitudinal cohort research that features multiple domains of investigation.

⁶⁷ Sylva, K., Melhuish, E., Sammons, P., Siraj-Blatchford, I., & Taggart, B. (2004). *EPPE Technical Paper 12: Effective Provision of Pre-school Education, The Final Report*. London: DfES/Institute of Education.

⁶⁸ UNESCO. (2006). *Strong Foundations: Early Childhood Care and Education*. Paris: United Nations Educational, Scientific and Cultural Organisation.

(f) Educational influences on cognition and skill

3.10. Much is known about the role of education in fostering cognitive understanding and skills⁶⁹, including those related to employment⁷⁰. Britain has one of the most well developed pupil and school databases in the world, allowing a new cohort study access to measures of attainment throughout education but also information about the school context itself, for example: relative economic disadvantage of other pupils in the school, or the proportion of pupils with 'additional' needs. The government's pupil tracking system is well developed and will add value to the other data sources. Earlier cohort studies have established the contribution of demographic factors to children's development; contextual administrative data would provide a fuller picture by linking demographic factors specific to the child and family into the wider school context and identifying those school factors (e.g. size, type, neighbourhood, employment) that promote development or even serve as protection against risk.

(g) Implications for measurement required

3.11. Although the precise specification of the research programme would await the appointment of the research team, it is useful to map out the kinds of influences upon the skills of the developing child that the new cohort study would need to assess. These can be represented as occurring within three broad levels: Those *internal to the child*; those *internal to the family*; and those *external to the family*.

3.12. *Child measures.* These would need to focus upon both biological development as well as the psychological development of skills and competencies.

- From the *prenatal periods onwards*, the validity and value of data collected to assess the development of cognitive and social skills requires the use of well-established objective methods rather than relying solely on parental reports. Whilst the child is *in utero*, visits and/or questionnaires would need to be made to assess the family, maternal and parental functioning prior to birth. Longitudinal research using the birth cohort studies demonstrates that competence in the areas of literacy and numeracy is based on early cognitive development, especially through the visual motor skills that are a pre-cursor of learning to read.
- From *early childhood onwards*, measuring the agency (as reflected in measures of motivation, self-efficacy, and temperament) of both children and their parents represents a

⁶⁹ Sammons, P (1999) *School Effectiveness: Coming of Age in the 21st Century*, Lisse: Swets & Zerlinger

⁷⁰ Hayward, G., Hodgson, A., Johnson, J., Oancea, A., Pring, R., Spours, K., Wilde, S., and Wright. S (2006) *Nuffield Review Annual Report 2005-06*

measurement across child and family levels. The reciprocal effects between child and parent (and sibling) agency on the child's development, family functioning, and family dynamics are only beginning to be understood. A new birth cohort study would provide an opportunity to make a major contribution to this developing field.

3.13. Family measures. These have provided consistent results (such as those relating to the home learning environment⁷¹), a new study would be able to analyse parental and familial attributes with a previously unseen depth and breadth in relation to the *prenatal period onwards* (including genetic effects). Furthermore, this understanding of the determinants of familial attributes would permit a unique understanding of the relationships between familial attributes (such as the home learning environment) and development from *early childhood onwards*. This would include children's cognitive and social skills, educational attainment, behavioural styles, dispositions and values across a variety of environments and social contexts⁷². By using sets of questions identified from earlier smaller scale studies, a new cohort study would be able to assess family functioning to a greater extent than previously possible. Media exposure in the family would also need to be assessed.

3.14. Community measures (and beyond). These can be separated into those pertaining to neighbourhoods and those pertaining to schools. As children grow older, their experience of these external factors changes. For example, the older children get the greater their direct experiences of neighbourhood effects.

- *School (and pre-school) experiences* would need to be studied because of their central role in later cognitive and social development⁷³. During *infancy* and childhood, questionnaires typical of cohort studies and/or, if feasible, school visits featuring interviews and assessments, would be used to ask educational establishments (schools and pre-schools) about the child's behavioural and skill development as well as the nature of the care they provide on an institutional level (indicators and moderators of quality) as well as at an individual level (staff-child relations and individual durations of attendance). The Pupil Level Annual School Census (PLASC) database would have a major role in any new birth cohort study as it would supply school level data such as Ofsted quantitative measures of leadership or teaching. Therefore, ensuring that the necessary permissions were gained for the new

⁷¹ Sylva, K., Melhuish, E., Sammons, P., Siraj-Blatchford, I., & Taggart, B. (2004). *EPPE Technical Paper 12: Effective Provision of Pre-school Education, The Final Report*. London: DfES/Institute of Education

⁷² Melhuish, E.C., Sylva, K., Sammons, P., Siraj-Blatchford, I., Taggart, B., and Phan, M. (in press). Effects of the Home Learning Environment and pre-school centre composition upon literacy and numeracy achievement in early primary school, *Journal of Social Issues*; Douglas, J.W.B. (1964). *The Home & School*. London, MacGibbon & Kee; Parsons, S., and Bynner, J. (1988). *Influences on Adults Basic Skills*, London: Basic Skills Agency; Furlong, J., Furlong, R., Sutherland, R. and Facer, K. (2003) *Screenplay: Children and Computing in the Home* (RoutledgeFalmer: London).

⁷³ Mortimore, P et al. (1988). *School Matter: the junior years*. London: Open Books

study to access this census would be one of the first tasks of the study team⁷⁴. We note however, that the exclusion of children attending private schools from this database presents problems.

- *Neighbourhoods* supply a broad social context in which children develop. They can be both sources of support for families and yet also adversity if associated with delinquency, abuse and crime⁷⁵. Clustering the sample in a new birth cohort study would help ensure the widest possible range of geographical variations and is considered in Chapter 6.

3.15. The multi dimensional scope of a new birth cohort has direct implications for the skills that are needed by the interviewers and field workers. For example, psychometrically trained field workers would be needed for psychological assessment both of children's development and the wider family. At the same time, fieldworkers trained in educational assessment would be needed to assess the provision of education and nurses would be needed to collect biological data. The need for such a wide variety of skills means establishing reliability between these professionals would have to be a central day-today aim of the study.

(h) Implications for design

3.16. Because development does not occur in a linear fashion (and as with other topic areas) early measurement 'after the event' brings sizeable benefits, for example, as soon as possible after pregnancy, after birth, and after a housing move. A first assessment of the child should be made postnatally at 3-4 months of age as this would provide a better understanding of the child's impact on their family than any later assessment as by then many experiences could have influenced the child and the functioning of their family. After this initial assessment of the child, the frequency of subsequent assessments would depend upon age and development of the child with annual assessments being taken throughout the pre-school period. Appendix 3 sets out a possible schedule.

3.17. One of the design implications brought to light by previous studies investigating the impact of risk and protective factors upon child development concerns the benefits of in-depth nested studies. Such work would serve to highlight differences between sub-samples of interest in comparison to the rest of the cohort (such as those identified as being at especially high risk) and whether these individuals' developmental trajectories and family's functioning differed. Furthermore, such investigations would make feasible the incorporation of intervention studies with sub-samples (with those at high risk) to

⁷⁴ <http://www.teachernet.gov.uk/management/ims/datacollections>

⁷⁵ Utting, D., Bright, J., and Henricson, C. (1993) *Crime and the family: improving child-rearing and preventing delinquency*. London: Family Policy Studies Centre; Farrington, D.P. (2000) Explaining and preventing crime: the globalisation of knowledge, *Criminology*, 38, 1-24.

provide a more powerful demonstration of causality than is usually possible with an observational investigation alone. The direct consequence of both these implications is that educational and intervention policies could be influenced on a more immediate basis (and with greater supporting evidence) than that possible if waiting for analyses of the entire sample (though representative) to be completed.

(i) Conclusions

- 3.18.** By incorporating multiple levels of measurement across multiple domains of inquiry, a new birth cohort would be able to make unique contributions to our knowledge and understanding of child development, to government policy (especially through education), and through policy to children's lives that can make an impact based on a more substantial evidence base than seen before. New understanding of the 'learning culture' of the home coupled with contextual information on schools and neighbourhoods could go beyond current cohort studies. Informed by new measurements now available and integration of theories from across the sciences, a new birth cohort study would be the first of its kind to offer valuable and comprehensive understanding of the interrelationships between children, their families, neighbourhoods, and wider communities. This will offer significant scientific and policy advance.

4. Physical Health and Development

(a) Health and the life course

- 4.1. There has long been a concern in the social sciences and economics with the relationship between health and social structure, organisation, opportunity and cohesion, and epidemiologists as well as policy analysts are now also deeply involved in these questions.⁷⁶ Using the life course paradigm in such studies has greatly enriched understanding of how the socio-economic context affects the health of the individual, and has introduced the concept of individual *health capital* that begins a pathway from health in early life to health throughout life.⁷⁷ In Britain research in this area has been greatly and uniquely enhanced by the opportunity to compare life course experiences and the development of health capital over times of considerable socio-economic change, using the existing birth cohort studies.⁷⁸
- 4.2. Life course studies show that slow or poor development at the beginning of life is associated with greater risk of death from and experience of some prevalent adult conditions, particularly cardiovascular disease, and with lower levels of physical function in adult life (e.g. blood pressure, respiratory function), and lower levels of cognitive function.⁷⁹ Poorer social and economic outcomes are also predicted throughout life.⁷⁹ Such findings have been well replicated. As noted in Chapter 2, growth and development take place in windows of unique opportunity, known as sensitive periods, which begin before birth, and are continued and completed through interaction with the postnatal environment. Research continues on whether aspects of development are to any extent reversible after sensitive periods, and of resistance to expected vulnerability associated with development.⁸⁰
- 4.3. Hypotheses have been developed to account for these long-term associations of life time health with early life development, based on the concept of response style and functional capacity established during the early years. The focus extends to the success or otherwise of finding adult environments compatible with those response styles, and responding

⁷⁶ Banks J., Marmot M., Oldfield Z., Smith JP. (2006) Disease and disadvantage in the US and in England. *Journal of the American Medical Association*, 295, 2037-45; Berkman LF, Kawachi I. (2001) *Social Epidemiology*. Oxford University Press, New York; Cornia GA, Panizza R. ed. (2000) *The mortality crisis in transitional economies*. Oxford University Press; United Nations (2003) *Human development report*. United Nations, New York. Hertzman C, Power C (2006) A life course approach to health and human development. In Heymann J, Hertzman C, Barer ML, Evans RG. (Eds.) *Healthier societies: from analysis to action*. Oxford University Press, New York.

⁷⁷ Kuh D, Ben Shlomo Y. Eds. (2004) *A life course approach to chronic disease epidemiology*. 2nd ed. Oxford University Press.

⁷⁸ Ferri E, Bynner J, Wadsworth MEJ. Eds. (2003) *Changing Britain, changing lives*. Institute of Education Press, London.

⁷⁹ Kuh D & Ben Shlomo Y. *op cit*. Pickles A, Maughan B, Wadsworth MEJ. Eds (2007) *Epidemiological methods in life course research*. Oxford, Oxford University Press.

⁸⁰ Feinstein L. (2003) Inequality in early cognitive development of British children in the 1970 cohort. *Economica*, 70, 73-98; Whincup PH, Cook DG, Geleijns JM (2004). A life course approach to blood pressure. In Kuh D & Ben Shlomo Y. *op. cit*. Pp 218-239.

physically and mentally to the challenges they offer. Much of the work involves longitudinal studies begun in adulthood, and in animal studies.⁸¹

- 4.4.** Longitudinal studies have been concerned with the effects of the adult micro-social environment on health (e.g. the Whitehall2 and ELSA studies) and have gone a long way towards explaining the social gradient in health.⁸² They point to early life as the time when the process of embedding social effects into biological processes of growth and development begins, with home and subsequently school, influences. Poor emotional attachment and poor adaptive response in conflict situations signal the beginnings of risk. 'This, in turn, can make the child less easy for caregivers and peers to relate to, which, in turn, can lead to deterioration of the child's immediate social environment, making it more stressful'.⁸³ A biological pathway (the hypothalamic-pituitary-adrenal or HPA pathway) has been identified as explaining how the adaptive and stress responses operate.
- 4.5.** Studies of the macro-social environment show the health risks of living in chronically disordered societies or communities with little social support.⁸⁴ Health problems, as indicated, for instance by reduced fertility and increased infant mortality and suicide rates in countries in the old Soviet Union, rose in prevalence as social stability changed to chronic uncertainty and insecurity.⁸⁵ In Britain growing up in economically deprived areas is associated with reduced life expectancy. Early life in poor countries followed by migration to a developed country is a risk for adult health because, it is hypothesised, that poor diet in early life development is a preparation for a subsistence life, rather than for the diet and life style of the developed economies,⁸⁶ with consequent increased risk of obesity, type2 diabetes and cardiovascular disease. Chronic exposure to psychological stress in early life in some migrants is likely also be a comparable source of vulnerability when exposed to the life style freedom of western nations. New adaptive responses to the effects of globalisation, migration and global warming should be targeted by a

⁸¹ Stansfeld SA, Marmot MG. Eds. (2002) *Stress and the heart*. Oxford University Press: Marmot MG, Elliott P. eds. (2005) *Coronary heart disease epidemiology*. Oxford University Press: Meaney MJ. (2001) Maternal care, gene expression, and the transmission of individual differences in stress reactivity across generations. *Annual Review of Neuroscience*, 24, 1161-92.

⁸² Marmot M, Wilkinson RG. Eds (2006) *Social determinants of health*. 2nd ed. Oxford University Press; Stepoe A, Feldman PJ, Kunz S, Owen N, Willemssen G, Marmot M. (2002) Stress responsivity and socio-economic status. A mechanism for increased cardiovascular risk? *European Heart Journal*, 23, 1757-63.

⁸³ Hertzman C. (2007) Human development, life course, intervention and health. In Pickles A, Maughan B, Wadsworth MEJ. Eds. *Epidemiological methods in life course research*. 118-9 and 115-6.

⁸⁴ Wilkinson RG (2006) Ourselves and others-for better for worse: social vulnerability and inequality. In Marmot M & Wilkinson RG. *op cit*. Berkman LF, Kawachi I. Eds. (2000) *Social epidemiology*. Oxford University Press: Bartley M. (2003) Health inequality and societal institutions. *Social Theory & Health*. 1. 108-29.

⁸⁵ Makinen IH. (2000) East European transition and suicide mortality. *Social Science & Medicine*, 51, 1405-20: Cornia GA, Panizza R. Eds. (2000) *The mortality crisis in transitional economies*. Oxford University Press.

⁸⁶ Barker DJP (1998) *Mothers and babies and health in later life*. 2nd ed. Churchill Livingstone, Edinburgh: Forouhi NG, Sattar N, Tillin T, McKeigue PM, Chatuverdi . (2006) Do known risk factors explain the higher coronary heart disease risk factors in South Asian men compared with European men? *UK Diabetologia*, 49, 2580-88.

new birth cohort study through comparisons with parents of the new cohort and comparisons with earlier cohorts. Outcomes would be measured in terms of growth, development, metabolic, immunological and behavioural responses.

- 4.6.** The macro-social environment may also influence genetic effects. Childhood experience, during a sensitive growth period, of poor harvests in Swedish rural communities was associated in a sex-specific way with longevity in their grandchildren i.e. for grandfathers and grandsons and for grandmothers and granddaughters.⁸⁷ In the ALSPAC study paternal smoking, was associated with greater body mass index in sons.⁸⁸ These findings are argued to be evidence of genetic imprinting in which ‘an imprint tag or epigenetic mark placed in one generation influence(s) gene expression in the next’ generation.⁸⁹

(b) New developments in the health sciences

- 4.7.** Three new developments in the health sciences make it possible to understand far more about the processes of development in early life. Use of these advances would enable a new national birth cohort study to make a new and significant contribution to understanding. The first development is the ultrasound method of measuring physical growth that makes it possible to go beyond present epidemiological methods that impute organ growth from measurements of body dimensions, such as birth weight, head circumference and height growth. Ultrasound makes it possible to measure skeletal, muscle and organ development (e.g. brain, kidney) before and after birth.
- 4.8.** The second new development is the direct measurement of genetic influence which can be quantified from sources of DNA that are easily and cheaply derived from the child studied, and from parents and siblings. Paternal sperm is also coming to be regarded as a carrier of genetic information and of value therefore for trans-generational studies. With such a source of DNA it will be possible not only to study gene/environment interactions, but also the environmental exposures that influence gene expression. This compares with indirect measurement previously carried out in epidemiological research by means of genetically informed designs such as ‘twin studies’.
- 4.9.** The third new development is the measurement of foetal and postnatal inflammatory response to exposure to infections and to environmental chemicals known to be detrimental to development. ‘Chemical exposures during pre and early postnatal life can have important effects on the gene expression, which determines normal development and also predisposes

⁸⁷ Kaati G, Bygren LO, Pembrey M, Sjöström M (2007) Transgenerational response to nutrition, early life circumstances and longevity. *European Journal of Human Genetics*, 15, 1-7.

⁸⁸ Pembrey ME, Bygren LO, Kaati G, Edvinsson, S, Northstone K, Sjöström M, Golding, J (2006) Sex-specific, male-line transgenerational responses in humans. *European Journal of Human Genetics*, 14, 159-66.

⁸⁹ Kaati G. et al *op. cit.*

the individual to disease risks during adolescence and adult life. Many environmental chemicals can alter gene expression by DNA methylation and chromatin remodelling. These epigenetic changes can cause lasting functional changes in specific organs and tissues and increased susceptibility to disease that may even affect successive generations.⁹⁰ The brain is particularly susceptible to toxic exposures during development. Windows of developmental opportunity are also windows of vulnerability to environmental toxic influence and infection that affect, for example, the developing immune and metabolic systems.⁹¹ Pollutants of the indoor environment are thought to affect the risk of asthma, and it has been estimated that in the US, environmental factors acting alone or in combination with genetic factors, cause 28% or more of developmental disabilities.⁹² Studies of the development of the immune system will also be possible with these new measures. Inflammatory responses to toxic exposures and infection have been linked to a range of disease outcomes in mental and physical health, and to sexual development and fertility.

- 4.10.** A new study that included these innovative measures of underlying biological processes would be able to make a unique contribution to unravelling the closely intertwined biological, psychological, genetic, environmental and socio-economic aspects of the developmental pathway. It would provide new information for studies of some prevalent contemporary problems in child health (e.g. obesity, diet, exercise, asthma, allergy), for studies of the impact of the chemical environment on health, for studies of the biological aspects of mental illness and problem behaviour, and for studies of the relationship of biological development with social and cognitive development.
- 4.11.** A new study is needed that has measured what are, by today's standards, all the essential elements. For example no British study has so far systematically investigated gene/environment interactions and gene expression in relation to the most recently developed measures of development and environmental exposure in early life, as described above. In Britain the Biobank, Whitehall2 and ELSA studies have genetic and environmental data which is being related to biological and cognitive measures of ageing, but because each of these studies begins in middle life or later they have to rely on inference and recollection for information about the developing years. Furthermore these studies are oriented towards adult disease outcomes, whereas the proposal here is concerned primarily with developmental and functional outcomes in early life and childhood. The 1946 birth cohort has genetic and environmental data in relation to ageing, and early life measures of growth, and of health and biological and cognitive function throughout life. However its sample size is small for many gene/environment interaction analyses, and it has no information on inflammatory response before middle life. The ALSPAC

⁹⁰ Proceedings of the International Conference on Fetal Programming and Developmental Toxicity 2007; www.pptox.dk.

⁹¹ Landrigan PJ, Trasande L, Thorpe LE. et al. (2007) The National Children's Study: a 21-year prospective study of 100,000 American children. *Pediatrics*, 118, 2173-2186.

⁹² Landrigan PJ. et al. *op. cit.*

study has a wide range of developmental data collected in pregnancy and throughout childhood, together with genetic data. However with the improvements in methods of measurement, much more analysis can now be undertaken with much smaller blood and tissue samples. The ALSPAC sample size is only just large enough for gene/environment interaction analyses, the sample is not truly representative of the UK population and it is suggested that a more detailed set of socio-economic measures should be collected in a new study. Implications for the design of a new birth cohort study are now considered.

(c) Implications for measurements required

4.12. In order to make progress in the social and health sciences in the study of development in early life it is necessary now to have a study vehicle that will provide better measures than have been available before of:

- Physical growth
- Diet and exercise in early life
- Maternal and paternal life style
- Health during infancy and early childhood
- Exposure to environmental chemicals
- Genetic characteristics

Some aspects of these measures may be derived from NHS records. It would greatly increase the value of the study if protocols for all aspects of biological measurement, sampling and sample storage for later use were comparable with those used in other large birth cohort studies elsewhere in Europe and the US.

4.13. Measurement of physical growth will be required before and after birth. Before birth routine NHS ultrasound scans are needed (recorded in digitised form) to measure growth. Similar scans ideally need to be undertaken during the first year of life and once more in the pre-pubertal period; since postnatal scans are not routinely undertaken they would have to be specially set up for the study. In addition conventional anthropometric measures of the mother (and ideally also the father) should be made twice during pregnancy, and of the child at birth, 6 months, 1 year, and thereafter annually.

4.14. Other important child measures include infant feeding and diet during the preschool years together with information about exercise habits. Ideally breast milk samples and blood samples should be taken for nutrient analysis. Measures of the child's health during the pre-school years, in addition to measures of growth already described, would include biological function (e.g. blood pressure, respiratory function). Information on illness, disability and injury, and on treatment, should be available electronically from NHS records.

- 4.15. Parental measures include life styles (smoking, diet, alcohol consumption, drug use and exercise) best measured in the prenatal period, including the pre-pregnancy years and in the postnatal period.
- 4.16. Measures of the chemical environment include those taken in homes before and after birth, and exposure to outdoor pollution. Biological indicators of exposure and reactions to exposure include those constructed from samples of cord blood and placenta taken at birth, and from blood, hair, and urine samples taken during infancy and childhood, and from discarded milk teeth.
- 4.17. Sources of genetic data include blood and saliva samples taken from the mother, the child and if possible the biological father, preferably during the pregnancy and ideally a sperm sample from the father. Genetic information from siblings will also ideally be collected at an early stage in the study

(d) Implications for study design

(i) Frequency and mode of biomedical data collection

- 4.18. The mode and frequency of the biomedical measures taken during the prenatal, post natal and subsequent periods include:

Prenatal

It should be possible to collect from antenatal clinic records two routinely taken ultrasound scan measures for most mothers. Anthropometric measures of both parents should be made either at an antenatal clinic or home visit. Maternal blood samples routinely taken at antenatal clinics would need to be augmented for the study purposes, e.g. for measurement of environmental chemical exposure, and nutrient analysis.

At birth

Anthropometric measures taken at birth would be those usually routinely undertaken, but some augmentation may be necessary. Samples of cord blood and placenta would be taken especially for the study.

Postnatal

Ultrasound scanning in infancy would have to be undertaken specially for the study at clinics, but anthropometric measures, blood sampling and measurement of blood pressure and respiratory function could be undertaken either at routine immunisation clinics, or at home visits made by research nurses.

(ii) Other data collection during pregnancy

- 4.19. At last one interviewer home visit and a supplementary postal questionnaire, will be needed in addition to the data collected three times i.e. in each trimester by antenatal clinic staff. Almost all biological measures in the preschool years (e.g. anthropometric measurement,

blood sampling, measurement of blood pressure and respiratory function) could be undertaken at routine clinic visits for immunisation, with home visit supplementation for those who did not attend for immunisation. It would be important to ensure that these measures were carried out to the study's protocol specifications. A clinic visit would be necessary for an ultrasound measure in the preschool years. In addition there would be a considerable flow of data from medical records, which would make good use of the NHS 'Connecting for Health' programme.

(iii) Sampling frame

- 4.20.** The national antenatal screening system would be a suitable sampling frame. Sample size considerations should be driven by the immediate needs for gene/environment interaction studies, rather than from considerations of the likely experience of particular illnesses. An area based sample would have advantages for health aspects of the study in terms of being able to get NHS staff 'on side', involved in the study, and prepared to use the study measurement protocols.

(iv) In depth studies

- 4.21.** The proposed data collection would be designed primarily to provide a strong basis for the multidisciplinary study of development, but it would also provide a framework from which samples might be taken for in -depth health studies, for example of obesity, and of the development of the immune and metabolic systems. Although numbers of cases of some types of serious illness and disability might be small, case and control(s) analysis within the cohort data set would be used, as well as pooling with comparable data currently being collected in the other new birth cohort studies beginning elsewhere in Europe and the US.⁹³

(e) Conclusions

- 4.22.** The primary scientific question for which biomedical measures are required in a new birth cohort study is how do the environmental and genetic influences that shape development, knit together to determine the unique developmental outcomes that will throughout life influence pathways in health, cognitive function and behaviour? The proposed new biological measures would provide uniquely valuable and innovative information for the social and biological sciences to address that multidisciplinary question.
- 4.23.** The biomedical data collected would also be of great value for two other purposes. The first additional value would be to provide markers, for comparison with cohorts born at other times and in other places, of the impact of macro-social change. The second additional value of the biomedical data would be to add to the developing international pool of developmental data (e.g. the scientific infrastructure proposed in EU

⁹³ Stoltenberg C, Pickles A. (2007) Designs for large life course studies of genetic effects. In Pickles A, Maughan B, Wadsworth MEJ. (Eds) *op. cit.* Pp 81-109. Landrigan PJ. et al. *op. cit.*

Framework 7 for a European wide data bank, and the Canadian Public Population Project in Genomics at <http://www.p3gobservatory.org>) that will be essential for gene/gene interaction and proteomic studies, particularly those that can also take account of environmental factors.

4.24. The current priorities should now be to fund:

- expert groups to plan the scientific questions in greater detail and to discuss scientific plans with principal investigators of the large birth cohorts studies elsewhere in Europe and the US, to discuss plans with paediatricians, obstetricians and NHS staff who run antenatal and immunisation clinics, and to undertake preparatory systematic reviews.
- pilot studies to address how to collect the data and ensure the highest quality, and how to design and present data collection methods that maximise willingness to participate and acceptance of the use of medical and other administrative records. These are key concerns now that survey response rates are falling and suspicion about use of central data bases is rising.

5. Emotional, Behavioural Development and Well-being

(a) Introduction

- 5.1.** Awareness of both the extent and the public policy significance of mental health problems has increased markedly in recent years. Current estimates suggest that one in ten children show clinically significant psychiatric conditions⁹⁴, with disadvantaged groups such as young offenders or children in the care system much more severely affected. In adulthood, that figure rises to one in six. The burden of these problems on individuals, their families and the wider society is huge: by 2030, depression is projected to be the leading cause of DALYs (disability adjusted life years) in high income countries world-wide⁹⁵. At a time when economic growth has contributed to major improvements in material circumstances and increased life expectancy, many individuals' sense of security and well-being appears to have declined. In Britain, these issues have been highlighted especially starkly: cohort comparisons show that rates of mental health-related difficulties rose among both adolescents and young adults in the later years of the last century⁹⁶, while international comparisons place Britain low in the ranking of rich nations on a range of indicators of child and adolescent well-being⁹⁷. Though much research on mental health problems focuses at the individual level, these simple findings provide powerful - if dispiriting - evidence that broader social factors must also play a major part.
- 5.2.** A new birth cohort study provides the ideal framework within which to advance understanding of these issues - and also to study the foundations of psychological well-being. Current evidence suggests that vulnerability to poor mental health - in which we include both emotional difficulties such as depression and anxiety, 'externalizing' problems such as ADHD, conduct disorder and drug and alcohol abuse, and rarer, more severe disorders such as autism and schizophrenia - can be laid down from the earliest stages of development, and that risks cumulate across the life course. Longitudinal data are thus crucial to understanding the unfolding of both positive adaptation and adjustment, and the roots of disorder and distress. The early stages of a new cohort study would provide new data on risk and protective factors for emotional and behavioural development in childhood – a period when problems in behavioural development can impede learning and school progress, impact on relationships with peers, and set individuals on the early

⁹⁴ Green, H, McGinnity, A, Meltzer, H, Ford, T & Goodman, R. (2005). *Mental health of children and young people in Great Britain, 2004*. Basingstoke: Palgrave Macmillan.

⁹⁵ Mathers, C.D. & Loncar, D. (2006). Projections of global mortality and burden of disease from 2002 to 2030. *PLoS Medicine* 3, 2011-2029.

⁹⁶ Collishaw, S., Maughan, B., Goodman R. & Pickles, A. (2004) Time trends in adolescent mental health. *Journal for Child Psychology and Psychiatry*, 45, 1350-1362; Schoon I, Sacker A, Bartley M. (2003). Socio-economic adversity and psychosocial adjustment: a developmental-contextual perspective. *Social Science & Medicine* 57, 1001-1015.

⁹⁷ UNICEF (2007). *Child poverty in perspective: an overview of child well-being in rich countries*. Florence: UNICEF

stages of negative trajectories that are increasingly hard to re-orient with time. In the longer-term, these early data would also provide a crucial basis for understanding well-being in adult life. Existing longitudinal studies have already demonstrated that much mental distress in adulthood has roots in childhood disorders⁹⁸, and that later life difficulties in relationships, in employment, and even in physical health, are impacted by early socio-emotional development. In a similar way, adverse experiences in childhood – exposure to stressors, or to less than optimal parenting – are also known to contribute to long-term psychological vulnerability. Mapping these influences early in development should lay the foundations for valuable advances in our understanding of psychosocial development across the life course.

- 5.3.** Birth cohort studies have already made major contributions in the mental health field⁹⁹, and recent years have seen rapid advances in many of the disciplines involved in mental health research. Each of these sources emphasizes the need to combine measures of both social and biological influences within a developmental frame. A new cohort study would be well-placed to build on these gains to study the emergence of risk and resilience in the new conditions of 21st century Britain. We sketch in here just some of the more important issues a new study could be designed to address.

(b) Prenatal influences

- 5.4.** Brain development is rapid - and so especially likely to be vulnerable - in the pre-natal and early post-natal periods. Evidence is now fast accumulating that adverse environmental exposures during these sensitive periods have powerful effects on the mechanisms underlying stress responsivity, with effects that persist across development. Recent studies suggest, for example, that some 15% of children's vulnerability to emotional and behavioural difficulties may be traceable to maternal stress in pregnancy, with animal models pointing to mediation via effects on the stress-responsive HPA (hypothalamic-pituitary-adrenal) axis in both mother and child¹⁰⁰. Though the most salient stressors are unknown at this stage, problems in relationships with partners have already been identified as likely to play an important part. Maternal life-style factors such as smoking and drinking in pregnancy have also been implicated in risk for behavioural outcomes, and low birthweight and length of gestation have been associated with later increased risk for depression. A new study beginning in pregnancy and including contemporaneous measures of mothers' own mental health, life-style and exposure to stress could add importantly to work in this area.

⁹⁸ Rutter, M., Kim-Cohen, J. & Maughan, B. Continuities and discontinuities in psychopathology between childhood and adult life (2006). *Journal of Child Psychology and Psychiatry* 47, 276-295.

⁹⁹ Colman I, Jones PB. (2004). Birth cohort studies in psychiatry: beginning at the beginning. *Psychological Medicine* 34, 1375-1383.

¹⁰⁰ Talge, N.M., Neal, C. & Glover V. (2007). Antenatal maternal stress and long-term effects on child neurodevelopment: how and why? *Journal of Child Psychology and Psychiatry* 48, 245-261.

(c) Gene-environment interplay

5.5. Studies in the psychiatric arena have been in the forefront of research on gene environment interplay. For many years, epidemiological studies highlighted an apparent paradox: though adverse early experience and other life stressors are strong risks for disorder in some individuals; others appear to remain resilient even in the face of major stress. Integrating genetic markers into studies of psychosocial risk has allowed for important progress here: in part, individual differences in sensitivity to social adversity are now known to be associated with genetically-based variations. Gene-environment interactions of this kind have already been reported in a number of contexts: in relation to stressors as varied as child maltreatment, adverse life events, heavy early use of cannabis, and maternal smoking in pregnancy; and outcomes spanning antisocial behaviour, depression, schizophreniform features and ADHD¹⁰¹. As knowledge of the genetic variants implicated in mental health problems expands, a new cohort study would be ideally placed to contribute to this important vein of research.

5.6. In addition, new work emanating from animal studies is now highlighting a further key type of gene-environment interplay: epigenetic changes whereby early environmental exposures affect the expression of key genetic influences in the young. Using animal models, Meaney's¹⁰² work on the effects of early maternal care in rats is now a classic example of an epigenetic event (methylation) affecting gene expression in offspring: in these studies, variations in the amount of nurturing early maternal care have been found fundamentally to alter the expression of genes involved in the stress response system and the reward mechanisms that may underlie attachment and bonding. Nothing is known as yet of the effects of prenatal stressors on the offspring's DNA – but it seems very likely that events in pregnancy may also have significant epigenetic consequences. At this stage, pursuing these insights in human studies presents challenges, as it is unclear how far hypothesized effects on brain mechanisms can be detected in readily accessible biological samples. Experts in this field conclude, however, that it should soon be possible to obtain useful information; establishing the extent of similarities and divergence in gene expression and regulation between brain and blood is the subject of ongoing studies, and work in the next year or so is predicted to yield rapid advances. A new cohort study beginning in the second decade of the 21st century should thus be ideally placed to contribute to this exciting new area of research.

¹⁰¹ Rutter, M., Moffitt, T., & Caspi, A. (2006). Gene–environment interplay and psychopathology: Multiple varieties but real effects. *Journal of Child Psychology and Psychiatry*, 47, 226-261.

¹⁰² Fish EW, Shahrokh D, Bagot R, Caldji C, Bredy T, Szyf M, Meaney MJ. (2004). Epigenetic programming of stress responses through variations in maternal care. *Youth Violence: Scientific Approaches to Prevention Annals of the New York Academy of Sciences* 1036: 167-180.

(d) Emotional/behavioural development in infancy and childhood

- 5.7.** After birth, trajectories of children's emotional and behavioural development are then seen as the cumulating, mutually-influenced outcome of the interplay between the child's temperamentally-based characteristics and aspects of the psychosocial environment. As outlined in Chapter 2, bioecological models conceive of this environment as involving a variety of levels of influence, varying in their proximity to the child. At the most proximal level, relationships with parents and other immediate caretakers are key in the earliest years of childhood; as children develop, so their social worlds expand to involve relationships with adults in other childcare settings; with teachers; and - possibly especially importantly in adolescence - with friends and peers. Each of these proximal levels of influence is likely to be shaped by more distal factors: social and family position and material advantage on the one hand, and neighbourhood, community and wider cultural and societal features on the other.
- 5.8.** At the centre of this nexus is the family, whose aspirations, resources and approaches to the care of children constitute the core influences on development in the early years. As we have seen (Chapter 2), many domains of family life – spanning variations in family structure and stability, in family poverty, indebtedness and wealth, and in the supports for, and stresses on parents – are now known to show an impact on trajectories of children's socio-emotional development. As we have also seen, in recent decades many of those same domains have been subject to massive secular change. Tracing effects of those changes constitutes one key impetus for a new cohort study. In relation to more proximal influences, past research has also identified dimensions of the immediate care-giving environment that seem especially likely to compromise positive emotional and behavioural development in childhood. These include environments that lack ongoing, harmonious and committed relationships; that are disorganized, unpredictable or inconsistent; harsh and punitive; dangerous or anxiety-provoking; severely lacking in stimulation; or lacking in sensitive responsiveness to children's developmental needs. Later in development, while the quality of relationships continues to be important, monitoring and supervision of young people's activities becomes of increasing salience. Wider social influences associated with peer groups, schools or communities may also be influential for the ethos and attitudes that they engender - and seem especially problematic when they are lacking in social cohesion. Findings of this kind also direct attention to the factors that may bear on caregivers' capacity to provide positive environments for children: parents' own mental health and personality characteristics; the stability and support available within the family; stresses on parents - including those emanating from social and material disadvantage; and the ways in which, for example, variations in neighbourhood and community cohesiveness go to reinforce or challenge families' own styles of

parenting, or in adolescence include deviant or delinquent peer cultures that prove strong influences on the young.

- 5.9.** To date, much research on children's emotional/behavioural development has focused on understanding the roots of 'problematic' outcomes, and on protective factors that may promote resilient functioning in face of adversity. More recently, interest has also been expressed in the 'positive' end of the spectrum of psychological functioning: in psychological well-being, the development of self-worth, and the foundations of positive relationship capacities. To date, much less is known about the key contributors to these features, and debate continues on whether they lie on the same dimensions (individual, familial or social) as risk factors for poor outcomes, or whether quite different parameters may be involved. As conceptual models of well-being evolve, and measurement strategies improve, a new cohort study could make an important contribution to this fast-growing field.
- 5.10.** There is still much to be learned about the inter-relationships among differing levels of influence on early emotional/behavioural development in the context of modern family constellations, relationships and life-styles, and in a society marked by increasing cultural diversity and an apparent decline in social cohesiveness. Past birth cohort studies have made important contributions here, and more recent ones continue to do so: recent findings from ALSPAC, for example, have underlined the importance of fathers' mental health for child well-being, while early findings from the Millennium Cohort Study have shown that as early as age 3, parents' own assessments of their children's emotional and behavioural development vary systematically with parental education; material and social disadvantage; family type; and ethnic background¹⁰³.
- 5.11.** Tracing the roots of these early social disparities is of central importance in both scientific and policy terms; assessing the extent to which the numerous policy initiatives now being put in place to support families can indeed make inroads into these early social gradients is a key task for future research. In addition, as the MCS study team note, relying centrally on parents' ratings of their children's behaviour, and accounts of their parenting raises important methodological issues: in part, associations among such measures may reflect shared method variance, or variations in educational and cultural background factors and expectations. To maximize the potential of a new study to address these issues, our respondents highlighted a number of methodological improvements/innovations that should be included in a new cohort study. We conclude by outlining some of these.

(e) Implications for measurements required

- 5.12.** Prenatal assessments: in addition to the measures of maternal life-style factors outlined in Chapter 4, studies in the mental health arena would

¹⁰³ Millennium Cohort Study Second Survey: A User's Guide to Initial Findings: www.cls.ioe.ac.uk
Hansen, K. and Joshi, H. (2007)

benefit from assessment of mothers' exposure to both acute and chronic stressors in pregnancy; more detailed assessment of mothers' own mental health at this stage (as mechanisms of transmission may vary with the types of difficulty mothers themselves experience); and indicators of the hormonal pathways that may be implicated in these effects.

- 5.13.** Early measures of child temperament – ideally taken within the first 3-4 months of life, before the effects of post-natal environmental influences become marked – would provide an important basis for understanding later developmental trajectories. Maternal reports provide one key source of information here – but, as outlined earlier, also raise measurement issues. Independent assessments – perhaps in sub-samples of the full cohort – could provide a valuable adjunct here.
- 5.14.** More generally, attention will need to be given to the type of measurement strategy to be adopted in assessing early behavioural/emotional development. Two main traditions of individual assessment can be identified in mental health research: (i) dimensional, questionnaire-based measures, often used as screening instruments in large-scale studies; and (ii) more detailed interviews and observational techniques, typically used to derive categorical indicators of disorder¹⁰⁴. To date, UK cohort studies have generally focused on the first of these, though adaptations of diagnostically-oriented measures have been used in some instances – and are increasingly being developed for use in web-based applications. One key issue for discussion in relation to a new cohort would be the extent to which more detailed assessments would be valuable in relation to disorders of particular concern (such as, for example, ADHD in childhood, or depression in adolescence) – either in the full cohort, or in selected sub-samples.
- 5.15.** Similar considerations apply to assessments of key aspects of parent-child relationships and styles of parenting. Brief reports from caretakers (and later from children and young people themselves) provide important insights here, but also have inevitable limitations. Increasingly, standardized assessments (based, for example, on observations of parent-child activities or tasks) are being developed that would allow for extensions in selected issues of particular interest.
- 5.16.** Increasingly, today's young children are cared for in a range of pre-school settings: in group-based day care, but also by grandparents and other 'informal' carers. 'Quality' of care has emerged as central to developmental outcomes here – and studies are increasingly moving towards a clearer understanding of what, in different circumstances, that involves. Assessing the nature as well as the extent of early child-care settings would add importantly to our understanding here; later in development, psychosocial aspects of school environments, and

¹⁰⁴ Costello, EJ, Egger, H, Angold, A (2005). 10-Year research update review: the epidemiology of child and adolescent psychiatric disorders: I. methods and public health burden. *Journal of the American Academy of Child & Adolescent Psychiatry*. 44, 972-986.

relationships with teachers and peers, as well as administrative data on school characteristics, would extend current knowledge in similar ways.

5.17. The characteristics of children's peers, as well as the nature of their relationships with them, are important influences on psychosocial development from early childhood onwards – and become especially key in adolescence. Parent (and later child) reports in these areas would thus form a key complement to assessments of family-based influences from early in development. If feasible, sociometric assessments of children's status within the peer group could add further to developmental understanding.

5.18. Neighbourhood characteristics can be assessed in a variety of ways: through the increasing range of standard deprivation and other indices that can be linked to individual records via geo-coding, and through participant reports of neighbourhood characteristics, cohesion and disorder.

(f) Implications for design

5.19. While many of the suggestions outlined above could be pursued within the context of a large-scale cohort study, others would be likely to be too resource-intensive, and/or raise problems of respondent burden. One solution to this dilemma would be to 'nest' more detailed studies of selected sub-samples (selected either on a random basis, or purposively, given the topic of interest) within the overall design.

5.20. A further design possibility, highlighted as attractive by a number of our informants, is the inclusion of population-based intervention studies within a cohort design. The rationale for this proposal is two-fold: first, to provide a more direct means of investigating causal mechanisms than is feasible in passive observational studies; and second, to provide information of immediate relevance to policy. To date, most studies of this kind (examining, for example, parent training programmes or school-based interventions) have been conducted in relatively selected samples or settings; extending work of this kind to general population samples, or in contrasting neighbourhoods, could have considerable appeal.

(g) Conclusions

5.21. A new cohort study of behavioural and mental health outcomes that allowed the influence of prenatal risks to be taken into account together with genetic effects and environmental characteristics of the neighbourhood, family, peers and pre-school and school settings, would present a uniquely valuable range of new research opportunities.

6. Design issues

(a) Introduction

- 6.1. Previous chapters have assessed the scientific case for a new birth cohort study that builds on the successes of the previous five. The case resides in the scientific programme that the new study would support taking advantage of the advances in scientific knowledge, methodological development and improved data accessibility since the last (Millennium) cohort study began. It was argued that a new study could make considerable progress in understanding the complexity of development, and how the processes involved interact with the physical and socio-economic environment, and the child's genetic endowment. Each of the substantive chapters, on cognitive development (chapter 3), physical development (chapter 4) and emotional and behavioural development (chapter 5) emphasizes the interconnectedness of developmental processes, and show how a new study would help to make good the gaps in scientific knowledge about them. The chapters also make clear that the quality of studies of outcomes in adolescence and adulthood will depend on the quality of data collected in the early years, and how well sample integrity has been maintained.
- 6.2. These considerations enable us to identify the key requirements that the design of the new birth cohort study would need to meet:

Representativeness:

For inferences for the whole UK population, probability sampling will be needed for robust parameter estimates, including minority population representation of adequate numbers for analysis. Continuity in the cohort studies series as a whole, demands generalisability across time as well, which similarly requires probability sampling.

Bio-ecological depth:

To encompass the range of interacting contexts with developmental indicators from the earliest possible age area-based ecologically rich data will be needed in the sphere of:

- the family, including siblings, and grandparents outside the home, including peers and significant adults
- the nursery and primary school, including teachers and classmates
- the community, including institutions and services, local facilities such as parks, community centres and playgroups

Capable of assessing gene-environment interaction

This implies a substantially larger sample than used previously to embrace the huge range of variation involved. It also points to the need for collection of DNA at the earliest opportunity and a range of

biomedical and social and physical environmental data pre- and post-birth, both on the mother and the developing foetus.

Utilising the widest range of relevant data

Requires the best use of instruments for measurement in the biomedical, social, cognitive and behavioural domains and of family and other contexts. It also means drawing on the widest range of relevant administrative and medical record data through local and national links to relevant databases, subject to relevant ethical clearance.

Ensuring data quality

Requires the highest data collection standards applied in clinical settings and in the family home conducted by highly trained personnel

Maximising recruitment and minimising drop out:

Requires effective strategies for persuading prospective respondents about the value of the survey and maintaining regular contact with them in between surveys to ensure their sustained interest. It also implies the collection of relevant data about non-respondents and refusers to enable imputation of missing data.

Adequate time for preparation

Requires a lead time, which will enable all necessary organisational arrangements with local institutions, data providers and so on to be put in place well ahead of main fieldwork. This will include piloting ideally with a longitudinal component to ensure that all factors affecting response and drop out can be adequately identified and necessary enhancements to procedures made.

Complementarity to UKHLS (via births to panel members)

This demands harmonisation of basic core demographic information and approaches to measurement of common indicators between the two surveys.

(b) Sample design and structure

6.3. The earliest birth cohort studies were unusual in relying on a sample of births which was effectively a census of all births in Great Britain (Northern Ireland was excluded) taking place in a particular week, approximately 17,000. The approach has been varied in two ways. First the ALSPAC study (starting in 1992) rather than seek to represent the population as a whole, focussed on a single area, in what was then the administrative region of Avon in which all pregnancies were collected over two years, approximately 12,000. Reflecting the increasing interest in ecological effects in development, that is to say those stemming from the neighbourhood and the wider locality plus interactions with peers, the Millennium Cohort Study (MCS) adopted what is best described as a 'weak' clustering approach. A sample of 400 electoral wards disproportionately stratified in terms of deprivation indicators and ethnic

minority composition and the four UK countries, supplied to the study all births taking place over a period of 15 months, 21,000.

- 6.4.** A major question that confronts the designers of any new birth cohort study is which sample design model to pursue, independently or in combination: area based or nationally representative with various degrees of clustering in between. Some of our informants argued against the need for further representative sampling (of the one week census kind) in favour of a highly clustered series of area studies in which all births taking place in each area would supply the sample. The ALSPAC study and especially such studies in New Zealand as Dunedin and Christchurch show how much scientific productivity can be obtained from such an approach, not least because of the linkage between individuals as they grow up and the local institutions and networks to which their families relate. This has the scientific merit of comprehensiveness of experience (at least in principle) as well as practical value because of the relationships which can be built with local suppliers of data relating to the cohort's development in the medical and social services. It also supports replication strategy in which hypotheses supported in one area can be confirmed or disconfirmed in others. The area approach can also ease such problems as attrition because of the enhanced sense of ownership of the study that local participants feel.
- 6.5.** Other respondents argued equally trenchantly for the need for national probability sampling, albeit with degrees of clustering for efficiency purposes, on the grounds that departure from this principle would break continuity in the birth cohort study series based on national samples, (i.e. the one weeks birth samples and the MCS clustered sample of which the new study would be part. There is also a need particularly for national policy purposes to have robust population parameter estimates of both the prevalence of key variables and the relationships between them. A national survey also guarantees high quality data and integrity through a standardised approach, i.e. a single protocol of questions directed at all sample members, professionally trained interviewers to collect the data and a national organisation in place to manage the survey.
- 6.6.** Thus each approach has its strengths and weaknesses, which relate directly to the kinds of scientific questions that are to be addressed: highly clustered samples gain in ecological depth and replication potential, but when converted into free-standing area studies lose generalisability. Operating outside the clearly defined principles of the probability sampling framework, the selection of clusters and deciding the precise boundaries defining them are also problematic, i.e. administrative boundaries versus school or GP catchment areas - the possibilities are endless. Then again how many clusters are optimum for the scientific purpose? The more the number of clusters in the sample expands, under a cash-limited budget for the survey, the smaller the number of respondents in any one of them.

- 6.7. The principal weakness of the probability sample is its dispersion across the contexts, that shape the developmental factors of interest. Thus for example, one or two sample members only are likely to fall in many schools, making any establishment of 'school effects' on the child's development impossible to determine. The 'context' in the national probability sample is the country as a whole, whereas development itself takes place in the confines of relatively small geographical areas.
- 6.8. The challenge is to find a balance between the two competing requirements implicit in these contrasts. The solution that we think should be pursued involves not one or other approach but both approaches in combination. We have considered three options for this which are discussed below.

(i) Clusters leading to area studies

- 6.9 Given our premise that a national probability sample must be a major component of the design attention here is directed at the role of clustering within the design, either as part of the probability sample or independent of it. We believe that the choice of clustering designs reduces to the following three:
1. *A probability sample of some 50-60 clusters, with about 1000 in each cluster that would provide both the information for national estimates and comparability with previous cohorts.* In this model there would be a choice between a fully centrally coordinated and implemented study with a single team, and a set of perhaps 3-4 teams each responsible for a set of clusters, determined geographically. The latter choice would allow some diversity of data collection and encourage replication. This design has some similarities with that of the US National Children's Study, with the advantage that population estimates are available. Its major disadvantage is that the number in each cluster would make it difficult to sustain useful context measurements, e.g. peer groups.
 2. *A probability sample of some 20-25 clusters, with 2000 – 3000 in each cluster, augmented with a large national sample selected in similar fashion to previous cohorts, but over the longer time period of a year.* The US Fragile Families study has some comparability with this approach, though the US sample is restricted to 20 cities and the numbers in each city cluster is much smaller, approximately 1000 in each. The national sample here is important for providing efficiency in national estimation. Allocation of teams would be along similar lines to the first option. This design would be more useful for measuring contextual effects.
 3. *A non-probability sample of 2-6 clusters together with a large nationally representative sample.* A cluster could be a geographically compact area such as in ALSPAC, or a combination of London boroughs, or it could be a geographically coherent but

large area such as a shire county or region and would have its own study team. The clusters would be able to contribute to national estimates through common measures across all components. In this option one emphasis is in terms of scientific replication. The other emphasis lies in the diversity of 'embedded' specialist investigations of development in the wide range of interactional settings available within clusters in addition to the collection and sharing of common data. This would address the issue of respondent burden. It is envisaged that the choice of clusters is based upon a tendering process from groups whose proposals would be accepted on their scientific merit, bearing in mind the need to ensure diversity of approach, within a common investigatory framework. The disadvantage of such a design is that it is untried and would require a fairly high level of sophistication at the analysis stage.

6.10 Each of these models would need strong coordination to ensure adherence to a basic common data protocol. Analysis would be centrally coordinated but locally carried out by cluster teams. Although the first two designs could be modified so that there was a hierarchical management structure with centralised analysis, it would seem preferable to spread responsibility and hence motivation. Each cluster team additionally could pursue its own special interests so that results and experiences from these would be available across clusters. The design is scientifically attractive in that findings in one cluster or group of clusters could readily be replicated in other clusters and this would need to be encouraged. The team responsible for the national probability sample would be the obvious candidate to undertake the coordinating role. As noted previously another important aspect of local clustering is that it should allow better incentives for participation. It will allow local knowledge to be used to encourage participation and reduce attrition, as has been found in ALSPAC. This is particularly the case with option 3.

(ii) Sampling frame

6.11. Evaluation of sample design options is greatly aided by the availability of a national database which meets many of the other design requirements of the study. The GP pregnancy register built from GP notes of first visits of women for diagnosis of pregnancy currently encompasses 80% of all pregnancies notified to GPs. The consequence of the visit is referral of the pregnant women to an antenatal clinic for first clinical examination and ultra scan usually within the first 11 weeks of pregnancy, which again forms a 'screening' record that goes into a national database. One possibility in using these data sources as a sampling frame is to take in effect a census of all pregnancies recorded over the given study year and request additional information e.g. basic demographics from the mother and the family and the neighbourhood for the special purposes of the study.

- 6.12.** The existence of such a sampling frame would enable all relevant variations in the design of the possible sample to be encompassed. Thus a national probability sample could be drawn from the frame, clustered in any way decided as appropriate to the finally agreed scientific programme on top of that provided by the natural clustering through GPs or clinics. For example, much broader clusters could be identified through administrative boundaries such as local labour markets or local authority areas as determined by best anticipated scientific returns. The development phase of the project would clearly be invaluable to test out different possibilities as well as offering the opportunity, at a national and local level, to increase the co-operation of GP's and to assess and improve the quality of the data recorded by each of them.
- 6.13.** Three visits to an ante natal clinic are usually made during pregnancy – one in each trimester with the first at 11 weeks. The information recorded at each visit could remove the need for any home visit to the mother in advance of birth though the possibility could be considered for a visit to collect just basic information from the selected sample, including blood and dietary information. The essential requirement for this procedure would first be to have the full cooperation of all GPs, especially those in the selected sample and secondly that of the ante natal clinics.

(iii) Sample size

- 6.14.** With each of the three options discussed above each cluster or group of clusters would require a sufficiently large sample to carry out useful local analyses, although in many cases strength could be borrowed from joint analyses. Based upon the experience of the 1946 cohort in particular this suggests a minimum of about 5000 for each area cluster to allow worthwhile analysis. As noted earlier, however, especially for certain kinds of genetic analyses larger samples would be required and we would therefore suggest some flexibility so that samples up to 10,000 could be envisaged in some cases. In addition, for options 2 & 3, a random national sample of 15,000 – 20,000 births should be selected so that national population estimates could be produced either very straightforwardly, or more efficiently, combining with the clusters. The size of the national sample will also be large enough to be used for regional estimates. It is also important to have a nationally representative sample, both to link the cluster data to national estimates and to include units that may be unrepresented within the clusters. If six clusters were chosen, and the numbers suggested for options 1 & 2 were used, this would lead to a total sample of size between about 50,000 and 80,000. It might also be an option for cluster teams to bid for resources to enhance their basic samples. The target sample sizes suggested above incorporate the recognition that non-response and attrition will inevitably lead to smaller samples available for analysis over time.

(iv) Oversampling specified groups

6.15. It has been pointed out that certain groups of importance such as ethnic minorities will not be well-represented in a general population sample. While the notion of oversampling certain identified groups has some appeal, we see some real difficulties with such an idea. First, it is difficult now to predict which groups will be 'minorities' in 5-10 years time. It is also difficult to know whether those minority groups that are regarded as important in 5-10 years time will remain so throughout the life of the cohort; it seems unlikely that they would be. Giving priority to a small number of such groups, therefore, is likely to come to be seen as a misdirection of effort. For these reasons we have not pursued this idea, though following the MCS precedent for strengthening the representation of disadvantaged groups would not rule it out entirely.

(c) Timing of data collection

6.16. Options here include the period over which births (or pregnancies) are collected, and the timing of first contact with the mother. The choices between them will be driven first by the scientific agenda and secondly by practical constraints such as fieldwork capacity.

(i) Sampling over time and ages

6.17. The MCS was able to spread its initial data collection over a relatively long period, and this has certain administrative advantages. It also has scientific advantages in that seasonal effects can be estimated and controlled for. Traditionally in cohort studies the interval between follow-ups has been the same for all sample members. The advantage of this design is that it provides a straightforward framework for analysis. One of the difficulties with such a design, however, is that there is no information available for intermediate ages. An alternative is to vary the interval between follow-ups across the cohort members. While this would reduce the sample size at any given age this could be mitigated by 'borrowing strength' across the sub samples to enhance the information at any one age. A particular advantage is that different ages tend to be important for different aspects of development so that a staggered age sampling would enable more critical events to be captured. Any decision on this can be postponed to the pilot stage. Another possibility that has been suggested is to have several (Quasi-sequential) 'cohorts' each starting at a different age; for example at birth, at time of infant school entry and at time of secondary school entry. This has certain attractions in that it allows limited longitudinal information to become available for the later ages earlier than for a single birth cohort. The problem is that the absence of earlier data for the later aged cohorts is serious given the known importance of the earlier years. Accordingly in terms of scientific returns we think that the best prospect lie with the (whole life) birth cohort study starting at birth or in pregnancy.

(ii) Pregnancy sampling

- 6.18.** For a birth cohort study there are four options for recruitment to the study and starting data collection: post birth; at birth; during pregnancy; at conception. The 1946, 1958 and 1970 studies started data collection at birth and the MCS at 9 months. The ALSPAC study sought to enrol already pregnant mothers. To capture women during early pregnancy, extensive publicity and collaboration are needed. The success of such a sampling procedure on national scale would be dependent on the effectiveness of GP and antenatal clinic registers as a sampling frame. It would clearly be much easier to organise locally, as in the highly clustered area study, where, for example, local GPs and antenatal clinics could be invited to collaborate in the study. The ALSPAC study, with its extensive publicity, managed to recruit some 92% of the target group, including women who were recruited after birth. From 2009 pregnant women will receive child benefit from 29th week of pregnancy. If the child benefit register is used, this should enable a very high recruitment rate around birth but it would miss the whole period of pregnancy leading up to it.
- 6.19.** One problem is that the times at which pre-birth information would be collected could vary markedly and it is very likely that the timing will be associated with maternal characteristics leading to potential biases that would need to be dealt with. It is clear that the most scientifically desirable time to start collecting data is as soon as possible after conception, with the 11 week antenatal visit the obvious target. The feasibility and cost of collecting pregnancy data need to be carefully studied at the pilot stage, drawing on the widest range of UK and international experience especially experience.

(iii) Starting the study

- 6.20.** The 1946, 1958 and 1970 cohorts, had a 12 year interval between them ALSPAC followed in 1992 and the MCS in 2000. Our informants generally saw no overriding reason for returning to the 12 year interval on the basis of scientific considerations. The judgment of when to start a new study should be made on the basis of scientific need and practicality. In terms of scientific need there is much to be said for the principle of generation renewal i.e. the age post-puberty when the previous cohort has the potential to start families of their own. This would suggest an interval between studies in the order of 12 to 16 years. We believe that the notion of a 15 year interval suggested in our preliminary report, roughly corresponding to a (minimal) generational gap from the MCS has appeal, because as advocated throughout this report it also offers a substantial period of development and pilot work in advance of the main study going into the field. For such pilot work to include a longitudinal component something in the order of five years might be needed.

6.21. General considerations suggest that a new study should not be unduly delayed in view of rapidly changing social and other factors. There will be a need to set up administrative and funding arrangements, including the recruitment of study teams. If funding became available in late 2008 there would then be a period of some 18 months for commissioning, assembling of teams and consultations before the commencement of the development work, comprising a continuous programme of development of instruments, and biomedical data storage and data processing facilities. A pilot study would need to start some 3 years before the main birth data collection; this would involve 18 months design of instruments and field work procedures and a year to evaluate the results and prepare for the main study. Sampling early in pregnancy then adds about 6 months before the first births. Since the intention is to collect births spanning an academic year this could imply data collection starting no earlier than births in late 2013

6.22. However we recognise that national research funding profiles and the need to produce results could override such an ideal schedule. A period of three years development including a single wave pilot could we consider be just sufficient to ensure that all the main features of the organisation of the new survey were properly in place. Beginning with a team in place by the end of 2009, this would offer the prospect of a 2012/2013 start for the new study.

(d) Other data sources

6.23. These comprise the supplementary data from other family members and administrative sources that could be potentially used to augment the data collected directly about the cohort member child and his or her parents.

(i) *How far should sampling extend to more than one child per family/household?*

6.24. If we start, as is traditionally the case, with a sample of births, then for each associated household we can collect a set of information on the other siblings, as well as adult figures. These siblings could then also be followed up, though perhaps less intensively. The data structure produced by this is thus a 2-level one of siblings within households. The importance of this is that it allows us to study within family relationships, for example between siblings. This is important in many areas where, for example, the influence of older and younger siblings is important.

6.25. For subsequent births we would also follow these up. In addition where a first birth is sampled we can consider asking all the mothers (or a subset) to take part in a prospective study so that when they again become pregnant then for these future births we would be able to follow them up along with the cohort members – possibly less intensively. This would provide information from the earliest possible time of pregnancy, effectively at conception, and provide a more reliable method for obtaining such information. The information obtained would be linked

through the main cohort data to provide population estimates for these early events. We could also extend this possibly to other than first births.

(ii) Utilising and linking with the new UKHLS

6.26. One of the advantages of the UKLHS is the wealth of household information that will be available. It would clearly be advantageous to be able to draw strength from the UKHLS for the cohort sample. This could be done through the household children, where babies are planned to be included from around 2012. A sample of these could be included in the cohort, though research would be needed to determine how this sample should be chosen in terms of its characteristics and size. The existence of common individuals in the two studies does, however, raise issues of respondent burden and cooperation and perhaps in the first instance this possibility should be treated as a pilot to assess feasibility.

6.27. A more radical suggestion is that the children of the UKLHS sample (~1200 per year) could over time constitute the basis for the proposed new study without further sampling, or at least the nationally representative component of the new study. In addition to the issue of respondent burden and administrative complexity, however, there are serious scientific drawbacks to this suggestion.

6.28. The first problem is that this would rule out the formation of tight clusters which is a feature of our design proposals. The second problem is that it would take some time to accumulate a sufficiently large sample to begin analysis. Thirdly, there are some children born outside households, for example in institutions. Fourthly, the target group are those children within the sampled households, but these will already have suffered from some non response, so that the bias/non-response problem is likely to be more severe than starting from a target consisting of all births in the population. Finally, and perhaps most importantly, over time the sample would contain births from the same households. Compared to a sample of births from the population of births in a limited time period this would provide less efficient estimates for many analyses, and the within-household clustering would need to be incorporated into all analyses that were carried out.

(iii) Linking with administrative data

6.29. Linking with administrative data is already a feature of existing cohorts and with developments in processing this will become technically easier, although there remain important issues around disclosure. There are also issues about the quality and accuracy of administrative datasets. Linked medical and educational databases would considerably enhance the utility of a cohort study. Some of these databases are also longitudinal, such as the PLASC/NPD with very high coverage and can therefore be used to judge and correct for biases due to non-response and attrition (see below). It will be important to plan such links from the outset, so that appropriate systems can be put in place and appropriate

data collected to facilitate the linking. The deficiencies of such databases need to be explored also, for example PLASC does not include private schools nor does it extend beyond England. One indirect benefit of the new cohort study would be to expose such weaknesses and exert pressure for comprehensive coverage. This could be part of the moves to improve the quality and accessibility of administrative data generally.

- 6.30.** Permission from parents or guardians needs to be sought for linking. Experience with the MCS¹⁰⁵ found that over 90% agreed to such linking, but there were important differences for some minority groups. Attention needs to be given to maximising agreement and to adjusting for any differential non-agreement. A particularly important issue is how to obtain agreement to continue collecting administrative data on those who drop out, purposefully or otherwise.

(iv) Technical data linkage issues

- 6.31.** There is a large literature on technical procedures for record linkage. Modern methods generally use some form of probabilistic matching in order to optimise linking¹⁰⁶. Typically, for a given variable for an individual in the data file of interest (DFOI) a weight is computed for each record in the administrative data set (ADS) based upon the log odds of the probability of a match. These log odds are best determined from a 'training set' but can also be estimated using a model based approach. The weights are averaged over the matching variables for each record in the ADS, to give an overall weight that is assigned to the DFOI individual. If the maximum of these over the ADS records is greater than a chosen threshold a match is accepted for the ADS individual corresponding to this maximum value. The cut-off threshold for the weights has to be chosen, for example, to minimise the percentage of 'false positives'.

- 6.32.** An elaboration of this basic procedure is to accept more than one, or all, of the acceptable matches, rather than that with the maximum probability. When modelling the data, methods analogous to those for dealing with measurement errors, using all the possible matches, can then be used, together with the weights to provide efficient parameter estimates.¹⁰⁷ One of the problems with this approach and data linkage models generally, is that they operate at the level of the individual when linking is carried out, whereas the matching probabilities will typically be specific to individual *variables*. An alternative is to use a multiple imputation approach that recognises this and thus is potentially more efficient, as well as more general in that it can also handle missing item

¹⁰⁵ Jaro, M. (1995). "Probabilistic linkage of large public health data files." Statistics in Medicine 14: 491-498.

¹⁰⁶ Tate, R., L. Calderwood, et al. (2006). "Mother's consent to linkage of survey data with her child's birth records in a multi-ethnic national cohort study." International Journal of Epidemiology 39: 294-298.

¹⁰⁷ For an example see Scheuren, F. and W. E. Winkler (1993). "Regression analysis of data files that are computer matched." Survey Methodology 19: 35-38

data even where records are matched¹⁰⁸. Goldstein et al. (2007) develop such procedures for multilevel models. All these methods tend to be computer-intensive and will require careful piloting.

(e) Organisation

(i) Disclosure issues

6.33. Especially with linked administrative data disclosure is likely to be a serious concern when secondary users have access to the data. It may be the case that existing procedures in place for existing cohorts are adequate, but they will need to be reviewed. There is currently much activity in Government and academic circles, including under ESRC auspices, studying disclosure issues and this should inform the decisions the new study will need to make. Some exploration has been carried out into the idea of providing secondary analysts with 'synthetic' data sets. These are essentially simulated data based upon the characteristics of the actual data set. It may be worthwhile exploring this idea further for certain purposes, but it is difficult to imagine that this would be a satisfactory approach overall for all possible data analyses. It is also unlikely to be acceptable to the majority of data analysts.

(ii) Dealing with non-response and attrition

6.34. Weighting has been the method of choice in the past for dealing with non-response and attrition and recent developments in 'doubly robust' estimation have improved the efficiency of weighting procedures, but they have problems. A major one in longitudinal data is that for individuals present at several occasions the weights attached to an individual will generally differ across occasions due to non-random attrition. Thus, when carrying out longitudinal analyses it may not be clear what weighting system should be used. This is further complicated if any kind of multilevel model is carried out with weights at more than one level of the data hierarchy. Thus, for example if a regression analysis is carried out across two occasions, using just individuals with values at both occasions, we may be confronted with two sets of weights. We can use the (marginal) second occasion weights so long as the second occasion individuals are a subset of those at the first occasion with non-missing data. In practice, however, individuals are lost and reappear later, which very much complicates any longitudinal analysis using weights.

6.35. In the Millennium cohort revisions of weights at follow ups were relatively small and preliminary study seems to suggest that for practical purposes the original sampling weights, adjusted for response and sample design, may be appropriate for analysis, but this conclusion

¹⁰⁸ Goldstein, H., S. Burgess, et al. (2007). "Modelling the impact of pupil mobility on school differences in educational achievement." *J. Royal Statistical Society, A*, to appear.

needs further confirmation. There is also the issue of how to allow for migration and decisions will be needed about population definition, especially if administrative data sources are used.

6.36. Multiple imputation (MI) is a technique that has been applied successfully to dealing with missing data in surveys and other studies. It involves generating several 'complete' data sets by a selection of values to replace those missing, fitting a model to each one and then combining results according to certain rules to provide efficient estimates. While it is computer intensive in terms of providing the imputed data sets for secondary analysis, this is less likely to be a problem in the future. For the secondary data analyst software can be made available that will 'transparently' carry out the necessary combinations and such software already exists in some packages. There are practical issues concerning the number of variables that can be made available but in principle this can be dealt with and there are also a number of other technical issues that need studying¹⁰⁹. In addition to handling 'randomly' missing data MI can also, within a single framework, deal with non-response given the presence of auxiliary variable information. Use of MI can also avoid the need for complex weighting systems, and in particular is able to deal satisfactorily with the differential attrition problem. The potential advantages of MI for complex modelling in a future cohort merit serious exploration.

(iii) Capacity

6.37. Many of the suggested sampling innovations will lead to a measure of data structure complexity that will require the use of sophisticated statistical modelling in order to make efficient use of the data. The simplicity of a single representative sample, regarded effectively as a simple random sample as embodied in the 1946, 1958 and 1970 cohorts, supplies the foundations on which more sophisticated modelling approaches would need to be built. The potential advantages of complex designs lie in design efficiency, contextual analysis and replication, as described above. Exploiting these gains to the fullest extent, does however, imply that the expertise to carry out such analyses must be readily available.

6.38. Given many of the current problems around the supply of quantitatively competent social scientists the feasibility of such provision for a future study needs careful examination. Some of the current ESRC initiatives in terms of fellowships and Centres for quantitative analysis may alleviate or even solve this problem. The future cohort study itself should incorporate a capacity building function: data analysis fellowships could be attached to the data collection and analysis teams and it is essential that statistically competent researchers become integrated members of research teams.

¹⁰⁹ Goldstein et al *op cit*

6.39. One of the lessons that can be learnt from existing studies is that those carrying out the data collection should also be involved in the data analysis. Specific funds and time should be allocated for this. To involve researchers in data collection as well as analysis has several advantages. First it attracts those with a scientific interest. Secondly, by being involved in the analysis of data a researcher can contribute importantly to maintaining the quality of the data, its accessibility to others and the planning of future data collections.

(iv) *Development and piloting phase*

6.40. As part of the development of the survey it is essential to have a pilot cohort that precedes the main cohort so that all aspects of design and question construction can be tested before going into the field. This needs to be fairly large since it too will suffer attrition. As noted earlier the pilot cohort would need to be started at least three years before the main study to ensure that lessons learned from it can be implemented. It should ideally include at least one follow up prior to the main study starting in order to test the feasibility of follow-up procedures. In addition the pilot cohort could also be used to pilot database construction and data analyses, especially where this is complex such as in the area of modelling missing data and carrying out data linkage.

(v) *General administrative issues*

6.41. It is proposed that a steering group, comprising representatives of the funding bodies, and each of the component studies (cluster and national teams) should constitute a body that would steer the research and ensure common measures and general compatibility of data bases etc. The group may also wish to co-opt experts to advise it. It would seem sensible that the team entrusted with the nationally representative component should administer this steering group and ensure that its decisions were implemented.

6.42. One model for the overall structure is a 'hub + nodes' structure, with a large measure of scientific autonomy given to the nodes to pursue their work within an agreed framework. The nodes could also be responsible for much of the capacity building with fellowships etc. A series of workshops and seminars should be part of the overall strategy, coordinated by the 'hub' and using the expertise of the nodes.

6.43. The issue of providing monetary or other incentives to enhance participation needs to be addressed and should be piloted. Experience from other studies may be helpful.

(f) *Conclusions*

6.44. The scientific programme mapped out in previous chapters implies certain features of an effective sample design: a nationally representative sample, clustered data to encompass the bio-ecological context of

development and a substantially larger large sample than used in the past to support appraisal of gene-environment interaction. Rather than argue for a particular design to meet these requirements, we offer three options for further consideration, each employing different combinations of probability sampling and clustering.

- 6.45.**Other features of the design follow including the recruitment of mothers to the study as early as possible in pregnancy, the collection of data about siblings and the extensive use of linkage to administrative data sources, including medical records, subject to data protection and disclosure constraints. Methods for maximising recruitment to the study and retention in it are also a major part of design strategy.
- 6.46.**The appropriate timing for the start of the new study needs to be based on sound scientific principle and the opportunity for a substantial development period for the study. This would include comprehensive piloting to ensure that the design is optimum to address the scientific questions of interest and effective procedures and ethical clearance are in place well in advance of the main field work. However we appreciate that what is ideal in this respect needs to be tempered by what is practical in terms of availability of funding and the delivery of results. On this basis we believe that start state in 2012 / 2013 could be just feasible.
- 6.47.**Our design proposals have major implications for capacity building to ensure that the necessary skills are available to ensure that the study can be carried out.

7. Operationalising the Design

(a) The processes of setting up

7.1. Setting up the proposed multi-disciplinary study of a birth cohort sampled partly on a probability and partly on an area sample basis would require a considerable lead time, the second aspect of which we direct particular attention to below. Based principally on the ALSPAC experience, an extended preparation time would be essential because of the processes that would have to be undertaken, as summarised below, in approximate sequence, although overlap between processes would certainly occur.

7.2. The suggested schedule is:

1. Scientific discussions leading to decisions on content and data sharing
2. Scientific discussions leading to decisions on data collection tools and techniques
3. Recruitment of principal investigators
4. Recruitment of core scientific team
5. Selection of sampling areas
6. Discussions with key scientists, education and NHS personnel who will be involved in each of the areas selected for the study
7. Designing the main and pilot study data collections, management of data after collection, deciding policies on informed consent and non-response
8. Obtaining ethical approval
9. Designing and setting up any pre-pilot studies and the pilot study, including training methods required
10. Carrying out the pilot study
11. Selecting samples and sampling protocols for the main study
12. Deciding finally on management processes and content in the light of pilot study experience

Because of the complexity brought to the above processes by the use of new measurement techniques in several fields, relatively untried sampling and recruiting requirements, and the preparation necessary for smooth running of a multi-centre study, we suggest that the lead time necessary for all processes of setting up is in the order of 3.5 - 4 years.

7.3. At present the most important considerations in this chapter are concerned with:

- compiling the sample
- collecting data on sample members
- minimising non-response
- handling data from the study.

(b) Compiling the sample

- 7.4. It is possible that in a few years time it will prove possible to use NHS e-numbers as a sampling frame for the study. But if not (and data protection legislation may rule it out) we believe that the ALSPAC model could be followed for early recruitment of pregnant women. A two-stage sampling approach could be used, with women being recruited at their first antenatal visit via a first-stage random sample of ante-natal clinics. But the task of securing the co-operation of randomly selected clinics should not be under-estimated, and at a minimum a feasibility study would be needed to test whether such an approach could realistically be made to work.
- 7.5. A compromise position would be to adopt a dual-frame approach to the sampling. Under this approach the *local* area studies would recruit pregnant women, using a model similar to ALSPAC. The very fact that these are local, rather than national, studies makes the task feasible, even if expensive and time-consuming. Then, for the nationally representative sample, if recruitment of pregnant women proves impossible, the option of selecting from Child Benefit records would remain. This would not be an ideal solution, because it would mean that there is no national pre-birth data, but might be the most practical solution. If recruitment via clinics is adopted, then before the start of the recruitment time will be needed for the enrolment and briefing of staff within these clinics.

(c) Collecting data on sample members

- 7.6. The data generated during the lifetime of the study is likely to be a complex combination of information from numerous sources, including linked administrative data, biological samples and measurements, questionnaire sources (self-completion, interviewer/nurse/other observer completion). Traditionally self-report data have been collected predominantly through face-to-face interviewing of the mothers, but with self-completion questionnaires being used at later waves or for collecting sensitive data during the face-to-face interviews. However, as with the UKLHS, mixed or multi-modes of data collection are likely to be used more frequently in the future on panel surveys, partly because interviewing by telephone or via computer is much less expensive than face-to-face interviewing, but also because some respondents prefer to use these media.
- 7.7. It would be essential for most early data collections from mothers to be carried out face-to-face (since at present such approaches generate the highest response rates and we do not anticipate this changing in the near future). Then, once mothers have 'bought in' to the study, a switch to other modes of data collection could be considered. However, we note that this decision would not only be dependent on considerations of the effect on response rates: the complexity and nature of the data to be collected would be key deciding factors.
- 7.8. Proposals for the collection of biological samples and measurements would sometimes require sending nurses to the homes of sample members, and sometimes inviting sample members to attend clinics. From a scientific perspective using clinics is to be preferred because it allows for a wider range of measurement. But, whereas, asking mothers to attend clinics for a small area based study is likely

to be feasible (following the ALSPAC model) because mothers do not have to travel large distances, replicating this model for the nationally representative sample is likely to be far more challenging and may ultimately prove impractical. The options around this issue would need careful testing during the study development stage.

7.9. A final point to note here is that, if early waves of data collection are to be carried out face-to-face using trained interviewers/nurses employed by survey organisations then few, if any, of the UK social survey organisations would have sufficient interviewers to manage the fieldwork needed for the area-based studies. So substantial local recruitment and training would be needed – all of which takes time. This, in turn, may contribute to the arguments about survey mode for the study, since having recruited interviewers to carry out one wave of data collection, there may be advantages in retaining them by making the next few waves of data collection face-to-face too, rather than doing a fresh recruitment round when another face-to-face interviewing wave is needed, if indeed the model of successive ‘waves’ is to be followed.

(d) Minimising non-response

7.10. One of the main criteria against which the success of such a study would be judged is response rates. The study’s credibility may be severely undermined if the initial response rate was low or if attrition after recruitment was high, and especially if there was evidence that this was associated with substantial bias. But the challenges faced here are enormous. Response rates across almost *all* major social surveys in the UK have fallen markedly in the last 10 to 15 years (at a rate of roughly one percentage point a year) and although birth cohort studies are likely to achieve much higher response rates than other studies, the evidence from the Millennium cohort study (MCS) is that high levels of recruitment and retention to the study cannot be taken for granted. The MCS, which started with an issued sample of 24,180 births, achieved interviews with 18,552 mothers/guardians at the first wave of data collection (at age 9 months); 15,590 at the second, wave (at age 3 years) and 15,246 at age 5 years. This is not straightforward cumulative attrition because some of the refusals at earlier waves have since rejoined the study, but the numbers do give some indication of the losses to the total sample size over time.

7.11. There are no magic bullets. To attract mothers to the study in the first instance, it is vital that it should be presented as interesting and salient. This is a particular advantage of the area studies where a combination of local services and communication channels like local newspapers can be engaged in promoting the study. At a minimum, development work with pregnant women on what would encourage them to take part (and what would put them off) will be needed. This can then feed into the publicity and literature for the study. The approach taken by the persons recruiting mothers to the study (be it survey interviewers, midwives or clinical staff) is vitally important, so appropriate training and briefing for these ‘front-line’ staff will be essential.

- 7.12.** Having recruited mothers to the study attention needs then to turn to strategies for retaining them. The obvious strategy here is to ensure that the interviews/questionnaires at each wave are interesting to the mothers, and that the interviews are not excessively long and burdensome. Beyond that, strategies for keeping in touch with mothers between data collection waves need to be considered.
- 7.13.** Beyond making the study appear interesting and worthwhile, it is now becoming increasingly common for social surveys to give small financial incentives to respondents to encourage cooperation. The research evidence around incentives is that they do not have to be large to improve response rates (the standard at present is around £5-£10) but they *do* have to be presented unconditional on response. That is, the incentive has to be paid up-front rather than being offered conditional on the interview taking place. One explanation for this is that pre-paid incentives are seen as gifts that encourage reciprocation, whereas conditional incentives are seen simply as payments.
- 7.14.** Recruiting fathers, especially absent fathers, to the study will present additional challenges, the main two being negotiating access in the first place (the assumption being that contact details would have to be provided by the mother) and then how to achieve a high response rate.
- 7.15.** We note that the ESRC has recently commissioned through the *Survey Design and Analysis* programme a series of methodological studies on response rate issues, including studies looking specifically at attrition in longitudinal studies, so there are good opportunities for incorporating findings from these studies into strategy for the new study.

(e) Handling data from the study

- 7.16.** As we have noted elsewhere in this report, the cohort study will have a very complex data structure with multiple data sources, multiple respondents, multiple data-collectors (interviewers, nurses, clinical staff) and with biological samples potentially being stored at multiple locations. Coupled with a very large sample size, the task of managing all the data and samples is formidable. To handle this smoothly and efficiently means that considerable resources will need to be invested in data management. Although *some* of the data management systems can be allowed to evolve as the study evolves, in practice a clear and coherent strategy will need to be put in place well before the start of the study in order to minimise any associated risks.
- 7.17.** It is also important that data release issues are resolved before the start of the study. One of the risks of collecting data from multiple sources is that, once all the data is linked the data can become highly disclosive. This is especially so for the area studies where essentially a census of mothers will be taken meaning that individual mothers/children will be easy to identify in the dataset. (Though notably no problem of this kind has ever been reported in ALSPAC or other overseas area studies that we are aware of.) However, there are undoubtedly tensions to be resolved between allowing access to the data for legitimate research whilst ensuring that the anonymity and confidentiality of respondents is preserved. Again,

some of the protocols around data release *can* be developed during the lifetime of the study, but the broad principles need to be resolved before the study starts (at the least to ensure that respondents can be told how their data will be used when asking their consent for data linkage, and to obtain and ensure scientists' collaboration). Existing activity in this area in science and government should provide guidelines.

(f) Conclusion

7.18. The ALSPAC model would be a valuable source of experience in how to set up and manage the local area features of the kind of study designs proposed. However it must be remembered that the design proposed here has the additional complexity of being multi-centred. In order to get the proposed multi-disciplinary and multi-centre study to work effectively and to produce data of high scientific value, the lead time necessary for all aspects of preparation must be sufficiently long and sufficiently resourced.

8. Final Considerations and Conclusion

- 8.1.** The scientific case that we have argued for a new cohort study began with the major challenges facing society in the coming decades of this century: the long-term effects of early child experience, ageing population, globalization, immigration. Our proposition was, that only through investment in scientific programmes of the kind that a major new cohort study could support, will the relevant evidence base be available to enable these challenges to be met. It should be remembered that the first 3 national birth cohort studies were initiated to address contemporary national problems in maternal and child care, and the first two were continued in order to address pressing educational problems. The Millennium Cohort Study similarly was driven in large measure by concerns about child poverty and disadvantage and the effectiveness of the government's *Sure Start* initiative to improve life chances. In today's terms important problems in relation to children can be identified with evident changes in disaffected youth, of assimilation of immigrants and social cohesion and in physical and mental health. But the longer consequences of experience are ultimately where the huge scientific value of the new study will lie. As the study progresses the returns to investment multiply.
- 8.2.** In this chapter we return to the main themes of the over-arching programme we have laid out. We then consider – as our brief requested us to – the main objections to the birth cohort study design as the best means to meeting the goals of the programme and our response to them. We then consider a wider set of constraints on realisation of the programme including, cost, capacity and feasibility. Finally we draw our conclusions.
- (a) Scientific agenda**
- 8.3** The scientific programme that a new birth cohort study will support, concerns in various ways the foundations and maintenance of individual, community and societal wellbeing - now enhanced through major new and continuing developments in the theory of developmental processes. The programme will also be greatly enhanced by continually improving research resources identified with the technological advances made in measurement, including the collection and processing of such key biomarkers as DNA. New ways of conceptualising and measuring the physical and social environment at different levels will enrich the data resource further. Increasing access to banks of administrative data for linkage into the cohort study will add to the completeness of the longitudinal record and contextualisation of development across the population more generally.
- 8.4** The major advance in developmental science is the study of interactions between genetic endowment and environment, the impact of which is realised from conception onwards. Both the MRC and most recently the

Wellcome Trust have expressed much interest in the scientific programme on these lines that the new study would support. The epigenesis principle points to gene expression, modified by the social and physical environment, again from the earliest stages of life. Such processes supply the foundations of later development of every component of human personality and its functioning ranging through the physical and the psychological to the socio-economic and political. They lie at the heart of differentiation in the life course and its outcomes through the various kinds of capital acquired and their deployment in response to, and in the creation of opportunities in the family, the school, the workplace and the community. They set in chain the development of the attitudes and values and capabilities that form the basis of identity. These different social environments are now conceived as operating at quite different levels in the family, in the school and in the community in the impact they have on individual's lives with interactions within and across them.

- 8.5** All these features of the new scientific programme are extended further through intergenerational analysis to monitor and understand the transfer of capital resources within and between families and the extension of the programme cross nationally for the purposes of comparative research. Multi-national studies have particular salience in a globalised, socio-economic environment, because they help pin down mediating effects of national policies and institutional frameworks, and the cultural assumptions lying behind them, on developmental processes. They also offer the potential for pooling data, especially for genetic investigations.
- 8.6** Paralleling the advances in measurement potential, survey design and analysis has also undergone transformation, recognised through the pioneering work of such community based longitudinal studies as ALSPAC in Britain and Dunedin in New Zealand. Sample design is much enhanced through clustering within neighbourhoods and wider communities, where the effects of physical and social ecology on individual development can be fully assessed. The advances of multi level modelling enable the effects of such ecology on individual development to be modelled at a number of levels in interactional (proximal) and structural (distal) contexts varying from schools and hospitals, to the family and community. Our proposals argue for a design including a large national probability (representative sample) spanning a years births (or pregnancies) and a number of options for including clustering as part of or independent of the sample. Establishing the study in a number of geographical areas would offer opportunities to encompass fully multilevel models including far more contextual information than has been possible in the past, while at the same time the nationally representative sample would maintain continuity of the series as a whole.
- 8.7** Further modifications include beginning the study in pregnancy rather than at or after birth to capture the earliest stages of development and

regular follow-up through this period and post birth on the ALSPAC and US NCS model.

- 8.8** The last aspect of the argument is in certain respects the most critical as to why the UK, perhaps more than any other country, should continue to invest in birth cohort studies. The existence of a series of such studies, going back to 1946, offers unique opportunities to develop and test models of the human life course and the developmental processes through which it is constructed across six studies spanning sixty years. Through such comparisons we are able to investigate not only the 'internal' processes of development for individuals born in a particular era; through comparison with those born in other eras, we are also able to discover how societal change has affected them in shaping the UK life course.

(b) Objections

- 8.9** Apart from considering the arguments for a new birth cohort study we were also asked to examine the case against it. The main objections came from those of our informants who believe that the current targets of birth cohort studies research have now been largely met or that better scientific returns can be gained from other kinds of research design.

(i) Scientific targets

- 8.10.** Although the long term value of a birth cohort study cannot be fully realised until adulthood, when the outcomes of early experience can be assessed to the fullest extent, the immediate returns from a new birth cohort reside in early child development. Family functioning, children's adjustment, pre-school preparation, school readiness and cognitive and physical development have all been the subject of intensive investigation contributing to a body of knowledge which, it is argued, is not going to be fundamentally changed by the new evidence that another birth cohort study produces. Far better, in the terms of some proponents, to let science crystallise much further through the massive amount of potential analysis still to be done using existing birth cohort data resources, especially the most recent of these – ALSPAC and the Millennium Cohort Study. The older longitudinal research resources, though not so widely used, still have much to offer (e.g. the Newcastle Thousand Families Study¹¹⁰, the Southampton Women's Study¹¹¹ and those beginning now to be developed (the Born in Bradford Study¹¹², the Gateshead Millennium Study¹¹³). Also better to focus new longitudinal study on populations where knowledge is inadequate or missing, for example, the new elderly population (75+) or the new immigrant population.

¹¹⁰ Paediatric Lifecourse and Epidemiology research Group at Newcastle University

¹¹¹ www.mrc.soton.ac.uk

¹¹² www.borninbradford.nhs.uk/Health+Professionals+Zone.htm;

¹¹³ www.ncl.ac.uk/gms/

8.11. The main answer to this objection lies first in the significant advances in scientific thinking, especially around the gene-environment interface, and secondly on the new conceptualisation of the social environment in social ecology terms. The failure to renew the knowledge base replenished with the additional scientific resource, offered by the new study would be short sighted. In terms of immediacy of knowledge about special populations of major policy concern, high priority can be attached to longitudinal investigations: ELSA with respect to ageing, and the UKLHS in relation to the all-age- population including boosts to encompass immigrants. These studies can be seen as complementary to the new birth cohort study rather than removing the need for it. In addition, by extending the scope of social environment measurement, special sub-population families can be specifically targeted for inclusion in the study. For example, in the clustered design one or more areas could be located with high prevalence of immigrants.

(ii) Alternative designs

8.12 Alternative research designs to the birth cohort study were proposed by those who believe the scientific agenda needs different kinds of data to test the hypotheses of interest. For example, it is argued that the recognition of pre-natal experience in shaping long term health outcomes is now well established. The top priority now should be much more experimentally driven investigations to pin down precisely components of the developmental processes of interest, such as gene expression under different environmental exposures. The demand for case control studies extends to the value of experimental methodology more widely. In the social policy field, for example, it was argued by one informant that very little has been established on the effects of government policies as selection bias' in the evaluations undertaken rule out any robust assessment of effects. The argument here is for randomised control trials on the US model applied to social and educational interventions. Another quite different variant on the same theme is that large scale longitudinal investigations rule out studying the minutiae of developmental and interaction processes, through which the improvement of organisations and effective practice can be understood. Far better in these terms to undertake much more intensive case studies in organisations or communities to unpack every aspect of the interactions involved, with a view to understanding what works and what doesn't from the stand point of all the actors engaged in them.

8.13 Again the answer to these objections lies not in denying the value of what is being proposed, but in recognising its complementarity with a new birth cohort study in a fully comprehensive scientific programme. Each discipline has its favoured approach to the building of knowledge ranging from the 'true' experiment in physics, biology and behavioural science to the ethnographic investigations of anthropology and sociology. The House of Lords Science and Technology Committee made the point in their critical discussion of ageing research, that only by

bringing all pertinent disciplinary perspectives and methodology into the same interdisciplinary scientific framework are the advances in scientific knowledge that are needed going to be made¹¹⁴. Though the birth cohort study cannot embrace every feature of scientific understanding that is sought it can through encompassing the earliest stages of an unfolding life course, supply components that no other methodology can. For this reason we conclude, together with the great majority of our informants, that the case for a new birth cohort study is demonstrated.

(c) Constraints

8.14 The main obstacle to a new birth cohort study resides less in scientific arguments, than in the constraints that have to be overcome to undertake it. There are four principal constraints that need to be considered:

- i. Cost
- ii. Capacity
- iii. Feasibility
- iv. Motivation

(i) Cost

8.15 Our brief did not require us to assess the costs of what we are proposing merely to evaluate the case for doing the new study and consider options for its design. Nevertheless it will be clear from the options we are supporting that by the standards of earlier studies – a substantial hike in expenditure is inevitable. But to set this in context, \$50million was spent on the development phase of the US NCS and the budget for the whole 25 years programme works out at \$2.7 billion.

8.16 In addition the costs of the new study cannot sensibly be divorced from the costs of the extant cohort studies programme. Each new study places further strains on an already over-stretched resource base. A further study when five previous ones (1946, 1958, 1970, ALSPAC, 2000) are still in the field would be unsustainable without a substantially increased budget operating across all of them. The scepticism therefore depends on the size of the budget that is sought and appraisal of the multiple demands upon it. When public awareness of the policy and scientific imperatives in the social, economic and health sciences reaches comparable levels to those in the natural sciences for radio telescopes and particle accelerators then, we may expect to see the kinds of budget they command becoming available to the birth cohort study programme as well.

¹¹⁴ 'The picture we have received from the evidence falls so far short of the ideal that we believe that radical measures must be taken to improve current arrangements.'
Ageing Scientific Aspects, Volume 1 Report, 2005, p 83 para 8.7

(ii) Capacity

8.17 The expansion of the UKLHS to eight times the size of the BHPS and the potential scale of the new cohort study, expanded to up to 60,000 births challenges capacity in a number of ways. Fieldwork agencies do not currently have the workforce to undertake what is proposed. There would need to be massive recruitment and extensive training, not least because the methodologies applied in data collection would extend substantially beyond typical current practice. Apart from the principle of training, involving perhaps 3 – 5 days for each interviewer/nurse briefing, current management resources would be stretched to the limit both within survey agencies and in the research teams responsible for the scientific programme.

8.18 The capacity of teams to undertake the work in a number of local areas, including design and analysis within a national framework, is also expecting far more from the current social science and medical research community than it is probably able to deliver. Longitudinal research experience and expertise operationally and in analysis capability may not be adequate to meet the needs of area studies on the ALSPAC model and the baseline national longitudinal survey. Capacity building thus becomes another top priority for the development period leading up to the new study.

(iii) Feasibility

8.19 The major issue for feasibility is the willingness of respondents in a new birth cohort study to take part. Considerations about the complementarity between the new birth cohort study and the UKLHS led to the idea of drawing the UKLHS children into the new cohort study. But we judge that this would impose an intolerable strain on the families involved, potentially damaging the prospects of both studies. In the new birth cohort study the proposed monitoring of development through the period of pregnancy and at repeated intervals following birth, may be seen as an ideal protocol, which in practice might prove difficult to implement on the very large scale proposed. The prospect of massive attrition from the study is a real danger, which can only be alleviated to a certain extent by post hoc adjustment and imputation of missing data.

(iv) Motivation

8.20 The key to success will be dedicated teams with strong leadership working to deliver the agreed programme of data production and analysis under often very demanding timeframes. To ensure recruitment and retention of high calibre staff and sustain motivation much greater recognition will be needed of the value of longitudinal survey work than is often the case in universities at present. This will require new ways of appraising performance much of which in the areas of survey maintenance, data preparation and documentation does not match conventional criteria for advancement.

(d) Need for a development phase

- 8.21** The birth cohort studies reflect a history of scepticism about feasibility, which was only circumvented by the idealism and enthusiasm of their original investigators. The area-based study with intensive data collection of the ALSPAC or Dunedin kind proves further that the construction of a whole network of resources around the design of a study conducted on an annual repeated basis can be achieved, given the will to put all the necessary arrangements in place. Furthermore, in relation to the existing UK birth cohort studies programme as a whole, the continuing high response rates show that an abiding interest in and loyalty to the study can be developed if the study has a clearly defined identity and purpose.
- 8.22** The proposed new birth cohort study expands design possibilities on a substantially larger scale. But given the right level of commitment and resources we believe the challenges can be met. The study will need high level coordination, as well as implementation of agreed procedures in a uniform manner to ensure standardisation and reliability of data. Such organisation requires an extensive period of development and preparation of all instrumentation and procedures, well in advance of main fieldwork. As argued in our report this would involve the development of scientific aims and agreement on measurement methods in each topic area. It would also include recruitment of professionals locally and officials responsible for local services and data sources. It would also include a pilot, involving ideally one follow up to make sure all the procedures work and are co-ordinated fully across the country before the main fieldwork begins.

(e) Complementarity with other British studies

- 8.23** A new birth cohort study of the kind described in this report would, in the tradition of the existing large birth cohort studies, and of Biobank and ELSA, focus on the processes of life course development of the selected individual from the earliest possible stage of life. That focus would complement rather than in any way compete with that of the UKHLS on family dynamics. It was clear, from discussions with the director of UKHLS, that there would be some degree of similarity of socio-economic and biomarker outcome measures in UKLS¹¹⁵ and the proposed new birth cohort study and we agreed with his suggestion that there was a case for some joint planning and harmonisation between the 2 studies from the outset. The proposed design for a new national birth cohort study would also be complementary to the work of the Biobank and ELSA studies (as already outlined in chapter 4), by providing new knowledge about the developmental period. It would be essential for the team to have similar harmonisation meetings with the Biobank and ELSA

¹¹⁵ e.g. see Hobcraft, J. (2007) *Enabling trans-disciplinary research in the UKHLS: Incorporating biomarkers and pathways into research on the interplays among social, economic, behavioural and health sciences*, Report to ESRC.

studies in the course of planning. Harmonisation with the existing large birth cohort studies would be similarly essential including especially ALSPAC and MCS.

(f) Conclusion

- 8.24** We believe our approach is innovative and appropriate to meet the demands of the scientific programme that is needed in the coming era. One innovative feature is in data collection comprising much improved measurement of the social environment and developmental and biomedical variables including DNA, parenting, family cultural and socio-economic resources, physical growth, maternal and child life-style factors, social and psychological development, home and neighbourhood context.
- 8.25** The other innovative feature is basing the sample in a number of contrasting areas linked to, or within, the context of a nationally representative sample. This clustered sample approach has the great merit of offering the opportunity to investigate the effects of social ecology on development in depth, through testing and replication of findings across areas, and continuity across the whole cohort studies series across 60 years.
- 8.26** Such a resource would thus maintain as much continuity as possible (in a changing scientific context) with the earlier large birth cohort studies, and deliver, as we have argued in this report, new opportunities for innovative science, and thus innovative policy thinking, both to British researchers and to the wider international scientific community,
- 8.27** The cost of a new birth cohort study is high, but the rewards scientifically and potentially in policy terms are huge. The challenges of the new century are such that the costs are worthwhile. Other countries such as the USA are already taking this path through their huge investments in new birth cohort studies. The new study offers the UK the opportunity to build on our achievements and maintain lead position in this kind of scientific enquiry.
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