Intergenerational continuity and discontinuity in cognitive ability

The first offspring of the British 1946 birth cohort

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Declaration

I, Michelle Byford, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Abstract

Cognitive development in childhood is a key factor affecting adult life chances, including educational and occupational success. Intergenerational continuity in cognitive ability is often observed. Thus the persistence of poor cognitive outcomes across generations may lead to a 'cycle of disadvantage' that is difficult to break.

In this thesis, intergenerational associations in cognitive ability between parents and first-born offspring were examined longitudinally. 1,690 members of the British 1946 birth cohort with at least one offspring constituted the study sample. Cognitive ability was measured at age eight years in parents and offspring. Social mobility and parenting practices were examined for their affects on the transmission of cognitive ability across generations.

Offspring of parents who improved upon the occupational social class of their own fathers by the time they were aged 26, as well as offspring of parents who remained in a non-manual class, had higher cognitive scores than those whose parents remained in a manual social class, or who showed negative intergenerational mobility. Upwardly mobile and stable non-manual parents were also more likely to use positive parenting practices. Four measures of parenting were shown to mediate part of the intergenerational relationship in cognitive ability. The intellectual home environment, parental aspirations and cognitive stimulation were positively related with cognitive outcomes in the second generation, while coercive discipline was negatively associated with offspring ability. Path analyses revealed that maternal education, but not occupation, was an important predictor of offspring cognition. The educational attainment of fathers indirectly influenced the cognitive development of the next generation through its effect on occupational social class.

For those parents with the lowest and highest ability scores, the quality of the intellectual environment enabled their offspring to 'escape' or replicate parental cognitive ability respectively. Cognitive stimulation and paternal aspirations helped offspring to avoid repeating the poor cognitive outcomes of their parents.

These data add to the relatively few studies that examine intergenerational continuity and discontinuity in cognitive ability. The results provide a basis for understanding some of the processes by which parenting practices may influence intergenerational relationships.

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List of abbreviations

CI .... Confidence interval
CFI .... Comparative fit index
FIML .... Full information maximum likelihood
HOME .... Home Observation for Measurement of the Environment
HPA .... Hypothalamic-pituitary-adrenal
IQ .... Intelligence quotient
LOCF .... Last observation carried forward
LRT .... Likelihood ratio test
OR .... Odds ratio
RMSEA .... Root mean square error of approximation
SEP .... Socioeconomic position

1. Introduction

Intelligence runs in families. Intelligent, well-educated parents typically produce children who achieve high scores on intelligence tests, excel at school and become high-achieving adults. Similar intergenerational continuity is found in parents with low intelligence scores whose offspring generally perform less well on scholastic and cognitive tests and attain lower occupational status in adulthood (Cairns, *et al.*, 1998; Hart, *et al.*, 2005; Plomin & Craig, 2001; Serbin & Karp, 2004). For years it was believed that intelligence was transmitted genetically by parents to children (Plomin & Petrill, 1997). It is now acknowledged, however, that individual variations in intelligence – also referred to as cognitive ability or IQ – reflect both genetic and environmental differences (Bouchard & McGue, 2003). The relative contribution of each is approximately 50% (Plomin, 2001). Since the environments to which human beings are exposed are potentially more modifiable than genetic factors, this work goes to the heart of two specific environmental effects that influence IQ continuity: social mobility and parenting.

Environmental influences include the social background and the educational setting of the individual as well as the quality of parenting received and experienced. Empirical evidence suggests that those with higher IQ scores in childhood tend to improve in social standing across the life course (Deary, *et al.*, 2005; Nettle, 2003). Such mobility towards a higher social class is accompanied by educational and occupational success, better than average access to social networks and health services, and superior material circumstances (Goldthorpe, *et al.*, 1980; Wadsworth, 1991). People benefiting from such environmental advantages may be better equipped to foster the cognitive development of their offspring through the provision of an intellectually stimulating home environment, greater educational opportunities and positive parenting. Correspondingly, those people who develop poor cognitive skills in childhood often fail to achieve at school and consequently may lack the skills, motivation or confidence to attain occupational success. As parents, they are more likely to adopt coercive parenting behaviours (Bradley & Corwyn, 2002) which may negatively affect the intellectual development of their offspring (Estrada, *et al.*, 1987; Kagan & Freeman, 1963; Smith & Brooks-Gunn, 1997), thus perpetuating a cycle of low cognitive ability from one generation to the next.

This work centres on these intergenerational associations in IQ, and aims to examine intergenerational social mobility and parenting practices for their role in the transfer of cognitive ability between parents and their first-born offspring. Four main objectives are addressed. Firstly, intergenerational social mobility in the parental generation is examined in order to understand how and why improvement or deterioration in social standing across the life course might affect the cognitive development of the next generation. One reason that social mobility may impact offspring IQ is that social background is associated with parenting behaviours, which in turn influence offspring cognitive development. Thus, the second objective of this thesis is to examine a range of parenting practices – including the quality of the intellectual environment, cognitive stimulation, parental aspirations, parental interest in education, affection, coercive discipline and corporal punishment – and to determine if they play a role in intergenerational cognitive ability associations. Thirdly, path analysis is employed to examine the indirect pathways between parental IQ and offspring IQ (e.g. via parental education), with special emphasis on the role that parenting might play in this trans-generational relationship. Finally, the role of parenting practices in perpetuating different types of continuity and discontinuity in cognitive ability is explored. In particular, what makes some parents who excel on cognitive ability tests produce equally high achieving children, while others do not confer this advantage to their offspring? Likewise, what do certain parents do, or fail to do, to ensure that their children do not replicate their own low or high cognitive ability scores respectively? In each case, cognitive ability in the parental and offspring generation is studied at age eight. Therefore, intergenerational continuity refers to similarity in childhood ability scores between generations, while discontinuity occurs when offspring outperform or underachieve on cognitive ability tests relative to their parents, when tested at the same age. Answering these questions should help develop our understanding of how cognitive ability is transferred across generations and identify precisely what it is that contributes to continuity and discontinuity.

These questions are examined using data from two linked longitudinal studies of parents from the British 1946 birth cohort and their children. The 1946 birth cohort is a prospective study that first comprised 5,362 people born during one week in March 1946 who have been followed up regularly since birth. A second-generation survey was undertaken in 1969 on 1,690 first-born children of either male or female members of the 1946 birth cohort born between 1965 and 1975. These datasets provide high quality, long-term longitudinal data extending from childhood into adult life and across generations. They form an unusual and remarkable basis for studying the relationship between the childhood IQ of the parents and the childhood IQ of their children, and what the mediators of this relationship are.

An understanding of how intellectual ability is transferred between parents and offspring may help us identify the processes whereby disadvantaged families unintentionally cause their children to be at risk of being on a path of continual negativity. Such understanding might help us to assist these families in protecting their offspring from this risk, and thus break an otherwise unceasing cycle of detriment.

2. Literature Review

2.1 Intelligence and cognitive ability

People differ in the ability to understand complex ideas, adapt effectively to the environment, learn from experience, engage in various forms of reasoning and to solve problems (Neisser, *et al*., 1996). The source of such variations in intelligence or cognitive ability has been the focus of debate for more than 100 years. Various experts have asserted different definitions of intelligence:

> "The ability to carry out abstract thinking" (Terman, 1921)
>
> "Intelligence is whatever intelligence tests measure" (Boring, 1923)
>
> "The aggregate or global capacity of an individual to act purposefully, to think rationally, and to deal effectively with the environment" (Wechsler, 1944)
>
> "…a very general mental capability that, among other things, involves the ability to reason, plan, solve problems, think abstractly, comprehend complex ideas, learn quickly and learn from experience. It is not merely book learning, a narrow academic skill, or test-taking smarts. Rather, it reflects a broader and deeper capability for comprehending our surroundings—'catching on', 'making sense' of things, or 'figuring out' what to do."
> (Editorial accompanied by 52 signatories) (Gottfredson, 1997)

2.1.1 The general intelligence factor, *g*

One of the most influential approaches to understanding intelligence is based upon psychometric testing, which regards intelligence as cognitive ability. This derives from work begun in 1904 by Charles Spearman, who noted that people who excelled in one type of mental ability test did well on others, and that those who performed poorly on one of them also tended to be below average on the others. Based upon this concept, he proposed the existence of a general factor of intelligence – *g* – constituting the general mental ability common to many different cognitive abilities (Spearman, 1904).

Throughout the twentieth century researchers argued for (Jensen, 1998; Spearman, 1927) and against the general factor *g* (Guilford, 1956; Horn & Cattell, 2006), while others insisted that a range of uncorrelated narrow abilities (Guilford, 1956) or more specific group factors, such as memory or number facility (Thurstone, 1938), accounted for individual differences.

As a result of a series of factor analyses undertaken to clarify the complex patterns of correlation first observed by Spearman, together with a more recent reanalysis of more than 400 datasets by Carroll (1993), a hierarchical model of intelligence gained prominence. This model places *g* at the apex, with more specific aptitudes – the group factors – arrayed at successively lower levels just below *g.* Below these are skills that are more dependent on knowledge or experience, such as the principles and practices of a particular job or profession (figure 2.1). The most prominent group factors are verbal, spatial memory and processing speed (Deary, 2001a). This hierarchical structure has been shown to be highly similar across diverse ethnic groups as well as between the sexes (Carretta & Ree, 1995).

Disputes over the utility of *g* have been many, with critics arguing that intelligence based upon test scores alone ignores important aspects of mental ability. As a result, more recent theories derived from multiple forms of intelligence have also gained support, particularly among educators who recognise that psychometric tests based upon *g* do not always distinguish the most able students (Neisser, *et al*., 1996). Gardner, for example, contended that there are several types of intelligence, including spatial, musical and interpersonal, and that every person has a profile of strengths and weaknesses (Gardner, 1983). Alternatively, Sternberg (1985) proposed a triarchic theory of intelligence composed of analytic, creative and practical abilities – of which only the first is measured to any significant extent by psychometric tests. Parallel with these arguments, developmental psychologists have focused on those processes whereby children come to think intelligently, rather than on the measurement of individual differences. Piaget, for example, described cognitive development as representing four levels, with development from one stage to the next being caused by the accumulation of errors in the child's understanding of the environment. Such accumulation eventually causes thought structures to reorganise themselves (Piaget, 1971). In contrast, biologists have suggested that certain aspects of brain anatomy and physiology might be relevant to intelligence, such as cerebral glucose metabolism (Haier, 1993) and brain size (Andreasen, *et al*., 1993).

Nevertheless, many researchers still regard *g* to be the most fundamental measure of intelligence, and while there is no absolute agreement on what *g* actually means it is often employed as the working definition of intelligence (Plomin & Spinath, 2002). For historical reasons the term IQ, which in the past referred to the intelligence quotient formed by dividing mental age by chronological age, is often applied to describe scores on tests of psychometric intelligence.

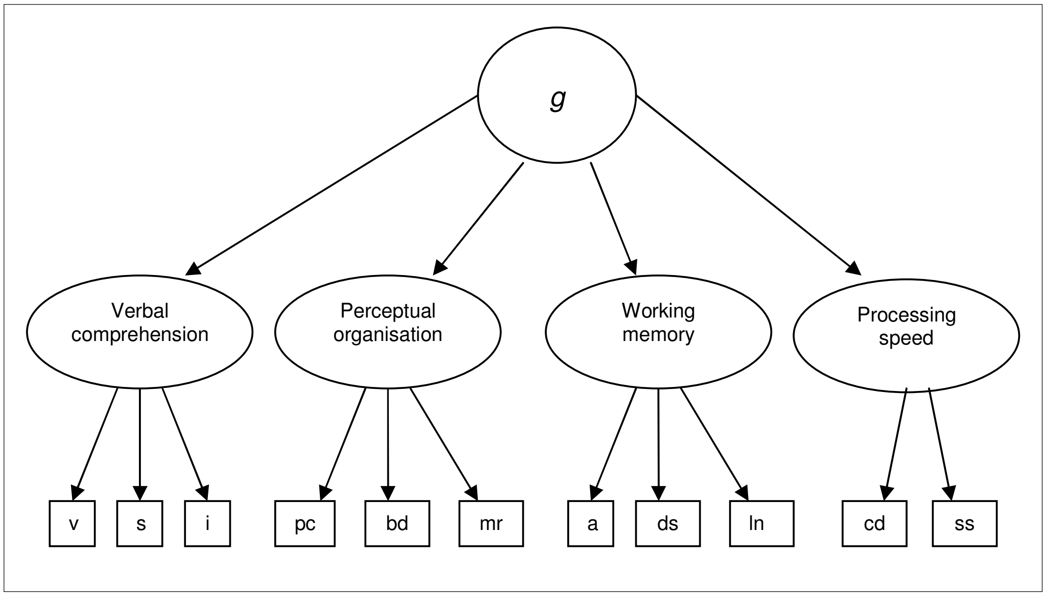

Figure 2.1 The hierarchical structure of cognitive ability differences, representing the group factors (verbal comprehension, perceptual organisation, working memory, processing speed) and below these, the skills acquired through learning (v:vocabulary; s:similarities; i:information; pc:picture completion; bd:block design; mr:matrix reasoning; a:arithmetic; ds:digit span; ln:letter–number sequencing; cd:digit-symbol coding; ss:symbol search) (adapted from Deary, 2001).

2.1.2 Cognitive ability tests

Cognitive ability tests, which originate in Alfred Binet's 1904 test to measure the ability of children to succeed in school (Binet, 1905), come in many forms. Some use only a single type of item or question – for example, the Peabody Picture Vocabulary Test, which is a measure of children's verbal intelligence (Dunn & Dunn, 1997). Others are designed to measure many different types of verbal and non-verbal abilities (Neisser, *et al*., 1996). Examples of these general tests include the Stanford-Binet (Thorndike, *et al*., 1986) and Wechsler tests (Wechsler, 1997). Since people from differing cultural or ethnic groups may interpret test materials differently, depending on their experiences and backgrounds (Neisser, *et al*., 1996), cognitive ability tests are usually designed to apply to a particular population. Similarly, developmentally-appropriate tests are available for different age groups. By convention ability test scores are usually converted to a scale where the mean is 100 and the standard deviation 15. The spread of IQ scores can be represented by the normal distribution with approximately 95% of the population having scores within two standard deviations of the mean – that is, between 70 and 130 (Spearman, 1927).

There is general consensus that *g* accounts for approximately half the variance among individuals in performance on diverse cognitive tests such that when *g* is taken into account, there is still variance attributable to the specific abilities that the test is meant to assess (Deary, 2001a). As emphasised by the theories of multiple intelligences, psychometric tests do not measure a wide range of human ability – such as creativity and spatial awareness. Test scores, however, are strongly related to school achievement (Deary, *et al*., 2007) and occupational performance (Schmidt & Hunter, 1998).

Previous studies investigating intelligence as a determinant of differences in social status and material conditions in adulthood include an early analysis of seven studies from the 1960s and 1970s by Jencks, *et al*., (1979). These studies ranged in size from 198 to 1,789 and they typically collected mental ability test scores during school years and assessed educational and occupational outcomes in early adulthood. They concluded that adolescent ability test scores accurately predicted educational outcomes and occupational status. These associations remained after controlling for parental background variables of the subjects. In an unadjusted analysis of the British 1958 birth cohort (also known as the National Child

Development Study), those achieving a professional class by age 42 had cognitive scores one-and-a-half standard deviations higher than those not reaching beyond the unskilled class, regardless of class of origin (Nettle, 2003). Using data from the National Longitudinal Survey of Youth in the USA, Hernstein and Murray (1994) reported inverse associations between early mental ability and later poverty, schooling, education, marriage, welfare dependency, child health, and crime.

Considerable evidence exists that intelligence scores are relatively stable across the life course (Deary, *et al*., 2000; Deary, *et al*., 2004; Richards & Sacker, 2003) and that there is a continuity in cognitive ability between generations. For example, making use of structural equation models Guo, *et al*., (2000) demonstrated that maternal cognitive ability exerted a consistent positive influence on the intellectual development of offspring across four measures of ability, after controlling for a variety of environmental factors such as cognitive stimulation, poverty and parenting style. Furthermore, parental intelligence scores have repeatedly been shown to influence offspring intelligence in genetic studies, with modest correlations of approximately 0.40 between parent and offspring scores (Plomin & Spinath, 2004). Such intergenerational similarities in cognitive ability are the product of both genetic and environmental factors.

2.1.3 Genetic influences on cognitive ability

Much of the evidence supporting a genetic influence on cognitive ability has come from behavioural genetic studies, which apply data from studies of twins and adopted children to examine sources of variation in human traits and characteristics. These natural experiments provide information on genotype-environment correlations that indicate similarity of observable traits, such as cognitive ability between parents, offspring and siblings, whether or not they are genetically related. Assuming a genetic influence, genetically-related family members living together should be more similar than adoptive members who are not genetically related, while genetically-related individuals adopted apart should be similar even though they do not share the same family environment.

A review of more than 8,000 parent-offspring pairs, 25,000 sibling pairs, 10,000 twin pairs and hundreds of adoptive families by Plomin and Spinath (2004) reported correlations of approximately 0.40 between parents and offspring and approximately 0.45 for siblings in cognitive ability scores. This resemblance is due both to genetic and to environmental influences, because such relatives share both. In adoption studies of cognitive ability, intergenerational correlations between biological parents and offspring adopted into another family were higher (0.24) than those seen in adoptive parents who had no genetic link with their children but who had brought them up (0.18) (Plomin & Spinath, 2004). This suggests a genetic contribution to parent-offspring resemblance. If the influence of parental intelligence on offspring ability was largely environmental in its effect, correlations would have been more similar in the two groups (Plomin, 2001). The twin method supports that conclusion. Monozygotic twins (who share all of their genes) raised together show correlations of 0.86 for cognitive ability tests, while dizygotic twins (who share on average half of their genes) showed correlations of approximately 0.60. Assuming that twins of both types share their environments (for example, parenting received) to the same extent, greater similarity in monozygotic versus dizygotic twins indicates a genetic influence (Plomin & Spinath, 2004).

Correlations between relatives are typically utilised to compute heritability estimates, ranging from 0 to 1. Heritability is interpreted as being the proportion of phenotypic variance that can be accounted for by genetic differences among individuals. The remaining variance is attributable to environmental factors such as nutrition and education, and experimental errors such as a lack of reproducibility in a test (Plomin, 2001). Environmental influences can be further subdivided into two components: the shared and unshared environment. The shared environment refers to experiences that are near perfectly correlated among family members (for example, the number of books at home) while the non-shared environment relates to experiences uncorrelated among siblings (for example, exposure to different parenting styles or peer relationships). The non-shared environment therefore includes events or occurrences both inside and outside the family. Simultaneous analyses of all the family, adoption and twin data reviewed by Plomin and Spinath (2004), yielded a mean estimate of heritability of approximately 50%, with genes accounting for about half the variation in cognitive ability, and environmental factors for the remaining 50%.

These estimates, however, might be confounded by several factors. Adoption into similar, yet separate, adoptive homes might exaggerate environmental influences when comparing adopted-apart siblings and twins. Furthermore, resemblances between biological parents and their adopted offspring might reflect prenatal environmental influences rather than genetic heritability (Plomin, 2001). It has also been found that monozygotic twins (compared with dizygotic twins) are treated more similarly by their parents, spend more time together and often share the same friends (Maccoby, 2000). These factors might weaken those findings that point in the direction of a genetic effect.

It is important to note that heritability estimates refer to the contribution of genetic differences to observed differences among individuals for a specific trait in a particular population. Indeed, data from twin studies suggest that genetic and environmental contributions to cognitive ability vary with age in that heritability increases linearly from infancy (20%) to childhood (40%) to adulthood (60%). Estimates of IQ heritability from the Texas Adoption Project and Colorado Adoption Project increased from 0.38 to 0.78, while estimates of shared environmental influence decreased from 0.19 to 0.00 as the adopted children in the families being studied aged. One plausible explanation for these age-related changes is that as individuals age, they increasingly choose environments in accordance with their genetic predispositions, thereby diminishing the influence of their social origins and family background (Neisser, *et al.*, 1996).

There is also some evidence that the proportion of IQ variance attributable to genes and environment varies non-linearly with social background. An analysis of twins, siblings, half-siblings, cousins and unrelated siblings reared together from the National Longitudinal Survey of Youth, concluded that heritability increased, and the influence of the shared environment decreased, as parental education increased (Rowe, *et al.*, 1999). In contrast, a study of impoverished families from the National Collaborative Perinatal Project, found that 60% of the variance in cognitive ability was accounted for by a shared environment while the contribution of genes was close to zero. The opposite effect was found in affluent families (Turkheimer, *et al.*, 2003).

Large heritability estimates do not necessarily mean that the environment has little or no effect on variations in cognitive ability. Genetic effects are known to depend on environmental influences, such as the learning environment or family background (Plomin, 2001). Vocabulary size, for example, has been shown to be largely heritable. Every word in the vocabulary of a person is learned, and this learning depends on exposure to new words as a genetic predisposition on the part of the individual to seek out and learn new words (Rutter, 2005).

Heritability estimates derived from genetic studies provide the best available evidence for the importance of environmental influences on cognitive ability. In behaviour genetics, estimates of an environmental effect are derived by assuming that genetic and environmental results can be separated into independent components that together add to 100% of the variance – that is, if heritability is 50%, environmental factors account for the remaining 50% (Plomin, 2001). Although proper interpretation of the influence of environmental factors on cognitive ability requires simultaneous consideration of genetic effects, there is extensive evidence that a range of social and biological variables affect cognitive development.

2.1.4 Environmental influences on cognitive ability

2.1.4.1 Generational gains in cognitive ability scores: the Flynn effect

One of the most prominent environmental effects on cognitive ability is the generational gains in mean intelligence scores observed over the past several decades. These increases, first described by James Flynn (Flynn, 1984), have been reported in numerous countries (Flynn, 1987; Lynn & Hampson, 1986) and have occurred during time spans too short to reflect genetic changes. The magnitude of this so-called 'Flynn effect' has been shown to vary in time and place and by cognitive ability test, but can generally be summarised to be about three to five IQ points per decade (Teasdale & Owen, 2005). As a result, most cognitive ability tests are periodically restandardised to a mean of 100 (Neisser, *et al*., 1996).

These ability gains over the course of time do not seem to be accompanied by a corresponding achievement advantage, thus emphasising the fact that though steady gains in general knowledge, vocabulary and reasoning are apparent, the relative position of individuals in comparison with others of the same age has not changed. Furthermore, these increases have occurred despite the fact that heritability estimates for IQ have remained relatively stable over the same time period (Maccoby, 2000). This highlights the fact that high heritability does not imply that cognitive ability is not also subject to the influence of environmental factors, or that it cannot be changed by alterations in environmental conditions (Dickens & Flynn, 2001).

The Flynn effect has been ascribed to several causes, including improved nutrition (Lynn, 1990) and educational development (Neisser, 1998). The 'Early Learning

Centre' theory (Deary, 2001b) suggests that test materials are becoming more familiar through, for example, children's toys, television programmes and computer games, and this results in higher test scores. Some studies concentrating on the distribution of cognitive ability scores across time have reported that generational intelligence gains are focused in the lower half of the distribution. For example, Colom, *et al.*, (2005) presented data supporting the nutrition hypothesis, which posits that gains in cognitive ability occur predominantly at the low end of the distribution where nutritional deprivation is most severe.

2.1.4.2 Education and occupation

Numerous longitudinal studies have reported significant associations between early socioeconomic position (SEP) and later intelligence. SEP is a reflection of an individual's or a family's social status based upon their control of economic resources such as assets or knowledge (Kuh, *et al.*, 2004). Measures of SEP, which include level of education, paternal occupation, income and housing conditions, are designed to identify adverse or protective factors that are socially patterned and reflect the social status of an individual. Studies discussed in this review used a variety of SEP measures. Some of them did not specify which aspect of social status they measured.

Influences of parental SEP on offspring cognitive ability have been reported as early as 22 months (Feinstein, 2003), with effects continuing into adulthood (Jefferis, *et al.*, 2002; Kaplan, *et al.*, 2001; Lawlor, *et al.*, 2005; Wilson, *et al.*, 2005). These associations persisted after adjustment for a wide range of possible mediating factors, including birth weight, breast-feeding (Jefferis, *et al.*, 2002) and education (Jefferis, *et al.*, 2002; Kaplan, *et al.*, 2001; Wilson, *et al.*, 2005). In these studies, measures of social background were typically based upon paternal occupation at birth or parental educational attainment. It was found that on the whole childhood intelligence was greater among those who had more highly educated parents, or a father who was employed in a professional occupation. For example, in a study based upon longitudinal data from a cohort of children born in Aberdeen, low paternal social class at birth was found to be linearly associated with intelligence at ages seven, nine and 11 years after accounting for a range of perinatal, parental and childhood factors (Lawlor, *et al.*, 2005). In adjusted models, children from the lowest social class group had intelligence test scores that were on average almost 14 points lower than those in more affluent social groups. Evidence for a persistent effect of early social background across the life course is provided by a population-based study of 496 Finnish men, which reported that lower childhood SEP was associated with poorer adult cognitive function after adjusting for own educational attainment (Kaplan, *et al*., 2001). However, Richards and Sacker (2003) used path analysis to show that the direct influence of paternal occupation on mid-life cognition was negligible, and was almost entirely mediated by childhood cognitive ability and, to a lesser extent, educational and occupational attainment.

The influence of paternal social class on childhood IQ is also important, because scores on tests of intelligence are known to be associated with intergenerational class mobility, with high scorers tending to improve their social positions compared with those of their fathers while low scorers are inclined to move downwards in social status (Mascie-Taylor & Gibson, 1978; Nettle, 2003).

2.1.4.3 Intergenerational social mobility

Social mobility may be intragenerational or intergenerational – that is, movement may occur between one social class and another over the life course of an individual, or may take place across generations respectively. However, a person born into the top social class can only move downwards or remain stable and someone born into the bottom social class can only move upwards or remain in the same class (Nettle, 2003).

Influences on the probability and direction of social mobility include factors such as material resources of the family of origin, education (Breen & Goldthorpe, 2001; Deary, *et al*., 2005; Jencks, 1979), and to a lesser extent the effect of individual differences such as height and health status (Blane, *et al*., 1999; Case, 2006). Only a small number of studies have assessed the contribution of IQ to intergenerational social mobility. The first of them applied correlation analyses to data from 5,083 men from the 1958 British birth cohort. Mobility was assessed using a measure of class trajectory calculated by subtracting the attained social class (defined according to occupation) from the paternal social class so that those with a zero score remained stable, those with a positive score moved up the SEP scale and those with a negative score moved down. It was found that regardless of social class origin, the higher the IQ, the more positive the social mobility (Nettle, 2003). Deary, *et al*., (2005), in a study of 242 Scottish men born in 1921, found that for each standard deviation increase in IQ score at age 11, the chances of upward social mobility increased by 69%, and the chances of downward mobility decreased by 35%. In models adjusted for height, education and number of siblings, education was shown to be most important for upward mobility, while low IQ was a risk factor for downward social mobility.

In analyses of British 1946 birth cohort members, Wadsworth (1991) found that intergenerational improvements in social class affected the cognitive development of their own children whose average scores on equivalent ability tests were higher. This suggests that intergenerational social mobility may play a role in facilitating the transfer of intellectual skills between generations. The question of whether or not changes in social class position explain intergenerational associations in cognitive ability is one of the key questions addressed by this work. Another central aim lies in the examination of the effect of parenting practices on intergenerational IQ associations. Evidence that parenting may be important in this relationship comes in part from the same study by Wadsworth, which noted that cohort members who were upwardly mobile were more likely to read to their children and to become involved in their schooling (Wadsworth, 1991). He also observed greater social participation and club membership among those in the higher social classes, and noted that they tended to 'extend and diversify' their patterns of social involvement. Similar findings were reported in a study of men aged 20 to 64 years (Goldthorpe *et al.*, 1980) indicating that upwardly mobile individuals benefit from increasing income as well as the associated advantages of good nutrition (Mishra, *et al.*, 2009), growing parental concern for educational attainment and intellectual stimulation. There is a growing body of research suggesting that these and other parenting practices are associated with offspring cognitive development.

2.2 Parenting

2.2.1 A historical perspective

Parenting – and what constitutes good parenting – has been at the centre of a long-standing debate. Concepts of parenting have varied in accordance with prevailing cultural standards, and changes over the last century have reflected an increasing recognition of the concept of childhood and a growing concern for children's rights. In the early 1900s, the most influential childcare expert was Dr Frederic Truby King, whose 'Twelve Essentials' for the raising of healthy infants were at the time considered to be revolutionary. These essentials were: air, sunshine, water, food, clothing, bathing, muscular exercise, sensory stimulation, warmth, regularity, cleanliness, mothering, management, rest and sleep. He advocated babies spending much of the day on their own outside in the fresh air. They should not be cuddled or comforted, even when in distress. Mothers were not encouraged to play with their babies, for fear of over excitement. Fathers had no role to play other than earning money (King, 1913).

Towards the middle of the twentieth century the idea that infant health was related to a mother's commitment to parenting led to the concept of "maternal inefficiency or incompetence". The measures of maternal inefficiency were based upon factors that were much more common among the poor through their lack of resources, leading to the general view that middle-class people were in fact better parents than working-class people (Herrnstein & Murray, 1994). For example, in the Newcastle 1,000 families study in the 1950s, the measures used to judge standards of family life included 'parent chronically sick', 'defective sleeping arrangements' and 'serious debt' - factors strongly correlated with lower social status (Spence, *et al*., 1954).

A more child-centred approach came into prominence as a result of increased interest in the psychological and social development of children. This interest evolved from experiments by Harlow on maternal deprivation and social isolation in Rhesus monkeys that demonstrated the importance of care-giving and companionship in the early stages of primate development (Harlow, *et al*., 1965). Following on from this, Bowlby's work on attachment theory had a profound influence on the way that parent-child relationships were viewed (Bowlby, 1988). He recognised the importance of parental affection and the role of parents in fostering a secure and loving relationship with their child early in life. He identified a sensitive period in the first five years of life when children were most dependent on parents for physical and emotional nurturance and protection. Subsequent work has shown that a secure and affectionate parent-child relationship during this period is related to positive mental health (Canetti, *et al*., 1997) and cognitive development later in life (Vanijzendoorn & Vanvlietvisser, 1988).

2.2.2 Recent developments in parenting research

In the late 1970s there was a marked increase in the volume and breadth of research on parenting, with important contributions coming from the developmental and psychological literature. This arose as a result of the apparent increase in behavioural problems (Collishaw, *et al*., 2004), child abuse and neglect, and juvenile crime and delinquency – for which parents were considered to be responsible (Taylor, *et al*., 2000). A review of the literature reveals that a wide range of criteria have been applied to define parenting, each of which varies in the number of items included, the definition, and mode of administration (summarised in table 2.1). The diversity of these criteria demonstrates that parenting, either good or bad, is difficult to define and equally difficult to measure.

2.2.2.1 Authoritative, authoritarian and permissive parenting

One of the dominant theories in development research on parenting, developed by Baumrind, categorises parents into three groups – authoritative, authoritarian and permissive – based upon the degree of control that they maintain over their children (Baumrind, 1971; Baumrind, 1991). Authoritative parenting is characterised by high expectations of compliance with parental rules and directions, an open dialogue on those rules and behaviours, and a child-centred approach characterised by warmth and high parental involvement, such as encouragement and an active participation in the child's life. Alternatively, authoritarian parenting involves the use of more coercive techniques to gain compliance, and little parent-child dialogue. This is a parent-centred approach characterised by a low level of trust and engagement towards the child with strict control. Permissive parenting is regarded as having few behavioural expectations for the child and is characterised by non-demanding parental behaviour and a lack of parental control. The permissive parent is generally described as lax and inconsistent, and uses withdrawal of love as a punishment. They also tend to show their ambivalence over discipline by alternating between praise and punishment. Many measures of parenting have been based upon Baumrind's three global typologies (e.g. Robinson, *et al*., 1995). Most notably, Maccoby and Martin (1983) revised Baumrind's conceptual framework to distinguish between two types of permissive parenting: those that are indulgent (warm but non-demanding) and those that are neglectful (non-demanding, non-controlling, and uninvolved).

These parenting styles are known to differ according to their affect upon children. There is consistent evidence that the authoritative style is associated with the best outcomes in many domains of child development, including psychosocial functioning (Lamborn, *et al*., 1991), academic achievement (Aunola, *et al*., 2000; Radziszewska, *et al*., 1996), emotional well-being, and behavioural adjustment (Steinberg, *et al*., 1994). This has been attributed to the encouragement of independent problem-solving and critical thinking. In turn, it has been suggested that authoritarian parenting detracts from learning by discouraging active exploration and problem-solving (Hess & Mcdevitt, 1984) while permissive parents do not foster self-regulation in children, which may leave them to be more impulsive and more likely to underachieve academically (Onatsu-Arvilommi & Nurmi, 1997).

2.2.2.2 Intellectual stimulation in the home environment

The developmental literature has also focused on aspects thought to be important for the psychosocial and cognitive development of children, such as the level and quality of intellectual stimulation that parents provide, as well as the variety of learning tasks that they facilitate or engage in with their children. One of the first measures designed specifically to assess the quality and quantity of stimulation and support available to a child in the home environment was the Home Observation for Measurement of the Environment (HOME) inventory. This instrument was first developed and used by Betty Caldwell and her colleagues in a longitudinal study during the 1960s (Elardo, *et al*., 1975).

Four age-appropriate versions of the inventory have subsequently been developed, each of which makes use of ratings of parent behaviour and the home environment based upon in-home observations of parent-child interactions and interviews with parents. The scales are comprised of variables that fall into three main categories: cognitive variables describing the experiences and materials that influence the level of cognitive stimulation in the home; social variables describing parent-child interaction; and physical environment variables describing the organisation of the physical environment (Bradley, 1994). Cognitive stimulation is indicated by the presence of toys that teach colour, size and shape. The HOME inventory is one of the most widely used observer rating scales and has been validated in many populations. Research has consistently demonstrated the association between scores on the scale and measures of cognitive, language, emotional and social development in normal and at-risk populations (Totsika & Sylva, 2004). This measure, however, has been criticised on the grounds that the outcomes are highly correlated with family SEP and therefore might be measuring the effects of socioeconomic status rather than parenting (Taylor, *et al*., 2000). Other measures used in the literature to demonstrate the positive effects of parental facilitation of development on cognitive and educational outcomes include parental aspirations and attitudes towards learning (Hobcraft, 1998) and engagement in learning-oriented tasks such as reading and outings (Cairns, *et al*., 1998; Guo & Harris, 2000; Marjoribanks, 2001; Marjoribanks, 2003; Maughan, *et al*., 1998).

2.2.2.3 Discipline

One aspect of parenting that appears repeatedly in the literature is discipline. This most often refers to methods that parents use to discourage inappropriate behaviour and to gain compliance from children (Locke & Prinz, 2002). Some disciplinary techniques have been shown to encourage appropriate child behaviour and prevent misbehaviour (for example, use of clear rules and requests, brief withdrawal of privileges and reasoning to increase the child's awareness of the consequences of certain behaviours). Others are seen as ineffective because they reinforce child misbehaviour or model inappropriate behaviour (for example, poor temper control) (Regalado, *et al*., 2004). Examples of ineffective discipline practices, often termed maladaptive parenting in the literature, include excessive attention leading to social reinforcement of bad behaviour, use of harsh physical punishment and frequent reliance on coercion (Locke & Prinz, 2002). Coercive parenting, which is often measured using items that fall under Baumrind's authoritarian typology, refers to external pressure that parents place on their children by adopting practices such as harsh discipline, bullying, deprivation of privileges, hostility, and threats. Such practices are especially associated with behavioural problems including delinquency, drug abuse and aggression (Bor & Sanders, 2004; Tremblay, *et al*., 2004).

One form of discipline that has undergone a vast change in perspective over the past century is that of corporal punishment. A commonly cited modern definition of corporal punishment is "the use of physical force with the intention of causing a child to experience pain but not injury, for the purposes of correction or control of the child's behaviour" (Elliman & Lynch, 2000). Other terms used to describe corporal punishment in the literature include: whip, smack, thrash, strike, hit, beat, belt, paddle and cane. Historically, Victorian Britain promoted the beating of children into obedience and duty and felt that they were divinely commanded not to "spare the rod and spoil the child" (Baron, 2005). However, since the 1950s there has been a shift from a complete acceptance of corporal punishment to one of limited approval, with the cane being outlawed in British schools in the 1986 Education Act. Much of this decline in the practice and approval of smacking children arose from increasing concern for children's rights (Davis, *et al.*, 2004), and more recently from questions arising about the efficacy of corporal punishment (Elliman & Lynch, 2000). Previous studies have established that under certain circumstances the corporal punishment of children can increase short-term compliance with parental commands, although comparisons in the same studies with alternative punishments such as one-minute time-outs did not establish that corporal punishment was more effective (Elliman & Lynch, 2000). Furthermore, some evidence suggests that its use is associated with adverse outcomes such as antisocial behaviour (Grogan-Kaylor, 2005).

2.2.2.4 Nurturance and responsivity

Two other widely studied parenting constructs are nurturance and responsivity. The former is concerned with the provision of a positive atmosphere for the parent-child relationship and the child's emotional development, and includes affection, verbal statements of love and playing a game together (Locke & Prinz, 2002). The HOME inventory, for example, asks the observer to record whether they saw behaviours such as a parent spontaneously praising a child's qualities; caressing, kissing, or cuddling a child; or using a term of endearment (Caldwell & Bradley, 1984). Responsivity goes a step further and recognises that the crucial feature in parent-child interactions includes both variety and meaningfulness of parental input in the stimulus sense, as well as reciprocity of interactions in terms of the active role taken by the child (Rutter, 1985).

It is also conceivable that not only does parenting affect the behaviour of children, but also that their reactions can influence the behaviour of their parents. This idea arose following studies showing that parenting practices varied according to the characteristics of the child. Early studies by Bell (1968) reported that parents were more likely to employ physical punishment when children were hyperactive or erratic in their behaviour. Similarly, boys have been shown to be punished more severely than girls indulging in similar behaviour, while maternal discipline is known to shift from physical techniques to verbal methods as children get older (Carter & Welch, 1981).

As can be seen from the diverse range of criteria used to measure parenting practices, no single definition of good parenting exists. Nevertheless, the reviewed studies agree that the relevant features include the provision of a variety of activities and experiences, ample parent-child play and conversation, responsivity to the child's verbal and non-verbal signals, parental nurturance, teaching of specific skills and opportunities for the child to explore, and to try out new skills and activities. It is also acknowledged that the child's active rather than passive participation is important so that there is sensitivity and responsiveness in reacting to the child's approaches and questions, and reciprocity in patterns of parent-child interactions (Rutter, 1985). In response to this seemingly endless list of what constitutes good parenting, many researchers have adopted the concept of 'good enough parenting'. This idea was first documented 60 years ago by Donald Winnicott (1965). He recognised that it is unrealistic to demand perfect parenting and to do so undermines the efforts of the vast majority of parents who are in most respects 'good enough' to meet their children's needs. Attempts at identifying the criteria that cause some parents to be 'good enough' and others 'not good enough' have focused on the development and antecedents of parenting practices across the life course and between generations.

2.2.3 Predictors of parenting practices

2.2.3.1 Intergenerational continuities in parenting

Part of the explanation for the behaviours of parents towards their offspring may reside in their own experiences as children. A small number of longitudinal studies of general population samples, many from the developmental literature, have concluded that those who were harshly treated as children grow up to subject their own children to similar practices (Conger, *et al*., 2003; Glass, 1999; Hops, *et al*., 2003; Wadsworth, 1985). For example, a study of aggressive parenting involving more than 600 people found that parental aggression predicted aggressive parenting by their children more than 20 years later (Huesmann, *et al*., 1984). Similarly, Conger, *et al*., (2003), employing structural equation modelling, demonstrated a direct connection between aggressive parenting in one generation and similar behaviours in the next. For this study, parenting behaviours were measured when the second generation reached 15 to 17 years of age and then when they themselves were parents, five to seven years later. More recently, a body of research focusing on the continuity of constructive parenting across generations, including warm-sensitive parenting (Belsky, *et al*., 2005), parental support (Chassin, *et al*., 1998) and supportive parenting (Chen & Kaplan, 2001), has also emerged.

These parenting behaviours may be replicated across generations as a result of the tendency of individuals to maintain the SEP (and the associated risk or protective factors) in which they were brought up. For example, the stressors associated with low SEP may promote irritability and increase the likelihood of harsh parenting in successive generations. Alternatively, the social background of an individual may influence that person's approach and attitude to parenting regardless of the SEP achieved in adulthood (Simons, *et al.*, 1991). Conger, *et al.*, (2003), in their study on aggressive parenting found evidence supporting a social learning model that hypothesises that children learn how to raise their own children from the ways in which they themselves were parented and through direct training resulting from thousands of parent-child interactions over the course of time. Chen and Kaplan (2001) suggested an alternative explanation for the intergenerational relationship in parenting practices based upon the life course approach. They established that variables measured later in adolescence and early adulthood partly mediated the relationship between parent and offspring parenting practices. They demonstrated that early experiences in the parental home engendered general interaction styles in interpersonal relations and also affected the type and extent of social involvement (such as continuing participation in schooling or religious organisations). These in turn were directly associated with constructive parenting practices. This is consistent with previous studies where personality and the development of a particular belief system have both been implicated in the transmission of harsh parenting (Putallaz, *et al.*, 1998).

Many of the findings relating to intergenerational continuities in parenting are based upon very small sample sizes. A further methodological limitation is that the measures of parenting generally varied between the two generations, and few of them assessed parenting when offspring were the same age in successive generations, thereby distorting intergenerational associations. Adolescence, for example, is a period where parent-child relationships undergo considerable adjustment, and parenting practices directed towards adolescent children will conceivably be different from those involving younger children (Chen & Kaplan, 2001). The empirical evidence for the intergenerational transmission of parenting practices is therefore fairly weak and this is confounded by the difficulty of comparing findings between studies since they are based upon different parenting practices in a variety of populations at different points across the life course.

Stronger evidence is available for the role of social and educational factors in predicting parenting practices.

2.2.3.2 Education and occupation

Socioeconomic factors have been shown to have a direct influence on parenting behaviour, both in disciplinary practices and the ways that the intellectual development of the child is fostered. Evidence for an effect of SEP at birth on later parenting skills was provided by a study that tracked 57 women and their offspring over a 17-year period. Using path analysis, this study showed that the mother's SEP as a child determined the quality of the 'literacy' environment in which her offspring were brought up (Cairns, *et al*., 1998). There is also evidence that poverty, income loss and unemployment variously reduce the degree of responsiveness, warmth, and nurturance of parents towards their children while increasing inconsistent disciplinary practices and the use of harsh punishment (Elder, *et al*., 1985; Herrnstein & Murray, 1994; Lempers, *et al*., 1989; McLeod & Shanahan, 1993).

Data from the National Longitudinal Survey of Youth indicated that children from poor families had reduced access to many recreational opportunities and other learning situations and materials from infancy to adolescence. They were less likely to be taken on trips, to visit a library or museum, or be given lessons directed at enhancing their skills (Bradley, *et al*., 2001). Without such opportunities, children can become bored and frustrated, leading to negative behaviour that contributes to the coercive styles of parenting seen in families of lower SEP (Bradley & Corwyn, 2002). Harsh discipline has also been associated with young parents. In several studies teenage mothers used corporal punishment more frequently compared with those of 20 years and older (Regalado, *et al*., 2004; Wissow, 2002). The basis for this association is uncertain since SEP variables, including household income and maternal education were controlled for in these analyses. It might be attributable to inexperience on the part of teenage parents.

Parental education may also influence the social distribution of parenting practices. In members of the British 1946 birth cohort, Wadsworth (1986) found that better educated mothers reported themselves to be less punitive, more affectionate, more stimulating and more imaginative in terms of coping with boredom in their children. In a study of low-income families, mothers whose partners had benefited from a higher level of education received higher scores on ratings of sensitivity and positive regard (Kagan & Freeman, 1963). Mothers possessing greater levels of education were also shown to be less likely to apply restrictive or coercive methods of discipline and more likely to justify any punishments imposed. One explanation might be that certain elements of parenting are altered by available financial resources and the extent of parental educational achievements so that children from relatively high SEP families experience an intellectually more advantageous home environment (Herrnstein & Murray, 1994). Family income, for instance, might influence the quantity and quality of books available at home, as well as the number of cultural trips that a family can afford that serve an intellectual purpose. Furthermore, SEP may affect the ways that parents interact with their children. Poor living conditions, ill health and unemployment may variously lead to greater psychosocial stress among lower SEP parents, rendering them less responsive to their children's needs (Guo & Harris, 2000).

2.2.3.3 Mental health

Mental health is another important factor affecting the quality of parenting. The literature on parenting behaviours of those with mental illness covers a wide expanse of parenting practices and comprises studies of diverse samples, methods and measures in children ranging from infancy to adolescence. Definitions of mental illness extend from clinical diagnoses to elevated symptoms reported on a standardised psychiatric interview, and include current diagnosis and lifetime diagnoses. Since childbirth itself increases the risk of serious psychiatric symptoms, such as depression and anxiety, with an elevated risk continuing throughout the early years of parenting (Downey & Coyne, 1990), much of the attention in the parenting literature is on mental illness in mothers.

Maternal mental illness is associated with a number of parenting problems, including increased hostility, higher rates of negative interactions (Lovejoy, *et al*., 2000) as well as the use of coercive discipline (Bor & Sanders, 2004) and more permissive parenting (Gisselmann, 2006). In a meta-analysis of 46 observational studies of maternal depression and parenting behaviour, Lovejoy, *et al*., (2000) concluded that depressed mothers of infants and young children were more hostile and irritable, more disengaged from their children and registered lower rates of play and other positive social interactions. In another analysis of postnatal depression, which specifically looked at maternal depressive illness following childbirth, mothers with depressive symptoms had reduced odds of playing with and talking to their infants (McLearn, *et al*., 2006a). One of the few studies to include both mothers and fathers demonstrated that self-reported depressive symptoms were associated with fewer positive parent-infant interactions, with a particular reduction in the degree of enrichment interactions, including reading, telling stories and singing songs (Paulson, *et al*., 2006). Overall, these effects were moderated by the timing of depression with current depression associated with the greatest effects. In studies of women with lifetime mental illness, the mother-child interactions were more negative and coercive than in the control groups (Lovejoy, *et al*., 2000; McLearn, *et al*., 2006b).

Such findings of impaired parenting are not specific to depressive disorders. In another review of mothers with serious mental illness, which included diagnoses of depression, schizophrenia, bipolar disorder and affective disorder, diagnosed mothers of school-age children were found to be less encouraging and less responsive towards their children, as well as being less active in interactions with them (Oyserman, *et al*., 2000).

Parental mental illness has also been shown to elevate children's academic problems (Oyserman, *et al*., 2005) and to have long-lasting effects on their cognitive development (Cogill, *et al*., 1986). A study of 317 low-income mothers all diagnosed with serious mental illness, attributed poor academic outcomes to a lack of parenting confidence, most notably an inability to impart appropriate discipline (Oyserman, *et al*., 2005).

These diverse patterns of parenting that vary according to mental health, education and occupation assume that parental behaviour is a learned pattern that reflects a history of influences across the life course, as well as current stresses and child characteristics. Nevertheless, behaviour genetic techniques have identified important genetic influences on parenting in addition to those environmental factors already discussed.

2.2.3.4 Genetic effects

Much of the evidence for a genetic effect on parenting comes from child-based designs that investigate the extent to which children's genetic propensities affect their parents' behaviour by comparing the similarity in the parenting received by monozygotic and dizygotic twins. Using this design, the child's genes are the unit of measurement. Thus genetically-influenced characteristics of children are expected to affect the way that parents treat them, so that monozygotic twins would tend to be parented more similarly than dizygotic twins, and full siblings parented more similarly than half or step-siblings (Neiderhiser, *et al*., 2004). In more than a dozen of such studies, higher monozygotic than dizygotic twin correlations indicated genetic influences on parenting dimensions, including parental warmth and support (Elkins, *et al*., 1997), discipline (Knafo & Plomin, 2006; Wade & Kendler, 2000) and negativity (Neiderhiser, *et al*., 2004). In contrast, primarily environmental influences were found for measures of parental monitoring and control, with little evidence of genetic influences (Deater-Deckard, 2000; Plomin, *et al*., 1994; Rowe, 1981). This approach, however, has its limitations in that genetic influences on parenting are measured only indirectly via genetic influences on children's behaviour that elicit certain parenting behaviours. For example, children who are relatively well adapted may predispose parents to respond with positive affection and positive discipline (Knafo & Plomin, 2006). The complementary genetic design that relies on parents, such as twins who are parents, centres instead on the influence of parents' genes on how they parent their children (Neiderhiser, *et al*., 2004; Plomin, *et al*., 1994).

Few investigations have used a parent-based design to assess genetic and environmental influences on parenting. Those of them that have, report inconsistent results. A study of twin women who were parents found that genetic and non-shared environmental influences were important for maternal warmth, while shared and non-shared environmental influences explained all of the variance for maternal protectiveness and authoritarianism (Kendler, 1996). Applying the same measures of parenting, Perusse, *et al*., (1994) found genetic influences for all parenting behaviours but no evidence for an environmental effect. Somewhat different results were reported in a separate study which found that both genetic and non-shared environmental influences were important for parental warmth and negative control (Losoya, *et al*., 1997). In another study of 300 twin pairs from Germany, a moderate genetic influence was observed for over-protectiveness, authoritarianism and supportive parenting (Spinath & O'Connor, 2003). Overall, the evidence supporting a genetic influence on parenting is contradictory. This may be due to variations in the study populations or designs but there is some suggestion that genetic factors may well operate alongside the environmental influences already discussed.

What is evident from the literature is that many influences exist across the life course that affect the development of parenting skills. Social, educational and genetic factors accumulate across the lives of parents to determine their behaviours towards their children. Furthermore, different parenting practices are known to be associated with a variety of outcomes in the succeeding generation, including antisocial behaviour (Dogan, *et al.*, 2007; Grogan-Kaylor, 2005), academic competence and, most notably, cognitive ability (Andersson, *et al.*, 1996; Estrada *et al.*, 1987; Olson & Kaskie, 1992; Wadsworth, 1986).

2.2.4 Parenting practices and offspring cognitive ability

Interest in the potential impact of parenting behaviours on cognitive outcomes in the next generation arose out of a series of early investigations using the HOME inventory by Caldwell, Bradley and Eldardo which, although based upon small sample sizes, provided initial evidence of a strong association between maternal responsivity, maternal involvement with the child and the provision of appropriate play materials, and mental test performance (Bradley & Caldwell, 1976a; 1976b; 1980; 1984) and language competence (Elardo, 1977) between the ages of six months and four years.

However, it is important to determine whether associations between parenting and the cognitive abilities of children are independent of parental cognitive ability or are perhaps accounted for by this. This work therefore examines which aspects of parenting have the strongest effects on offspring cognitive development and whether or not these parenting practices are involved in the intergenerational transfer of cognitive ability. The background to these questions was considered in a review of prospective longitudinal studies that directly assessed the influence of parenting practices on offspring cognitive ability in early childhood. Some 14 such studies were identified (they are summarised in table 2.1). Three of the selected studies related to analyses of British birth cohorts (Douglas, 1967; Maughan, *et al.*, 1998; Richards & Wadsworth, 2004; Wadsworth, 1986) and one was based upon the National Longitudinal Survey of Youth conducted in the USA (Guo & Harris, 2000). The studies ranged in size from 50 (Kagan & Freeman, 1963) to 2,742 parent-offspring pairs (Maughan, *et al.*, 1998), year of birth from 1946 (Douglas, 1967; Richards & Wadsworth, 2004) to 1999 (Lugo-Gil & Tamis-LeMonde, 2008; Tamis-LeMonde, *et al.*, 2004), aspect of parenting measured, age of offspring (three to 11 years) and type of cognitive assessment. Most notably, 'parenting' was poorly defined and varied markedly between the various studies.

Overall, the studies indicated that teaching specific skills (Tamis-LeMonde, *et al*., 2004), providing opportunities for children to explore and try out new skills and activities (Guo & Harris, 2000), parental encouragement (Douglas, 1967; Maughan, *et al*., 1998), nurturance (Andersson, *et al*., 1996), and affection (Estrada *et al*., 1987; Guo & Harris, 2000; Wadsworth, 1986) all benefit cognitive development, whereas controlling, harsh and coercive behaviours (Estrada *et al*., 1987; Kagan & Freeman, 1963; Smith & Brooks-Gunn, 1997) adversely affect cognitive outcomes. What is also evident is that in addition to learning opportunities and materials, children require a responsive, reciprocal interaction and communication rather than a one-way input (Olson & Kaskie, 1992; Rutter, 1985).

Kagan and Freeman (1963) showed that the positive effects of maternal justification of discipline and the detrimental influence of coerciveness on children's ability scores remained significant after the effect of maternal education was partialled out. In a study of 128 Bermudan families, Scarr (1985) found that maternal discipline techniques were significantly related to offspring cognitive ability at the age of four but these positive relations were fully accounted for by maternal cognitive ability and education. Another study of 715 low birth weight children reported that high levels of harsh physical punishment were associated with lower mean ability scores in girls after adjusting for the effects of maternal education, SEP and birth weight. However, the selective nature of this study population might have distorted effect estimates since premature children are known to be at risk of harsher parenting as behavioural characteristics render them more difficult and less responsive to maternal interactions and care-giving (Hoy, *et al*., 1988). In another study, Estrada, *et al*. (1987) reported that the affective quality of the mother-child relationship, which measured levels of warmth, responsiveness and punitiveness, were correlated with children's four and six year ability scores after maternal cognitive ability and SEP had been taken into account. Consistent with this finding, Olson and Kaskie (1992) reported that verbal interaction between mothers and their children remained positively associated with offspring ability scores at ages six and eight years after controlling for SEP. However, these studies were based upon correlation analyses of small sample sizes ranging from 50 (Kagan & Freeman, 1963) to 715 (Smith & Brooks-Gunn, 1997) parent-child pairs. The findings should therefore be viewed with some caution.

More robust support for the role of parenting practices in predicting offspring cognitive ability is provided by a number of regression analyses. In a study by Andersson, *et al.*, (1996) of 234 mothers and their small-for-gestational-age children, the relationship between maternal nurturance and cognitive ability scores in boys, but not girls, remained after the effects of maternal cognitive ability and SEP were controlled. In two high-risk sample of low-income families (Lugo-Gil & Tamis-LeMonde, 2008; Tamis-LeMonde, *et al.*, 2004), the positive effects of supportive parenting on offspring cognitive ability scores at 24 and 36 months remained when parental education and SEP were taken into account. The five population-based studies which used prospective data from the two British birth cohorts (Douglas, 1967; Maughan, *et al.*, 1998; Richards & Wadsworth, 2004; Wadsworth, 1986) and the National Longitudinal Survey of Youth in the USA (Guo & Harris, 2000) provide the most robust evidence for an association between parenting variables and offspring cognitive ability. In the 1958 birth cohort, parental interest was positively associated with offspring ability in analyses adjusted for SEP and parental education. There was also some evidence that cognitive development in girls benefited from parental reading habits (Maughan, *et al.*, 1998). In support of this finding, a study of 57 mother-offspring pairs reported that a high literacy environment, defined according to how often mothers read to their children, was associated with increases in ability scores in girls, but not boys (Cairns, *et al.*, 1998).

Guo and Harris (2000) employed structural equation modelling to show that maternal cognitive ability, but not educational attainment, was positively and directly related to offspring cognition. However, both education and mother's cognition exerted a highly significant and independent effect on cognitive stimulation, which in turn predicted offspring intellectual development. This finding points towards a possible role for parental intelligence and education in determining offspring mental ability through its effect on the development of parenting behaviours.

2.2.4.1 Evidence from the British 1946 birth cohort

Previous analyses of the British 1946 birth cohort, which included more than 1,500 parent-offspring pairs, revealed associations between various parenting measures and cognitive outcomes in cohort members when they were children (Douglas, 1967; Richards & Wadsworth, 2004), and also in cohort members and their second-generation offspring (Wadsworth, 1986). Average to poor maternal management and understanding was strongly associated with lower cognitive ability at age eight independent of paternal social class and maternal education (Richards & Wadsworth, 2004). Douglas (1967) showed that cohort members whose parents gave them the most encouragement and took an interest in their school work did better in picture intelligence tests as well as in reading, vocabulary and arithmetic at both eight and 11 years of age. Social class differences were also evident in this cohort in that middle-class parents took more interest in their children's progress at school than manual-class parents, and they (the middle class) became relatively more interested as their children grew older. A further analysis, controlling for the effects of social background, showed that the residual influence of parental interest on measured ability although attenuated, was still considerable (Douglas, 1967). The positive effects of parental interest were shown to persist into the next generation in that British 1946 birth cohort members who received high parental encouragement and interest in their education were subsequently the group most likely to enrol their own first-born children into some kind of preschool education at age four, and in due course this experience enhanced the chances of the offspring of gaining high scores on verbal attainment tests taken at age eight (Wadsworth, 1986). This study of the offspring of cohort members also provided initial evidence of an effect of parenting practices on mental ability across generations. The level of affection shown by mothers towards their offspring, and action taken by mothers when their children were bored, were related to verbal attainment scores in G2 offspring. This thesis builds on this work by including a wider range of G1 parenting behaviours and investigating their effects on intergenerational associations in cognitive ability.

2.2.4.2 The role of the father

Most of the reviewed studies focused their attention largely on the maternal role in child-rearing. One study that specifically considered the role of the father in cognitive development reported no significant differences between paternal and maternal contributions to intellectual development. In this investigation of low-income families by Tamis-LeMonde, *et al*. (2004), parenting skills in fathers were associated with the same behaviours in mothers, indicating that individual children experienced similarly high or low levels of parenting from their mothers and fathers. It has been suggested, however, that fathers may affect the cognitive development of their children indirectly through their influence on the mother-child relationship or through their demographic characteristics, including the number of years of education and level of income. Financial contributions by fathers might provide the necessary resources that facilitate good intellectual stimulation and ensure better housing, which in turn promote desirable cognitive outcomes (Easterbrooks & Goldberg, 1984). There is also some evidence that the content and meaning of father-child interactions differ from mother-child interactions. Fathers are more likely to engage in 'rough and tumble play', to encourage risk-taking pursuits and to be less likely to prohibit their infants' activities. They are also more likely to be less engaged and sensitive (Cabrera, *et al*., 2000; Tamis-LeMonde, *et al*., 2004). Father-child interactions have been shown to vary with gender, temperament and health status of the child (Lamb, 2004), highlighting the concept that children may have some reciprocal influences on the child-rearing practices of parents.

2.2.4.3 The contribution of child characteristics

A few studies assessed whether there were any sex differences in the relationship between maternal child-rearing practices and children's cognitive abilities. Andersson, *et al*. (1996) in their study of 234 small-for-gestational-age children, found that maternal nurturance was significantly positively related to cognitive ability in boys, but not girls. There is also evidence from two studies that parental reading habits positively influence the ability scores of girls, but not boys (Cairns, *et al*., 1998; Maughan, *et al*., 1998). No differences in offspring IQ by sex were identified between maternal restrictiveness or coerciveness and cognitive outcomes in the correlation study by Kagan and Freeman (1963). On the other hand, one study of low-birth-weight children found that harsh discipline practices resulted in lower measured ability in girls (Smith & Brooks-Gunn, 1997). Genetic variations in the way in which boys and girls respond to different home environments and discipline practices may explain these gender differences.

Just three of the reviewed studies examined the effects of children's behaviour on parenting practices and their subsequent effect on offspring cognition. In the correlation analysis by Scarr (1985), children who were rated as cooperative scored higher on cognitive ability tests than those who were not. On the contrary, Olson and Kaskie (1992) reported no association between child temperament and later cognitive outcomes but found modest associations between an observational index of troublesome behaviour (e.g. non-compliant behaviour and rule violation) and cognitive ability scores in the expected inverse direction. Estrada, *et al*., (1987) went a step further and examined the effects of child characteristics on parenting practices. They found that children with positive affective relationships with their mothers were more likely to persist in activities and to choose challenging tasks and initiate new activities, and less likely to resist maternal assistance. These children also scored higher in cognitive ability tests. The authors proposed that parents who engaged and supported their children instilled confidence in their offspring that facilitated the flow of information between adult and child and promoted future learning and social interaction. Indeed, Rutter (1985) argued that the crucial feature in fostering cognitive development is not so much the parental 'input' but rather the reciprocity of interactions, the variety and meaningfulness of their content, and the active role taken by the child.

2.2.4.4 Intervention studies

Given the evidence that cognitive stimulation in the home and positive interactions between parents and children may improve cognitive outcomes among children, numerous parenting and child intervention programmes have been implemented, predominantly in the USA, to test the validity of these associations. These intervention studies were concerned largely with children judged to be at risk of poor cognitive development or of social exclusion because of the disadvantaged educational or social circumstances of the parents. A meta-analysis of 12 studies examining cognitive outcomes in early childhood development programmes in the USA concluded that programmes, including the Caroline Abecedarian Project and Head Start, had the effect of improving the results of cognitive ability tests (Anderson, *et al.*, 2003). The most successful interventions were those focused on working with parents in learning-oriented programmes that provided them with instruction, materials and role playing in parenting practices. Head Start, which began in 1965, included more than 20 million children in its first 35 years and represents one example of an intervention that has successfully improved the cognitive outcomes of children from low-SEP homes through the provision of educational toys, games and books, as well as parent participation (Hubbs-Tait, *et al.*, 2002). However, although the programmes produced an initial elevation in measures of general cognitive ability, the gains underwent rapid attrition once such interventions were withdrawn (Lee, *et al.*, 1990). Summarising the existing literature and data from unpublished studies on Head Start, McKey *et al.* reported the immediate positive and educationally meaningful effects of intervention. However, these gains were followed by variously declining performances in subsequent years and few statistically significant differences between Head Start and control groups in measured ability by the second year after the end of Head Start attendance (McKey, *et al*., 1985). Nevertheless, the authors concluded that despite loss over time of the Head Start advantage in terms of cognitive ability, participants had a greater advantage in school by virtue of their having gained an important measure of social competence enabling them to "…progress in school, stay in the mainstream, and satisfy teachers' requirements better than their peers who did not attend". As part of the UK government's initiative to prevent social exclusion, the Sure Start project was launched in 1999 targeting preschool children and their families in disadvantaged areas with a number of interventions including good quality play, learning and child care (Roberts & Hall, 2000). An early assessment of the effectiveness of this programme showed little benefit of the parenting intervention at 36 months, children of teenage mothers as well as unemployed or lone parents, scored lower on verbal ability tests in relation to comparison groups. One explanation for this may be that less deprived families might have been better able to take advantage of the services provided, with the result that those with fewer personal resources would have had less access (Belsky, *et al*., 2006). Nevertheless, a more recent study reported that families enrolled in the programme employed less negative parenting behaviours and provided a better home-learning environment (Melhuish, *et al*., 2008).

2.2.4.5 Potential mechanisms

A number of mechanisms have been proposed to explain the influence of child-rearing practices on intellectual development. It may be that children who experience frequent restrictive and punitive exchanges with their parents tend to have lower cognitive ability scores because they are discouraged from engaging in active environmental exploration and learning experiences. In addition, involvement in frequent disciplinary transactions may limit the amount of time parents are able to spend in positive, cognitively-stimulating interactions with their children (Hess & Mcdevitt, 1984; Onatsu-Arvilommi & Nurmi, 1997). On the other hand, positive parent-child interactions may enhance the capacity and confidence of children to engage in cognitive-enriching tasks, as observed in the study by Olson and Kaskie (1992) which showed that toddlers securely attached to their care-givers tended to work more enthusiastically, persistently and effectively with their mothers in complex problem-solving tasks than insecurely attached infants.

There is some indication that adverse parenting affects those biological pathways involved in cognitive development through what is known as allostatic load or 'wear and tear' on the body produced by repeated activation of the stress-responsive systems, particularly the hypothalamic-pituitary-adrenal (HPA) axis (McEwen & Seeman, 1999). The effect of rearing style on the HPA axis has been demonstrated in rodents using tactile stimulation associated with maternal care (Caldji, *et al.*, 2000; Francis, *et al.*, 1999). High levels of maternal licking and grooming of pups were associated with high levels of cognitive and behavioural competence, and it was shown that these immature rodents were able to regulate stress adequately by means of a complex set of direct influences and feedback interactions between the hypothalamus, the pituitary gland, and the adrenal glands. Conversely, rats that were made to undergo high levels of prenatal stress or extended maternal separation in the neonatal period exhibited a reduced ability to regulate the activity of the HPA axis (Liu, *et al.*, 2000).

2.3 Conclusions

It is evident that cognitive ability runs in families. Such intergenerational continuity is influenced by both genetic and environmental factors, although the relative contribution of each is not fully understood. What is clear from the reviewed evidence is that IQ is associated with a range of factors that may mediate intergenerational similarities in cognitive ability, including: education, occupation and parenting practices. Overall, several parental behaviours related to the provision of an enriched environment conducive to intellectual development have been positively related to offspring cognitive ability. In contrast, harsh discipline practices have demonstrated predictive correlations with poor cognitive development. A life course approach that encompasses a study of the pathways that link early life experiences, cognitive development and parenting practices across the life course and between generations, offers a rare, if not unique, opportunity to investigate intergenerational continuities in mental ability in greater detail.

Table 2.1 Overview of prospective longitudinal studies investigating associations between parenting practices and cognitive outcomes in children.

Study	Study population: Country	Study population: *n*	Measure of parenting	Cognitive ability assessment	Main findings *(Confounders considered)*
Correlation analysis					
Estrada, *et al.*, (1987)	USA	67 mothers and their children.	Affective relationship between mother and child ranging from (low score) rejection, rigidity and punitiveness to (high score) warmth, responsiveness and sensitivity Rated during observations of interaction tasks when the child was aged 12 years. (inter-rater agreement >0.97)	Peabody Picture Vocabulary Test at age 4 years. Wechsler Intelligence Scale for Children at age 6 years.	Partial correlation coefficients between affective relationship and offspring cognitive ability: 4 years: r=0.37** 6 years: r=0.41** *(Maternal cognitive ability, SEP: paternal occupation and education)*
Kagan & Freeman (1963)	USA	50 mothers and their children.	• Restrictiveness • Justification of discipline • Coerciveness Rated during home observations when child was aged 2-7 years. (inter-rater agreement >0.80)	Stanford-Binet Intelligence Scale at ages 3.5, and 5.5 years.	Partial correlation coefficients between parenting variables and offspring cognitive ability: *3.5 years*: Boys / Girls; *5.5 years*: Boys / Girls Restrictiveness: 0.00 / -0.10; -0.06 / -0.27 Justification: 0.31 / 0.76**; 0.56** / 0.60* Coerciveness: -0.38* / -0.32; -0.30 / -0.37 *(Maternal education)*
Olson & Kaskie (1992)	USA	85 mothers and their children.	• Maternal teaching and responsiveness • Maternal restrictiveness • Maternal affection Observed at 6, 13 and 24 months of age during home visits and during a laboratory-based interaction task when the child was aged 6 years. (based upon HOME inventory)	Peabody Picture Vocabulary Test at age 6 and 8 years.	Correlation coefficients between parenting variables and offspring cognitive ability: *Age 6* / *Age 8* Teaching (13 months): 0.00 / 0.06 Affection (13 months): 0.04 / 0.08 Affection (24 months): 0.18 / 0.10 Verbal interaction (24 months): 0.46*** / 0.36** *(SEP: paternal occupation - for verbal interaction only)*

* p<0.05; **p<0.01; *** p<0.001

Table 2.1 Overview of prospective longitudinal studies investigating associations between parenting practices and cognitive outcomes in children (continued).

Study	Study population: Country	Study population: *n*	Measure of parenting	Cognitive ability assessment	Main findings ***(Confounders considered)***
Correlation analysis					
Scarr (1985)	Bermuda	125 mothers and their children.	• Maternal control of child rated during observation of teaching situations. • Self-reported methods of maternal discipline: positive methods included reasoning and explaining; negative methods included physical punishment.	Stanford-Binet Intelligence Scale at ages 3.5 - 4 years.	Partial correlation coefficients: Positive control and cognitive ability: Unadjusted: *r*=0.29*** Adjusted: *r*=0.11 Positive discipline and cognitive ability: Unadjusted: *r*=0.26** Adjusted: *r*=0.15 No association between negative discipline and ability *(Maternal vocabulary score and maternal education)*
Multivariate analysis of variance					
Smith & Brooks-Gunn (1997)	USA	715 mothers and their low birth weight children.	Harsh discipline: mothers' reports of frequency of use of physical punishment; and observer reports of corporal punishment during home visits when child was aged 1 and 2 years. (based upon HOME inventory)	Stanford-Binet Intelligence Scale at age 3 years.	Mean ability score at age 3 years: *Boys* / *Girls* Low levels of harsh discipline: 89.99 / 94.13 High levels of harsh discipline: 88.76 / 86.32*** Difference between two groups significant *(Maternal education; family income, birth weight)*
Regression analysis					
Andersson, *et al*., (1996)	Norway, Sweden	234 mothers and their children born small for gestational age.	• Maternal nurturance • Maternal restrictiveness Self-reported by mothers when the child was aged 5 years.	Swedish and Norwegian versions of the Wechsler Preschool and Primary Scale of Intelligence-Revised. (Age of testing not reported)	Standardised regression coefficients for the effect of nurturance on offspring cognitive ability: Boys: β=0.20** Girls: NS No association between maternal restrictiveness and offspring cognitive ability. *(Maternal cognitive ability, SEP: mother's education, occupation and income)*

p*<0.05; ***p*<0.01; * *p*<0.001

Table 2.1 Overview of prospective longitudinal studies investigating associations between parenting practices and cognitive outcomes in children (continued).

Study	Study population: Country	Study population: *n*	Measure of parenting	Cognitive ability assessment	Main findings *(Confounders considered)*
Regression analysis					
Cairns, *et al.*, (1998)	USA	57 mothers and their children.	• Harsh discipline • Literacy environment (how often mother read to child). Reported by mothers during interview when children were aged 1-2 years.	Peabody Picture Vocabulary Test administered soon after school entry.	Standardised coefficients for the effect of literacy environment on cognitive ability: Boys: NS Girls: β=0.50*** No association between harsh discipline and cognitive ability. *(SEP; maternal age)*
Douglas (1964)	Britain (British 1946 birth cohort)	NR	Parental interest in school activities: based upon comments made by the class teachers at the end of the first and fourth primary school year and on the records of the number of school visits made by parents.	Picture intelligence, reading and vocabulary tests at ages 8 and 11 years.	Children whose parents gave them the most encouragement in school work scored the highest average scores and children whose parents were the least interested scored the lowest average scores. *(No adjustment for confounders)*
Maughan, *et al.*, (1998)	Britain (British 1958 birth cohort)	2,742 adopted and non-adopted cohort members and their parents or caretakers.	• Parental interest in education: rated by teachers when child was aged 7 years • Parental reading habits: reported by parents when child was aged 7 years.	Southgate Group Reading Test at age 7 years	Regression coefficients for the effect of parental interest in child's education on cognitive ability at age 7 years: Boys: β=0.21*** Girls: β=0.25*** Regression coefficients for the effect of parental reading habits on cognitive ability at age 7 years: Boys: β=NS Girls: β=0.07* *(SEP: father's occupation, housing circumstances; parental education)*

* p<0.05; **p<0.01; *** p<0.001 NR=Not reported

Table 2.1 Overview of prospective longitudinal studies investigating associations between parenting practices and cognitive outcomes in children (continued).

Study	**Study population**		**Measure of parenting**	**Cognitive ability assessment**	**Main findings**
	Country	***n***			***(Confounders considered)***
Richards & Wadsworth (2004)	Britain (British 1946 birth cohort	1,339 cohort members and their parents.	Maternal management and understanding: Good vs. Average/poor. Observed during home-based interview when the child was aged 4 years.	Picture intelligence, reading and vocabulary tests at age 8 years.	Regression coefficient for the effect of maternal management on offspring cognitive ability Good vs. Average/poor: β=-0.25*** *(Maternal education, SEP, Birth order, Sex)*
Tamis-LeMonda, *et al*., (2004)	USA	290 low-income fathers, their partners and children.	• Supportive parenting: composite measure of sensitivity, positive regard and cognitive stimulation. • Overbearing parenting: composite measure of negative regard and intrusiveness. Observed during videotaped engagements between parents and offspring when the child was aged 2 and 3 years. (inter-rater agreement >0.84)	Peabody Picture Vocabulary Test at age 3 years.	Regression coefficients for the effect of supportive parenting on offspring cognitive ability: Mothers: β=0.14 Fathers: β=0.25** No association between overbearing parenting and offspring cognitive ability. *(Parental education, Paternal education, SEP: father's income)*
Wadsworth (1986)	Britain (British 1946 birth cohort)	1,690 cohort members and their first-born children.	• Parental affection: based upon maternal description of affectionate relationship. • Cognitive stimulation: based upon frequency of story-telling or reading. Self-reported by mothers during semi-structured interviews when the child was aged 4 years.	Verbal attainment scores on tests of vocabulary, reading and sentence completion at age 8 years.	Regression coefficients for the effect of parental affection on offspring cognitive ability: Vocabulary: β=2.4***; Reading: β=1.6***; Sentence: β=1.7 Regression coefficients for the effect of cognitive stimulation on offspring cognitive ability: Vocabulary: NS; Reading: NS; Sentence: 1.7*** *(Maternal education)*

* p<0.05; **p<0.01; *** p<0.001

Table 2.1 Overview of prospective longitudinal studies investigating parenting practices and cognitive ability outcomes in children (continued).

Study	Study population		Measure of parenting	Cognitive ability assessment	Main findings
	Country	*n*			***(Confounders considered)***
Structural Equation Modelling					
Guo & Harris (2000)	USA	NR	• Cognitive stimulation: books and magazines available, mother read to child, record or tape available, child taken on museum visits. • Parenting style: mother conversed with child, mother hugged and kissed child, mother's voice positive, mother answered child verbally. Self-reported by mothers during a home-based interview. (based upon HOME inventory)	Four Measures of the Peabody Individual Assessment Test (PIAT): Reading Recognition, Reading Comprehension and Mathematics Assessment at age 3 years, and the Peabody Picture Vocabulary Test-Revised at age 5 years.	Unstandardised coefficients for the effect of cognitive stimulation on offspring cognitive ability: β=15.52*** Unstandardised coefficients for the effect of parenting style on offspring cognitive ability: β=4.39*** *(Maternal cognitive ability, Maternal education and SEP included in SEM)*
Lugo-Gil & Tamis-LeMonda (2008)	USA	2,089 mothers and their children	Parenting quality: composite measure of: sensitivity, positive regard and cognitive stimulation, and observations of the home environment. Observed during videotaped engagements of mother-child interactions when the child was aged 2 and 3 years. (based upon HOME inventory)	Bayley Mental Development Index at age 2 and 3 years.	Standardised coefficients for the effect of parenting quality on offspring cognitive ability: Age 2: β=0.21 * Age 3: β=0.17 * *(Maternal education and SEP included in SEM)*

* p<0.05; **p<0.01; *** p<0.001 NR=Not reported

3. A life course approach

Life course epidemiology has been defined by Kuh and Ben-Shlomo as

> '…the study of long-term biological, behavioural and psychosocial processes that link adult health and disease risk to physical or social exposures acting during gestation, childhood, adolescence, earlier in adult life, or across generations' (Kuh & Ben-Shlomo, 2004).

A catalyst for recent interest in early-life factors and their relation to adult health outcomes originated in research by Barker and his colleagues. In 1995 they found that individuals who developed coronary heart disease in adulthood grew differently during early life compared with those who did not. Following on from these findings, Barker proposed the 'foetal origins hypothesis'. This states that foetal undernourishment in middle to late gestation leads to "disproportionate foetal growth and programmes later coronary heart disease" (Barker, 1995). This hypothesis has since been confirmed in many populations (Barker, 2004; Barker, 2005; Stein, *et al.*, 1996) resulting in a growth in the field of life course epidemiology.

Prospective longitudinal studies are the design of choice for studying life course epidemiology because they offer the ability to measure biological, behavioural, and psychosocial processes that operate over the course of life of a person or across generations. The British 1946 birth cohort is the oldest of such studies in Britain. It has collected data from birth and has continued to follow up members of the same population during childhood, adolescence and adulthood. Longitudinal studies are costly to undertake, require long follow-up periods and are subject to attrition of cohort members over time, but they offer a unique perspective on the precursors of later outcomes, as well as identifying those factors likely to increase resilience in high-risk individuals (Serbin & Stack, 1998).

3.1 An intergenerational approach

With the development of life course epidemiology, increased attention has been paid to questions regarding cross-generational associations. The concept that traits observed across the life course of one generation may be transferred to subsequent generations was highlighted in a speech in 1972 by the then Secretary of State for Social Services, Sir Keith Joseph, who spoke of the persistence of poverty in Britain, and its apparent tendency to be concentrated in particular families (Rutter, 1998). Such 'intergenerational cycles' are best investigated using linked longitudinal studies to identify factors, exposures and environments experienced by one generation that relate to the health, growth and development of the next (Cairns, *et al*., 1998).

Only a few prospective longitudinal studies, mainly from the developmental literature, have used several generations to examine the intergenerational continuity of behaviours such as aggression (Cairns, *et al*., 1998; Capaldi & Clark, 1998; Conger, *et al*., 2003), antisocial behaviour (Serbin, *et al*., 1998; Thornberry, *et al*., 2003), early pregnancy (Scaramella, *et al*., 1998), parenting (Capaldi, *et al*., 2003; Hops, *et al*., 2003), smoking (Chassin, *et al*., 1998) and depression (Weissman, *et al*., 2006). In many of these studies, parenting practices, variously defined, emerged as a mediator for the transfer of characteristics between generations. Intergenerational continuities tended to be only moderate, indicating that there are substantial levels of discontinuity as well as similarity across generations, thus emphasising that explanations need to be found both for discontinuities and continuities (Shaw, 2003). These studies also drew attention to a number of important methodological considerations, which in addition to the inherent challenges of conducting longitudinal research, arise when including a second generation.

One challenge is that both parents are rarely enrolled in the original sample. Information is therefore available on only one of the second generation child's parents. This may lead to an underestimation of intergenerational effects unless retrospective data can be obtained from contemporaneous records (Serbin & Stack, 1998). The timing of birth of children also presents difficulties. In most cases parents are recruited as birth cohort members, as in the case of the British 1946 birth cohort, or during a relatively short time period. However, cohort members are unlikely to have children in a predictable manner, with the result that further waiting is required in order to have a sufficient number of offspring to study (Shaw, 2003). Previous research has also acknowledged that the rigorous assessment of intergenerational continuity requires the study of traits in children and also in their parents when they in their own time were children (Cairns, *et al*., 1998). For example, cognitive ability tests taken in childhood and adulthood may not be directly comparable given their age-appropriate design. Furthermore, ability tests taken later in life are more likely to be influenced by education and other life experiences and this may affect the intergenerational association.

Intergenerational studies might also be limited by the lack of comparable measures between generations, since the continuation of an existing longitudinal study to include another generation will be constrained by the purpose of the original sample (Wadsworth, 1998). Comparability of measures may be achieved by comparing individual scores or positions in one generation in relation to those of others in the next. Measures used at earlier times may also be updated. For example, childhood ability tests taken by offspring of British 1946 birth cohort members were made generation-fair by replacing outdated words (Wadsworth, 1998).

Even after taking these design issues into account, the presence of an intergenerational association needs to be considered in the light of historical events, contextual conditions, secular trends and other factors outside the design. Contextual factors, such as changes in educational policy, labour market structure and health care provision, may affect successive generations differently. Furthermore, continuities across generations may not be familial. For example, health risks are consistently higher in socially disadvantaged families and such risks might influence the perpetuation of deprivation across generations (Dubow, *et al.*, 2003). Cultural factors relevant to the parents' generation may be of less importance when their children reach a similar age. There have been, for example substantial changes over the past 50 years in perceptions of teenage pregnancy and non-marital cohabitation (Rutter, 1998). Secular trends such as the year-on-year increase in IQ (Flynn, 1984) are also important, since the causes for changes in level over time may be different from the causes of individual variation.

It is also necessary to differentiate between continuities driven by characteristics of the parental generation and those driven by the experiences of rearing provided for the offspring. Failure to take into account differences in the ways that children react to the parenting they receive could distort intergenerational associations by masking or exaggerating any parent-child similarities (Rutter, 1998). Many studies on psychosocial risk, for instance, hypothesise that intergenerational risk arises from adverse rearing experiences and fails to take into account the child's reaction to the experience (Wadsworth, 1998).

One key issue in intergenerational studies, emphasised by a number of authors, is the need to assess genetic variables that might account for cross-generational continuities (Kuh & Hardy, 2002; Rutter, 1998; Serbin & Karp, 2004). Unfortunately, most of the existing intergenerational longitudinal studies were not designed to examine genetic transmission of risk, since their sample sizes were too small and information on family histories too limited to extract genetically relevant information using conventional genetic research design (Serbin & Stack, 1998). Nevertheless, cognitive ability has multiple determinants, both genetic and environmental, and the prospective intergenerational design provides an opportunity to investigate continuity and discontinuity in IQ between generations and to elucidate the roles of parenting and social mobility as mediators in transferring and fostering cognitive ability across generations.

4. The British 1946 birth cohort – the parents (G1)

Intergenerational relationships between parental and offspring cognitive ability were examined using data from two generations. The first generation of parents were drawn from the British 1946 birth cohort, a longitudinal study of more than 5,000 men and women born in 1946. Their first-born offspring comprised the second generation and will be described in greater detail in chapter five. For clarity, the different generations will be referred to as follows: the 1946 birth cohort members (i.e. the parents) will be denoted as G1; their offspring will be referred to as G2, and their own parents (i.e. the grandparents of G2) as G0.

4.1 Introduction to the dataset

The main focus of the 1946 birth cohort, since its inception, has been the study of health and changes in health in relation to environmental and personal characteristics. During the school years, from the ages of five to 15 years, its objectives were expanded to include a description of physical and intellectual development in the cohort and to compare the results of cognitive ability tests with those of achievement in the educational system. Furthermore, descriptions of parental care were broadened to include not only health but also the assessment of parental encouragement and interest in their children's educational progress (Wadsworth & Kuh, 1997). When cohort members reached adulthood, the study included aims to investigate early career in relation to educational and family circumstances, and from the age of 36 onwards, began investigating the process of physical and mental ageing. Among female participants, a postal survey was conducted annually from 1993 to 2000 in order to study the menopause transition and other aspects of women's health (Kuh & Hardy, 2002). Detailed accounts of the study and its findings to date are available in a number of papers and books (www.nshd.mrc.ac.uk/publications).

4.2 The sampling frame

The cohort members were all born during one week in March 1946 and were initially part of a maternity survey investigating the health and survival of infants at birth and the cost of maternity services (Joint Committee of the Royal College of Obstetricians and Gynaecologists and the Population Investigation Committee, 1948). Of the 15,130 mothers who gave birth during the chosen week, 13,687 (90%) were successfully interviewed for the maternity study. From this population a class-stratified sample of 5,362 single legitimate births was selected for follow-up as part of the British 1946 birth cohort, otherwise known as the MRC National Survey of Health and Development (figure 4.1). The aim of the sampling method was to include a sufficient number of non-manual individuals to allow for the analysis of social class effects. To this end the sample selected comprised one in four of births to the wives of manual workers, and all births to wives of non-manual and agricultural workers. This enriched the sample with children born to middle-class parents whose attitudes and opportunities were of special interest at the time (Douglas, 1967; Wadsworth, *et al.*, 2005).

The sampling frame excluded 672 births out of marriage since most were adopted and therefore impossible to trace, as well as 180 multiple births which were thought too few for the purposes of analysis (Wadsworth, *et al.*, 2003). In previous analyses, a statistical weighting procedure was applied to compensate for the effect of sampling one in four children from manual social class homes, but no allowance can be made for the initial exclusion of illegitimate and multiple births.

British 1946 birth cohort

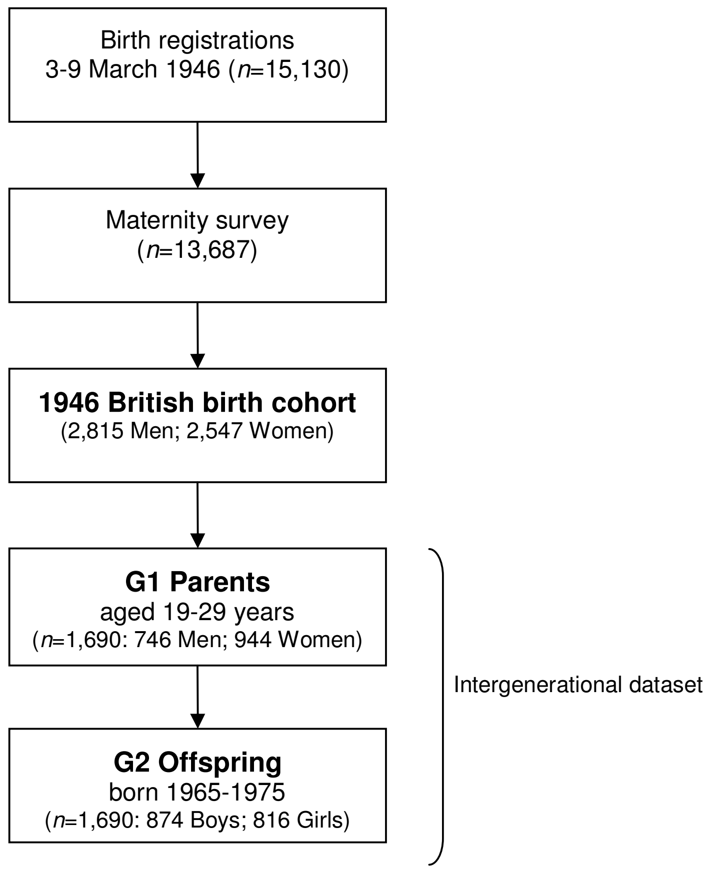

Figure 4.1 Sampling frame for the British 1946 birth cohort.

4.3 Data collection

Cohort members were followed up at intervals of no more than two years during childhood and adolescence and at slightly longer intervals during adulthood (table 4.1). Information about sociodemographic factors, health indicators, education, cognitive ability and psychological function during childhood was obtained 12 times from mothers and teachers, and from direct medical examination. A further 11 interviews and examinations were undertaken with cohort members during adulthood (Wadsworth, *et al.*, 2005). This occurred most recently in 1999 at age 53, when the sample size was 3,035. Information was obtained from a variety of sources. As table 4.1 shows, data were collected by a wide range of professionals during the childhood of participants. In more recent times a team of research nurses was recruited and trained specifically for the task (Wadsworth, 1987).

In summary, all births included in the study were investigated by means of a questionnaire that health visitors administered to mothers during home visits when the selected child was eight weeks old (Wadsworth, 1991). In the early years of follow-up (nought to four years) data collections were carried out by health visitors at home visits and from medical and infant welfare records. During the school years (five to 15 years) mothers agreed to answer questions during home visits when the children were six, seven, eight, nine, 11 and 15 years old, and consented to have the survey child medically examined at school at ages seven and 11 years. In addition, teachers administered educational and cognitive ability tests, completed behaviour and attitude rating scales and provided information on their schools. Teachers also assessed the level of interest that (G0) parents of (G1) cohort members showed in school progress and gave an account of parental visits to school. In early adulthood (16 to 35 years) a series of postal data collections were combined with a home visit when cohort members were interviewed. At each contact information was collected on occupation, home and family circumstances, and health and illness. Reliability of information was checked by comparing answers given in one year with those in the next, and by comparing different sources of information (Douglas, 1967). The next major data collection, in the sixth decade of the life course, is currently in progress.

Table 4.1 Follow-up contact made with British 1946 birth cohort members after the initial survey (adapted from Wadsworth, 2003).

Year	Age (years)	Respondents	Data collector [a]	Location	Target sampled [b]	Achieved sample (% achieved)
1946	8 weeks	Mother	HV, M, O	Home	5,362	5,362 (100)
1948	2	Mother	HV	Home	4,993	4,698 (94)
1950	4	Mother	HV	Home	4,900	4,700 (96)
1952	6	Mother and child	SD	School	4,858	4,603 (95)
1953	7	Mother and child	SN or HV	School	4,838	4,480 (93)
1954	8	Mother and child *	SN or HV & T	School	4,826	4,435 (92)
1955	9	Mother and child	SN or HV & T	School	4,807	4,181 (87)
1956	10	Child	T	School	4,811	4,077 (85)
1957	11	Mother and child *	SN or HV SD T	School	4,799	4,281 (89)
1959	13	Child	T	School	4,794	4,127 (86)
1961	15	Mother and child *	SN or HV & T	School	4,790	4,247 (89)
1965	19	All CMs	HV	Home	4,741	3,561 (75)
1966	20	All CMs	P	Home	4,715	3,899 (83)
1968	22	All CMs	P	Home	4,638	3,885 (84)
1969	23	All CMs	P	Home	4,518	3,026 (67)
1971	25	All CMs	P	Home	4,446	3,307 (74)
1972	26	All CMs *	I	Home	4,410	3,750 (85)
1977	31	All CMs	P	Home	4,293	3,340 (78)
1982	36	All CMs	RN	Home	3,863	3,322 (86)
1989	43	All CMs *	RN	Home	3,839	3,262 (87)
1999	53	All CMs *	RN	Home	3,673	3,035 (83)

CM = cohort member.
[a] HV=health visitor; M=midwife; O=obstetrician, SN=school nurse; SD=school doctor; T=teacher; P=postal contact; I=interviewer; RN=research nurse.
[b] Excludes the dead, those living abroad, and permanent refusals.
* Cognitive ability assessed.

4.4 Follow-up and representativeness of the sample

Research on the 1946 birth cohort depends on the continuing representativeness of the original sample. A crucial factor in any prospective investigation is that of maintaining adequate follow-up and identifying the possibility of differential attrition. By the age of 43 years, losses through death (365, 6.8%) and emigration (607, 11.3%) had occurred at an age-appropriate rate. Other losses resulted from refusals (540, 10.1%) and difficulties in tracing cohort members in time to meet an interview deadline (607, 11.3%) (Wadsworth, *et al.*, 1992). Despite such difficulties, between 70% and 90% of eligible sample members, alive and resident in Britain, provided information at each contact.

In 1989 the cohort was shown to be representative in most respects of the UK population of legitimately and singly born individuals in the immediate post-war period. Exceptions were an over-representation among non-responders of the never-married, the least literate, those always in the manual social class, and the mentally ill. There was also a disproportionate loss to follow-up of those with low cognitive ability (Wadsworth, *et al.*, 1992). To maintain response rates, a birthday card was sent to cohort members annually from the time they reached the age of 16, which requested notification of changes of name and/or address. It now includes a review of recent work and references to publications (Wadsworth, *et al.*, 2003).

4.5 Benefits of the British 1946 birth cohort

The 1946 birth cohort is a study that began at birth and thereafter has continued to collect data regularly into adulthood. The prospective design has the advantage of regular data collection, so that events in the lives of cohort members are recorded as they occur or while still fresh in the informants' memories. Furthermore, the cohort benefits from a national and representative sample, a wide range of social, biological and psychological data all of which have been repeatedly collected at different times, using trained specialists for the purpose (Wadsworth, *et al.*, 2005).

One drawback is that the design of the birth cohort does not permit an adequate estimation of heritability indices for cognitive ability or parenting that would be afforded by a genetically-sensitive design. A further shortcoming from an intergenerational viewpoint is that complete life course information is only available for one parent of the G2 offspring, although a certain amount has been collected on their spouses. Nonetheless, the large sample size, long-term follow-up period, and the comprehensive data accumulated in the British 1946 birth cohort, together provide a rich opportunity for the study of cognitive development longitudinally. With the extension of data collection to include the first-born offspring of cohort members, it offers a valid means of investigating intergenerational influences on cognitive function.

5. The second generation survey – the offspring (G2)

The second generation survey was undertaken in 1969 and included 1,690 children (874 boys; 816 girls) who were born to either male or female members of the British 1946 birth cohort during the years 1965 to 1975 when their ages ranged from 19 to 29 years (Wadsworth, 1991). These children make up the second generation (G2) of the intergenerational dataset (figure 4.1).

5.1 Sampling frame

All singleton babies born to 1946 birth cohort members during the study period were regarded as being eligible for inclusion in the second generation survey, unless at age four years the child in question was no longer living with the cohort member (G1) parent, or was living abroad, or adopted. Only first-born children were included, since follow-up of subsequent children would not have resulted in a sample of sufficient size to analyse once factors such as sex and birth order had been taken into account.

5.2 Data collection

Second generation (G2) offspring were investigated by way of questionnaires administered by health visitors during home visits when the child concerned was aged four and eight years. At such visits trained interviewers carried out semi-structured interviews with the G1 mothers or the wives of G1 fathers, during which a wide range of medical, social and psychological information was collected (table 5.1).

The first interview was conducted at the age four years. Children of that age were not yet attending full-time education but were considered to be living in a social world in that they were mixing and interacting with other young children. It was also considered to be a time when possibly certain kinds of physical and emotional influences had a lasting effect, as suggested by previous work on the 1946 birth cohort (Douglas 1967, 1975; Wadsworth, 1979). Age eight was chosen for the second home interview to complement data collected when their

G1 parent was of the same age, thus allowing for intergenerational comparisons. Interviewers also gathered information on the parenting practices of the G1 parents (Wadsworth, 1986). A detailed account of these measures is given in section 7.2.5.

When G2 offspring were aged eight years, the interviewer conducted generation-fair versions of three cognitive ability tests that their G1 parents had taken at that age in 1954 (described in section 7.2.3). In addition, a brief postal questionnaire was sent to the children's schools seeking information on their progress and enthusiasm. It also sought information on the availability of learning materials, such as books, and on school attendance.

Table 5.1 Data collected during home-based interviews of G1 mothers or the wives of G1 fathers when G2 offspring were aged four and eight years.

Subject	Example of data collected
How the children spend their time	Preschool education, friends, imaginary friends and games, time spent with parents, reading and use of libraries, preparation for school.
Independence	Things that the child is permitted to do alone, dressing, personal hygiene.
Habits and dreams	Habit behaviour (e.g. biting nails) and whether or not an attempt is made to stop it, frequency of dreams and notions of their cause, methods to avoid them.
Bladder and bowel training	Methods used, degree of success to date, advice asked, time taken.
Health, illness and accidental injury	Admissions to hospital, allergies, respiratory illness, mother's worries about child's health.
Separation	Cause, length, own assessment of effect, care of child while mother works and goes out.
Family cohesion	Activities together, husband's help at home and with the child, holidays, parental use of free time, contacts with the wider family, own assessment of family closeness, associations with friends and neighbours.
Emotion and temper	Own assessment of each parent's emotional relationship with their child, frequency of child's temper tantrums, handling anger and temper.
Sex education and family planning	Sex education of child, intentions for family size and spacing, own (i.e. parents') sex education.
Mother's self assessment and her assessment of her child	Mother's worries about bringing up her child, her assessment of child's intellectual ability, degree of independence and character.
Recollection of childhood	Parental relationships, discipline, copying or avoiding things from own and spouse's upbringing.
Intellectual environment and education	Parental interest and involvement with school activities, cognitive stimulation e.g. teaching child colours, present school and parent's wishes for further schooling and employment.

5.3 Follow-up and representativeness of the sample

The rate of refusal in those eligible to take part in the second-generation survey was generally low, ranging from 6% when G1 parents were aged 22 to 0% at age 27 (table 5.2). The gradual improvement in response rate with time was mainly the result of increased efforts to trace 1946 birth cohort members who had moved at the outset of the study in 1969.

Since this sample of G1 parents was restricted to those aged 19 to 29 years at the birth of their first-born offspring, the findings will need to be considered in light of possible selection biases. Given that certain negative parenting practices, such as harsh discipline, are more prevalent among teenage mothers (Regalado, *et al.*, 2004; Wissow, 2002), findings pointing towards a possible role for such measures in determining intergenerational continuities may be underestimated in this sample. Just 3% (50/1,690) of G1 parents were teenagers at the birth of their first-born offspring, and by the time parenting practices were first assessed four years later, all of the G1 parents, including the wives of G1 fathers, were over 20 years of age. Furthermore, since only or eldest children consistently show slightly higher cognitive ability scores than later born siblings, the overall level of intelligence in the G2 sample may be higher compared with a population sample, and might thus underestimate intergenerational associations (Rutter & Madge, 1976). Rutter (1985) suggests that these ordinal position effects may occur since parents relate differently with first-born children in that they are likely to interact and converse more with them compared with younger children.

Table 5.2 First births to British 1946 birth cohort members and second generation survey response rates (adapted from Wadsworth, 1981).

Year of first birth	Age at first birth (years)	Numbers of first births		Total first births	Response rate (%)*
		to males	to females		
1961	15	0	2	2	**
1962	16	1	13	14	**
1963	17	6	42	48	**
1964	18	16	73	89	**
1965	19	46	116	162	71.6***
1966	20	68	162	230	71.2
1967	21	107	186	293	66.3
1968	22	129	189	218	78.8
1969	23	130	152	283	82.5
1970	24	129	140	269	83.7
1971	25	170	136	306	81.6
1972	26	150	113	263	89.2
1973	27	127	110	237	97.8
1975	29	101	43	144	95.5

*The denominator comprises all births known of and defined as eligible for inclusion in the study.
** Second generation survey not begun during these years.
*** Interviews conducted for only part of the year.

6. Aims and Objectives

6.1 Overall aim

The overall aim of this thesis is to examine the roles of intergenerational social mobility and parenting practices and the parts that they play in the transmission of cognitive ability from one generation to the next. This is examined on existing data from the British 1946 birth cohort and the offspring cohort of first-born children. These two linked prospective samples of parents (G1 parents) and their children (G2 offspring) provide a powerful design encompassing a life course approach in which to examine how social background makes continuities in early mental ability more, or less, likely between successive generations, and how such effects may be mediated by social mobility and parenting practices. This is considered within the following theoretical framework, depicted in figure 6.1.

The social background of G1 parents at birth (i.e. GO social class) predicts a range of adult outcomes, including cognitive ability, educational and occupational attainment, and the extent and direction of social mobility. These outcomes in turn affect their ability, as G1 parents, to develop constructive parenting practices that assist the progress of cognitive development in their offspring. Constructive parenting practices and upward social mobility contribute to continuities and discontinuities in IQ between generations in that they ameliorate the negative effects of poor G1 SEP (G0 social class, G1 education, G1 social class), thereby facilitating improvement in intellectual ability across generations (i.e. discontinuities). Positive parenting and improvements in social class may also drive continuities in intellectual ability between generations with parents and offspring achieving similarly high scores on cognitive tests.

Conversely, parents who are unable to provide an environment appropriate for the intellectual development of their children, place their offspring at risk of poor cognitive outcomes. Parents may either lack the skills to prevent their offspring from achieving similarly low scores on ability tests as they themselves did (i.e. continuities) or fail to prevent their children from achieving comparatively lower scores than themselves and thus facilitate intergenerational discontinuities in cognitive ability.

A further pathway to explore is the link between G0 and G1 parenting practices. Continuities in parenting skills between the G0 and G1 generation may facilitate continuities in intellectual ability in the G1 and G2 generations in that similar environmental influences may produce similar cognitive outcomes. These hypothesised pathways examine the effects of G0 grandparents (SEP and parenting practices) on G2 children via the G1 parental generation.

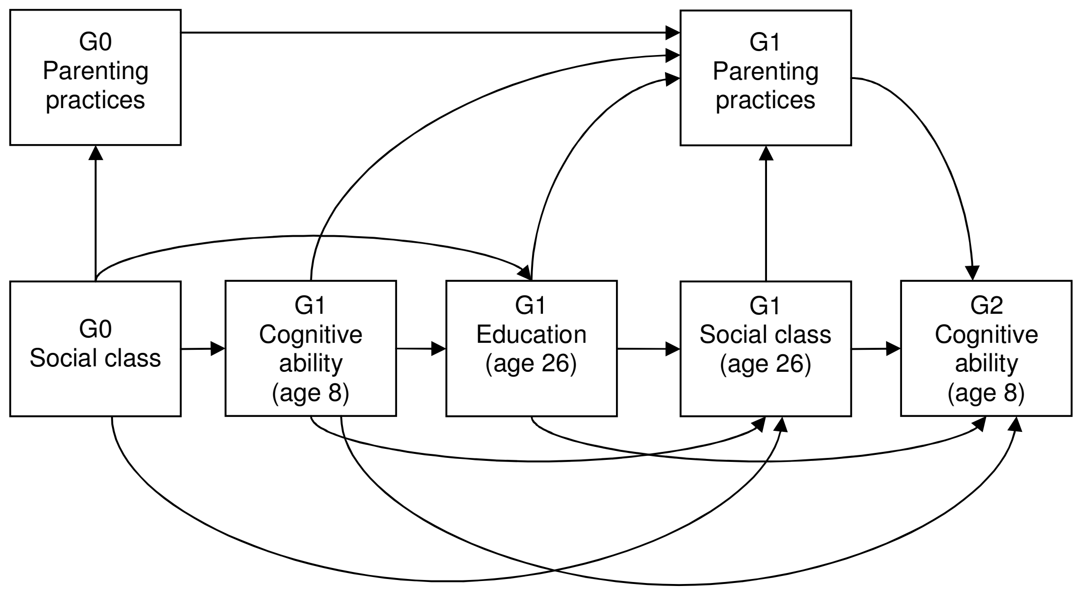

Figure 6.1 Theoretical framework for pathways mediating intergenerational associations in cognitive ability between G1 parents and G2 offspring.

6.2 Objectives

An initial description of the two study populations included in the intergenerational dataset (G1 parents and G2 offspring) is presented. This includes an investigation of established associations between SEP variables (education, social class) and cognitive ability, and intergenerational associations in cognitive ability between G1 parents and G2 offspring. Following on from this, the four main objectives of the study are then addressed.

Objective 1: To investigate the intergenerational effect of G1 social mobility – defined as movement between G0 social class and G1 social class at age 26 – on cognitive outcomes in G2 offspring, and to determine how far this explains intergenerational IQ associations.

Objective 2: To identify factors across the life course of G1 parents – for example, social background and education – that are associated with subsequent parenting behaviours, and to determine if these parenting practices mediate intergenerational associations in IQ, i.e. if the effects of parenting on offspring cognitive ability are explained by parental cognitive ability.

Objective 3: To clarify the pathways involved in intergenerational associations in cognitive ability by means of path analysis. This will allow indirect paths between parental cognitive ability and offspring cognitive ability (e.g. the effect of parental IQ on offspring IQ, via parental educational attainment) to be examined.

Objective 4: To determine if certain parenting practices contribute to different types of continuities (e.g. parents and offspring with similarly high cognitive ability scores) and discontinuities (e.g. low scoring parent and high scoring offspring).

7. Methods

7.1 Introduction

Analyses in this thesis are based upon data derived from two concurrent longitudinal datasets – the British 1946 birth cohort, an account of which was given in chapter four, and the second generation survey, described in chapter five. Together they contain information on three generations.

G0 Grandparents: This refers to the parents of 1946 birth cohort members and the grandparents of second generation offspring. They were born over a wide range of years from 1882 to 1931 and information is available on their social status in adulthood and their interest in the school activities of their children.

G1 Parents: This refers to British 1946 birth cohort members who gave birth to, or fathered, a first-born offspring included in the second generation survey.

Most of the relevant data (e.g. cognitive ability, educational attainment) were not available for the spouses or partners of G1 cohort members. However, since mothers were the informants for the second generation survey, selected demographic information on the wives of male cohort members was available for just over half of the sample. This included information on maternal age at childbirth and parenting behaviours (figure 7.1).

G2 Offspring: This refers to those children born to G1 parents from 1965 to 1975 and who are included in the second generation survey.

The intergenerational dataset included 1,690 G1 parents (746 men; 944 women) whose G2 offspring are included in the second generation survey (figure 4.1).

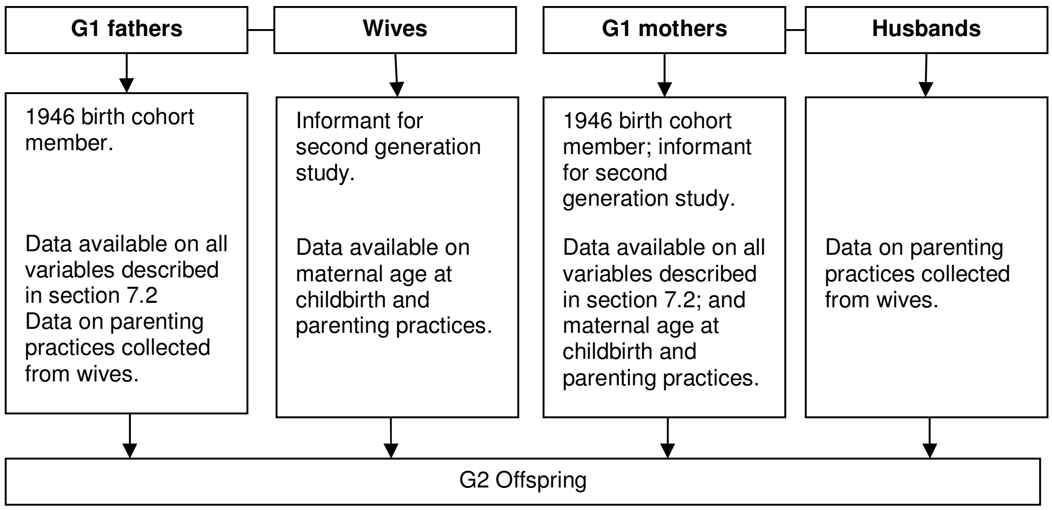

Figure 7.1 Summary of data available for the parents of G2 offspring.

7.2 Main variables used

The data used in these analyses are secondary data. As a result, the variables for the G0 and G1 generation were pre-specified. The variables from the G2 generation were all derived for the purposes of this thesis. This includes data obtained from the offspring cohort questionnaires, such as maternal age at childbirth. Together, these variables from the three generations were used to undertake regression and path model analyses.

7.2.1 Socioeconomic position

Socioeconomic position (SEP) is a commonly employed concept in health research that is related to numerous exposures, resources and susceptibilities that affect health and development. A variety of terms, such as social class, social stratification and socioeconomic status are often used interchangeably to measure SEP and may be represented by various classifications of occupation, educational qualifications, housing tenure, levels of income or ownership of assets. Conceptually, SEP refers to those social and economic factors that influence what positions individuals or groups hold within the structure of society. For example, occupation-based indicators reflect a person's place in society related to his or her social standing, income and intellectual and social networks. These factors in turn determine an individual's material living standard and may be related to certain privileges such as access to superior education, better than average health care and good working conditions (Galobardes, *et al.*, 2006a). SEP at birth, therefore, provides a good indication of the material, genetic and educational inputs that children can be expected to receive throughout childhood (Feinstein, 2003).

There is no single best indicator of SEP suitable for all study aims and applicable at all points in the life course. Various indicators measure different, often related aspects of socially-distributed factors. Accordingly, if an individual measure of SEP shows an association with an outcome of interest, this might not encompass the entirety of the effect of SEP. For example, educational attainment reflects particular aspects of SEP, such as possession of greater skills and wider knowledge, and at the same time it helps determine an individual's adult occupation and income (Galobardes, *et al.*, 2006a). Multiple measures of SEP assessed across the life course of G1 parents were therefore applied in order to avoid residual confounding of unmeasured socioeconomic circumstances.

7.2.1.1 Occupational social class

Occupational social class was assigned using the UK Registrar General's classification system (Office of Population Censuses and Surveys, 1970). This measure is based upon the prestige or social standing accorded to a given occupation in society, and is often interpreted as being an indicator of both social standing and material reward and resources (Galobardes, *et al.*, 2006b). Occupations are categorised into six categories: I Professional, II Managerial and technical, IIINM Skilled non-manual, IIIM Skilled manual, IV Partly-skilled and V Unskilled. Class I includes professionals or owners and managers of large businesses and is regarded as the 'highest' level, while class V, which includes unskilled manual workers, is the lowest (Bartley & Plewis, 1997). For many analyses, SEP was dichotomised to non-manual (classes I, II & IIINM) and manual (classes IIIM, IV & V) social class.

Grandparental (G0) SEP was assigned according to the occupation of G0 grandfathers when G1 parents were aged 11 years, or if this was unknown, their occupations when G1 parents were aged four or 15 years. G1 SEP was assigned according to the occupational status of the 'head of household' when G1 parents were aged 26. In the British 1946 birth cohort, the head of household was mostly the G1 father and therefore this measure was also used as an indicator of the SEP of the spouse and the G2 offspring, or the household as a unit. Applied in this way, occupational status measures the contribution that the father's job makes to the social and economic environment in which the rest of the family live – that is, it is a contextual measure. G1 SEP based upon the G1 parent's own occupation at age 26, regardless of whether or not that parent was the head of household, was also used as a measure of G1 mothers' attained social class for analyses on social mobility in chapter eight. This individual-level measurement of attainment may reflect skills gained from current occupation as well as life course factors, such as social class at birth and education, which contributed to current occupational status. Data on own occupation was available for 97% (1,640/1,690) of G1 mothers.

One of the limitations of occupational indicators is that they cannot be assigned to individuals who were not employed when the data were collected. This may have been for a number of reasons – that they were students, farmers, in the armed forces or unemployed at age 26. Due to the unclear hierarchical relation of these groups to the Registrar General's socioeconomic categories, 2% (36/1,690) of G1 parents were not allocated an occupational social class (head of household) at age 26 and were excluded from the analyses. There was no statistically significant difference between the excluded individuals and those included in the sample in terms of cognitive ability and educational attainment.

7.2.1.2 Educational attainment

Education reflects the material, intellectual and other resources of the family of origin and is partly determined by parental characteristics. Education can therefore be conceptualised within a life course framework as an indicator of early life SEP that is also a strong determinant of future employment and income (Galobardes, *et al*., 2006a).

For G1 parents, the highest educational or training qualifications achieved by age 26 years were classified according to the Burnham scale (Department of Education and Science, 1972): no qualification; below ordinary secondary qualifications (vocational); ordinary secondary qualifications ('O' levels and their training equivalents); advanced secondary qualifications ('A' levels and their training equivalents); or higher qualifications (degree or equivalent). This classification reflects the distribution of educational qualifications at the time. It also distinguishes those parents whose formal education had stopped at primary, secondary or tertiary level but also took account of those who had not attended secondary school but who returned to their studies in early adulthood. For most analyses, these categories were dichotomised to ordinary education or lower and advanced education or higher. The latter reflects the decision to stay at school beyond the statutory leaving age which, at that point in time, was 15. Data on educational attainment were available for 97% (1,640/1,690) of G1 parents, of which the majority (68%; 1,153/1,690) had attained ordinary education.

7.2.2 Maternal age at childbirth

Reviewed evidence suggests that certain negative parenting practices, such as coercive discipline, are more prevalent among teenage mothers (Regalado, *et al*., 2004). Thus, mothers who gave birth to their G2 offspring when they were aged 19 or younger were compared to non-teenage mothers. Maternal age at childbirth was calculated from information collected from G1 mothers and the wives of G1 fathers (date of own birth and birth year of first-born offspring) on the two questionnaires administered for the second generation survey. Data on maternal age at childbirth were available for 82% (1,393/1,690) of mothers. Just 3% (50/1,690) were teenagers when they gave birth to G2 offspring.

7.2.3 Cognitive ability

Since intergenerational continuities are best examined by making use of independent information from childhood traits in two successive generations assessed prospectively at the same ages (Cairns, *et al.*, 1998), the main independent variable in most of the analyses was G1 parental cognitive ability at age eight and the main dependent variable of interest was G2 offspring cognitive ability at age eight. These scores represent ability measured at a time when children were still in primary education, prior to individual differences in the number of years of full-time education and before the choice of academic subjects in secondary education. They therefore provided a measure of cognitive ability with minimal influence of education.

Cognitive tests were taken by G1 parents in schools at ages eight, 11 and 15 years, and at home at 26 years (table 7.1). Consistent with previous findings in the British 1946 birth cohort, cognitive scores at the four different ages were highly correlated (table 14.1 in appendices). G2 offspring took tests at age eight equivalent to those taken by their G1 parents at the same age, including reading (ability to read and pronounce a series of words), sentence completion (ability to complete an unfinished sentence with an appropriate word), and vocabulary (ability to explain the meaning of a word) tests. Each test was made generation-fair by replacing outdated words such as “muslin” and “guinea” with words of comparable difficulty (Wadsworth, 1986). Since the reading, sentence completion and vocabulary scores for tests at age eight were highly correlated in parents and offspring (r=0.60-0.84, p<0.001, table 14.1 in appendices), scores for individual tests were not analysed separately.

The cognitive ability scores from each test were standardised to generate z-scores with a mean of zero and a standard deviation of one. The z-scores from each age were summed to yield a global ability score, and this summed score was then standardised again to yield z-scores which allowed comparability between ages and across generations. Thus an individual with a standardised score of zero had an average score relative to the others. Cognitive ability scores were available for 91% (1,545/1,690) of G1 parents and 80% (1,351/1,690) of G2 offspring.

Table 7.1 Summary of cognitive ability tests undertaken by G1 parents and G2 offspring.

Cognitive ability test	Description	Example
G1 PARENTS AGE 8		
Word reading test (50 items)	Test of ability to pronounce a series of words. Words became progressively more difficult.	1. 'cat' and 'egg' 50. 'ophthalmic' and 'haemorrhage'
Sentence completion test (35 items)	Test of ability to complete an unfinished sentence with an appropriate word. Sentences became progressively more difficult.	1. Come with me to the shops to buy some (FIRE, WATER, STONE, SWEETS, MOTORS). 35. The political dangers of monopoly seem to have been much (EXASPERATED, EXCISED, EXAGGERATED, EXPROPRIATED, EXPOSTULATED).
Vocabulary test (50 items)	Test of ability to explain the meaning of a word. Words became progressively more difficult.	
Non-verbal picture test (60 items)	Test of ability to identify the odd one out in a series of pictures, to continue a series of four pictures by choosing one from a group, and to continue a series of relationships between pictures.	
G1 PARENTS AGE 11		
Verbal and non-verbal test (80 items)	Test of ability to complete the series of three words or shapes with an appropriate fourth choice taken from five possibilities.	
Arithmetic test (50 items)	Test comprised of 50 addition, multiplication, subtraction and division sums which became progressively more difficult.	1. Add 34 + 47 50. This [diagram] is a plank of wood worth 4*s*. 6*d*. How much is the shaded piece worth?
Word-reading test (50 items)	As used at age 8	
Vocabulary test (50 items)	As used at age 8	

Table 7.1 Summary of cognitive ability tests undertaken by G1 parents and G2 offspring (continued)

Cognitive ability test	Description	Example
G1 PARENTS AGE 15		
Verbal and non-verbal test Group ability test AH4 (130 items)	The first 35 items comprised shape matching and selection tasks, and the second 35 items were verbal and number problems which became progressively more difficult.	1. 1,2,3,4,5,6,7,8,9. Multiply the middle of these figures by 2. 2. *Easy* means the opposite of … problem, simple, difficult, always, cannot.
Reading comprehension test Watts-Vernon reading test (35 items)	Test of ability to complete an unfinished sentence with an appropriate word. Sentences became progressively more difficult.	1. You can buy stamps at a post (station, house, shop, man, office). 2. Before we make a decision we must consider all (relevant, relative, competent, decisive, comparable) factors.
Mathematics test (47 items)	Test included arithmetic, geometric, trigonometric and algebraic questions which became progressively more difficult	1. Underline the number below that means a quarter of a million; 2,500,000 250,000 25,225 40,000. 2. Sin A x cosec A =.
G1 PARENTS AGE 26		
Reading comprehension test Watts-Vernon reading test (45 items)	Test used at age 15 was extended by ten items at increased difficulty	45. The historical records are kept in (arches, interims, archives, inquest, sojourn).
G2 OFFSPRING AGE 8		
Word reading test (50 items)	As used at age 8 in G1 parents	
Sentence completion test (35 items)	As used at age 8 in G1 parents	Tests were made generation-fair by replacing outdated words such as "muslin" and "guinea" with words of comparable difficulty.
Vocabulary test (50 items)	As used at age 8 in G1 parents	

7.2.4 G0 Parenting variables

7.2.4.1 Parental interest

A measure of the level of G0 parental interest and encouragement in the school work of G1 parents when they were children was collected during primary education at age eight. Each parent was assigned a score from 0 to 50 based partly upon comments made by class teachers, and partly on records of the number of times each parent visited the school to discuss their child's progress with the head or class teacher. Parents with high scores were regarded by teachers as showing an interest in the work of their children and had taken the opportunity to visit the school at least once a year to discuss progress. Those with a low level rarely paid visits and took little interest in their child's school work (Douglas, 1967).

Since the measure of educational interest was based partly upon comments made by class teachers and partly on the records of the number of times each parent visited the school to discuss progress, these gradings represented only a crude indication of parental interest. However, this measure took account of the attitudes of both parents and was shown to be a marker of overall care, in that parents who seldom visited their child's school made little use of the available medical services and as a result there was increased illness and school absence among their children, who consequently did less well at school (Douglas, 1967). Data on parental interest were available for 98% (1,509/1,690) of G0 parents.

7.2.4.2 Affection

When G1 parents were aged 43, the Parker Parental Bonding Instrument (Parker, *et al*., 1979) was implemented to collect information on their childhood relationships with their own parents. The instrument comprises 24 questions and was designed to rate relationships on aspects of care and control. The care dimension incorporates the degree of affection and closeness of relationships involving questions on warmth and understanding. In particular, G1 parents were asked to rate how affectionate their mothers and fathers were on a scale of one (very like this) to four (very unlike this). The information from this question was used as a retrospective measure of the degree of parental affection shown towards G1 parents when they were children. Previous analyses of the British 1946 birth cohort reported that associations between retrospective accounts of parenting, assessed with the parental bonding instrument at age 43, and adult affective symptoms could not be explained as spurious relationships arising from other features of childhood adversity. This suggests that distorted recall arising from contemporaneous depressed mood was unlikely to have introduced bias (Rodgers, 1996). Data on affection were available for 81% (1,372/1,690) and 79% (1,340/1,690) of G0 mothers and fathers respectively.

7.2.5 G1 Parenting variables

Data on G1 parenting practices were collected from the mothers of G2 children at ages four and eight years. Mothers were asked more than 20 questions on a range of topics related to cognitive stimulation, discipline style and parental interest in school activities (table 7.2). Similar age-appropriate questions were asked at ages four and eight years. For example, identical questions about the type of parent-child affection were asked at both ages. At age four parents were asked about their teaching of basic school skills (e.g. the alphabet) prior to starting primary education, whereas at age eight these skills were no longer relevant and questions focused on the degree of stimulation provided by the reading culture in the home, which was more likely to contribute to their cognitive development.

In order to form coherent subsets between questionnaire items that were highly correlated (for example, parents taught their child the alphabet; parents taught their child to write), factor analysis was employed to maximise the information available at each age while reducing the number of variables into factors. Each factor score represents a continuum along which individuals vary and can be used in subsequent regression analyses. Components of each factor can be summed to yield an ordinal scale representing the relative position of individuals on that scale. Factor analysis has previously been used to define parent-child relationships by identifying factors corresponding to parental involvement in their child's schooling (Garcia Bacete & Oliver Rodriguez, 2004) and the family learning environment (Marjoribanks, 2001; Marjoribanks, 2003) in a cohort of Australian families, as well as authoritative, authoritarian and permissive parenting typologies (Robinson *et al*., 1995).

Table 7.2 Questions relating to G1 parenting practices. Respondents were G1 mothers or the wives of G1 fathers when G2 offspring were aged four and eight. Responses were binary (Yes/No) unless otherwise stated.

Question	**Age 4**	**Age 8**
Have you (or your husband) taught X the alphabet?	▪	
Have you (or your husband) taught X to count?	▪	
Have you (or your husband) taught X to write?	▪	
Have you (or your husband) taught X his/her colours?	▪	
Have you tried to prepare X in any way for going to school?	▪	
Does your husband read or tell stories to X?	▪	
Do you read or tell stories to X?	▪	
Do you regularly take out books from the library?		▪
Does your husband regularly take out books from the library?		▪
Do you or your husband read for pleasure?		▪
Does X use a lending library of any sort at all?	▪	
Does X regularly take out books from the public library?		▪
Does X regularly take out books from the school library?		▪
Does X read for pleasure?		▪
When X has been naughty do you ever send X out of the room or up to bed?	▪	▪
When X has been naughty do you ever keep X indoors or make X sit still?	▪	▪
When X has been naughty do you ever smack X?	▪	▪
When X has been naughty do you ever stop X sweets or not allow X to do something he/she enjoys?	▪	▪
When X has been naughty do you ever tell X you won't love them if he/she behaves like that?	▪	▪
When X has been naughty do you ever say that you will send him/her away or that you'll have to go away?	▪	▪
When X has been naughty do you ever try to frighten X with something like a policeman?	▪	▪
When X has been naughty do you ever threaten to use a stick or something like that?	▪	▪
Do you and your husband generally agree about dealing with X when he/she is naughty? [a]	▪	▪
On the whole, do you feel that where discipline is concerned that you are consistent? [b]		
If X has been especially good during the day, do you generally like to let X know?	▪	
If you want X to be good on a particular occasion do you ever promise him/her anything in advance?	▪	
Do you or your husband show affection towards X or are you fairly reserved?	▪	▪
Have you met X's class teacher or head teacher during the past year? [c]		▪
Do you ever discuss X's progress with the class teacher or head teacher? [c]		▪
At what age would you like X to leave school? [d]		

[a] Item dichotomised to 'Usually agree' vs. 'Rarely agree' and 'Never agree'.
[b] Item dichotomised to 'absolutely consistent' and 'fairly consistent' vs. 'not very consistent'.
[c] Responses: Yes, with class teacher; with head teacher; with both.
[d] Responses: 15 years, 16 years, 17 years, 18 years or later.

7.2.5.1 Factor analysis

Factor analysis is a method of investigating whether or not a number of variables of interest are linearly related to a smaller number of unobservable factors. This is achieved by transforming variables that correlate with one another into a new set of uncorrelated components (called factors) using a correlation matrix (Jolliffe, 2002). Since the questionnaire items related to parenting were predominantly dichotomous, a tetrachoric correlation was applied as opposed to the more frequently-used Pearson correlation. The tetrachoric correlation between two dichotomous items estimates the Pearson correlation one would obtain if the two constructs were measured continuously. Tetrachoric correlations have been made use of by previous researchers to account for dichotomous responses to questions on symptoms of psychosis (McGorry, *et al.*, 1998) and cannabis-related problems (Copeland, *et al.*, 2005). The resulting matrix is adopted as the starting point for factor analysis.

In factor analysis, the first factor identified will have maximal contribution to the common variance of the observed variables; the second will have maximal contribution subject to being uncorrelated to the first, and so on. A more interpretable solution is often achieved by a process of factor rotation. There are a number of different types of rotations that can be performed after the initial extraction of factors, including orthogonal rotations, such as varimax, which impose the restriction that the factors cannot be correlated, and oblique rotations, such as promax, which allow the factors to be correlated with one another. In these analyses the varimax rotation, which is favoured for simplicity, was used.

The resulting factor loadings, shown in table 7.3 represent how the variables are weighted for each factor. Individual items were retained if they had a loading near or over 0.35 (Jolliffe, 2002). The number of factors to be retained was decided by applying two standard statistical and visual tools commonly used in factor analysis.

i. Factors with eigenvalues smaller than one were excluded since factors retained in this way account for more variance than the average for the variables. This is known as the Kaiser rule (Jolliffe, 2002).
ii. An examination of the plot of the eigenvalues against the corresponding factor numbers, known as the scree plot (figure 7.2). The plot looks like the side of a mountain, and ‘scree’ refers to the debris that has fallen from the mountain and lying at its base. The rate of decline tends to be rapid for the

first few factors but then levels off. The point at which this occurs is often called the 'elbow' and is considered to indicate the maximum number of factors to extract.

In light of previous research (reviewed in chapter 2), questionnaire items representing aspects of parenting purportedly related to offspring cognitive development, such as parental teaching or assisting in school-related learning activities and harsh discipline, were included in the factor analysis. Using these items, a four-factor solution was the clearest and most readily interpretable and accounted for approximately 70% of the total variance in the observed variables (table 7.3). Extracted factors were unique in that few parenting variables loaded substantially on to more than one factor. Furthermore, the internal consistencies of the four factor scores were acceptable with values of Cronbach's alpha ranging from 0.6 to 0.7. This means that the questionnaire items making up each factor should all measure the same thing (Cronbach, 1951).

7.2.5.2 Intellectual environment

The first factor, labelled 'intellectual environment', was composed of questionnaire items representing the reading culture in the homes of G2 offspring when they were aged eight, including the reading habits of their G1 parents and frequency of visits to the library. This factor accounted for 45% of the total variance. Whether or not children read for pleasure did not load strongly onto this factor. Data on intellectual environment were available for 80% (1,349/1,690) of parent-offspring pairs.

7.2.5.3 Coercive discipline

Factor 2 included items relating to parental use of threats and coercion to achieve favourable behaviour, and was labelled 'coercive discipline'. Items related to threats of being sent away, promises of reward for good behaviour and practices that involved withdrawing privileges or making the child sit still did not load strongly onto this factor and were therefore excluded from the factor analysis. Likewise, the use of corporal punishment (Do you ever smack X?) did not load strongly onto any of the factors and was therefore used separately as a measure of punitive discipline. Data on coercive discipline were available for 76% (1,290/1,690) of parent-offspring pairs.

7.2.5.4 Affection

The third factor represented items relating to levels of G1 parental affection shown towards G2 offspring when they were aged four and eight years by their parents. Data on affection were available for 79% (1,338/1,690) of parent-offspring pairs.

7.2.5.5 Cognitive stimulation

Factor 4 – labelled 'cognitive stimulation' – identified items representing direct measures taken by parents to stimulate or teach their children. This factor therefore contrasts G1 parents who taught their children school-related skills prior to starting formal education with those parents who did not. This factor accounted for the remaining 7% of the total variance in the original data. Many parents taught their children the alphabet or colours by means of a game and therefore items in this factor are likely to represent activities in which there was positive and reciprocal involvement between parents and their offspring. Attempts by parents to prepare their child for school, and parents reading stories to their children, did not load strongly onto this factor. Data on cognitive stimulation were available for 94% (1,592/1,690) of parent-offspring pairs.

Since the extracted factor scores were continuous measures but did not meet the assumptions of normality required for linear regression, 5-point scores were calculated for each of the four extracted factors to produce a minimum score of 0 (parents did not answer 'yes' to any of the questions making up that factor) and a maximum score of 4 (parents answered 'yes' to all of the questions making up that factor). For the coercive discipline factor, a maximum score of 9 could be assigned but since only 30 parents applied all or most of the discipline practices making up this measure, those with scores of 5 to 9 were recategorised to form a score with a maximum of 4. These additive scales were normally distributed (kurtosis approximately 3; skewness approximately 1) and could therefore be used in regression analyses representing a continuum along which parenting differed with low levels (0) at one end and high levels (4) at the other.

In addition to the measures of G1 parenting derived from factor analysis, three other variables that did not load strongly onto any of the factors were also included in the analyses – parental interest in education, parental aspirations for future educational achievement and corporal punishment.

Table 7.3 Factor loadings, eigenvalues and cumulative variance for factor pattern of G1 parenting practices.

G1 Parenting practices (*n*=1,309)	**Factor 1**	**Factor 2**	**Factor 3**	**Factor 4**
Intellectual environment				
Mother regularly took books out of the library (age 8)	0.91			
Father regularly took books out of the library (age 8)	0.84			
Parents read for pleasure (age 8)	0.79			
Child regularly took books out of the library (age 8)	0.75			
Coercive discipline				
Parents told child they wouldn't love him/her (age 8)		0.77		
Parents disagreed about discipline practices (age 8)		0.59		
Parents told child they wouldn't love him/her (age 4)		0.57		
Parents used discipline inconsistently (age 8)		0.56		
Parents disagreed about discipline practices (age 4)		0.49		
Parents threatened to call a policeman (age 8)		0.48		
Parents threatened to call a policeman (age 4)		0.43		
Parents threatened to use a stick (age 4)		0.38		
Parents threatened to use a stick (age 8)		0.33		
Affection				
Father was affectionate towards child (age 4)			0.82	
Mother was affectionate towards child (age 8)			0.77	
Mother was affectionate towards child (age 4)			0.70	
Father was affectionate towards child (age 8)			0.62	
Cognitive stimulation				
Parents taught child to count (age 4)				0.77
Parents taught child to write (age 4)				0.69
Parents taught child the alphabet (age 4)				0.67
Parents taught child his/her colours (age 4)				0.60
Eigenvalues	4.34	2.38	2.14	1.66
Cumulative variance	0.45	0.55	0.63	0.72

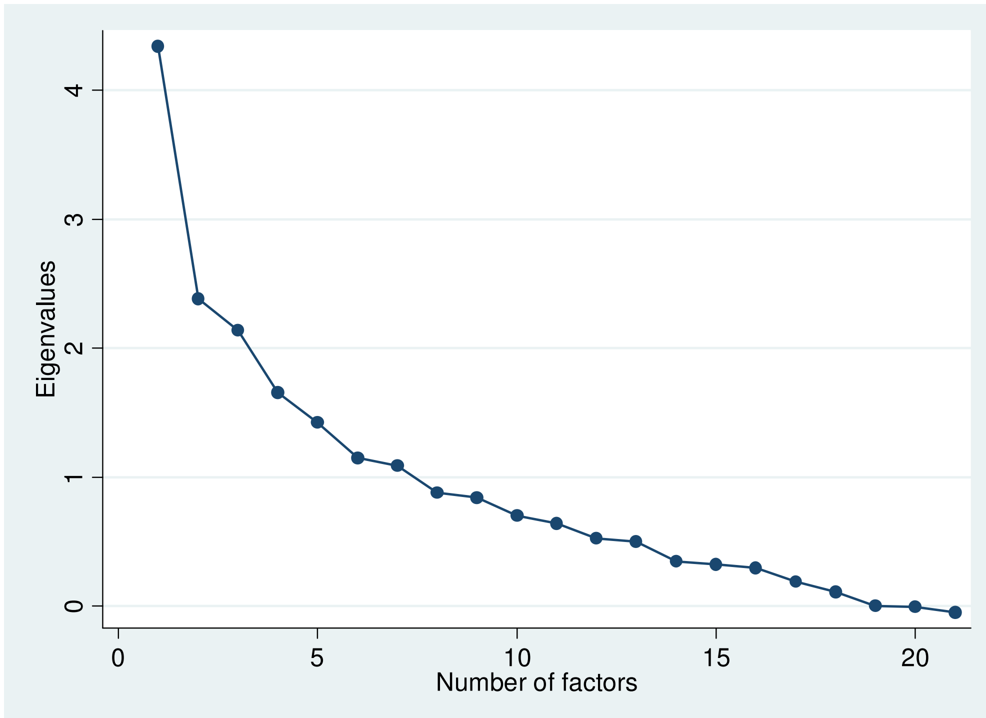

Figure 7.2 Scree plot illustrating the 4-factor solution resulting from factor analysis of parenting practices

7.2.5.6 Parental interest

A measure of G1 parental interest in the school activities of G2 offspring at age eight was based upon responses from mothers on second generation survey questionnaires to items on teacher-parent contacts and teacher-parent communication. Parents with a maximum score of 4 had met and discussed their child's progress with both the class teacher and head, while those with a score of 0 had done neither. This was a self-reported measure in contrast with the measure of parental interest in G0 parents, which was teacher-rated. Data on parental interest were available for 82% (1,386/1,690) of parent-offspring pairs.

7.2.5.7 Aspirations

A measure of G1 parental aspirations was based upon parental wishes, expressed when their child was aged eight years that the child should remain at school beyond the minimum school leaving age, together with their hopes for him or her progressing to some form of further education. This variable is a 5-point scale coded as (0) no aspirations (1) leave at age 15, the minimum school leaving age at the time; (2-3) leave at age 16 or 17; and (4) hopes for the G2 child staying on at school until age 18 or later. Data on parental aspirations were available for 82% (1,394/1,690) of parent-offspring pairs.

7.2.5.8 Corporal punishment

A binary measure of corporal punishment (yes/no) was derived from mothers' responses to questions at ages four and eight asking them if they smacked their children as a form of punishment. Data on corporal punishment were available for 82% (1,393/1,690) of parent-offspring pairs.

7.2.6 G1 Mental health variables

7.2.6.1 Psychiatric disorder (age 15 to 32)

A composite variable was used to describe the duration and severity of psychiatric disorder in G1 parents between ages 15 and 32, based upon a detailed examination of all available medical records during the relevant time. Three groups were identified: a severe group whose members had suffered psychiatric episodes of more than a year's duration, or had had any out-patient or in-patient episodes for psychiatric disorder (5%, 91/1,690); a mild group reporting minor or inconsequential nervous disorders (36%, 609/1,690); and a group exhibiting no evidence of psychiatric disorders between ages 15 and 32 (59%, 990/1,690).

7.2.6.2 Neuroticism and extraversion (age 26)

Neuroticism and extraversion, measured by the Maudsley Personality Inventory (Eysenck, 1958), was employed as an indication of anxiety-proneness at age 26. At the time of these assessments, G2 offspring were aged 5 to 15 years. This measure comprised 12 yes/no questions in which each 'yes' scored one point. Three representative items for this scale were i) "Are you the type of person whose feelings are easily hurt?"; ii) "Are you the type of person who is rather nervous?"; and iii) "Are you the type of person who is a worrier?" Points were summed to yield a total score ranging from 0 to 12. Higher scores indicated a higher degree of neuroticism or extraversion. Neuroticism and extraversion scores were available for 98% of G1 parents (1,651/1,690 and 1,652/1,690 respectively).

7.2.6.3 Postnatal depression

Information on postnatal depression in G1 mothers was collected retrospectively at age 51 using the Bromley postnatal depression questionnaire (Stein & Vandenakker, 1992). These data were collected as part of a series of postal questionnaires sent to women in the British 1946 birth cohort every year between ages 47 and 54, and therefore only G1 mothers and not the wives of G1 fathers were included in these analyses. Women were asked if they had experienced postnatal depression according to the following description:

> "A period of a few weeks or months, starting in the first year after giving birth when you felt depressed or low-spirited, or rather anxious, with times of panic. During

this time you slept poorly, wept frequently, daily or almost daily, could not really laugh or enjoy anything, felt irritable and in poor temper, and felt awful for much of the time."

If they gave a positive response they were asked how long it had been after giving birth that depression had started (in the first month, from 1 to 3 months, 4 to 6 months, 7 to 12 months); how long it had lasted (less than one month, from 1 to 3 months, 4 to 6 months, 7 to 12 months, more than 12 months); and whether or not they had consulted a GP or psychiatrist for depression during the first year after birth. Postnatal depression was defined as episodes lasting longer than a month. By this definition 7% (65/944) of G1 mothers had experience of one or more episodes of postnatal depression. Data were available for 58% (550/944) of mothers.

7.2.7 G1 Physical health variables

7.2.7.1 Chronic illness (age 20 to 25)

Chronic illness was defined as "a physical, usually non-fatal condition that lasted longer than three months in a given year or necessitated a period of continuous hospitalisation of more than one month". Fourteen per cent (238/1,690) of parents experienced chronic illness during the early childhood of their G2 offspring when they were aged 20-25 years.

7.2.7.2 Physical activity (age 36)

Information on the frequency and duration of a range of active leisure pursuits in the preceding month were collected by trained interviewers during a home visit when birth cohort members were aged 36. Individuals were classified as 'most active', 'less active' or 'inactive' based upon estimates of energy expended during various activities and from reported duration times in accordance with the criteria in table 7.4. Ninety per cent of the interviews were conducted between April and September to minimise seasonal influences on the frequency of physical activity (Kuh & Cooper, 1992). In the G1 parent group, 34% (568/1,690) were classed as most active, 24% (413/1,690) as less active and 30% (501/1,690) inactive; 12% (208/1,690) were missing physical activity scores.

Although activity recall may be prone to bias, one study showed that the questionnaire used to collect information on leisure time activities correlated well with treadmill estimation of oxygen uptake and body composition, two traditional 'gold standards' for physical activity measurement (Capaldi & Clark, 1998). However, since these data were collected on average ten years after the assessment of parenting measures and offspring ability, it is likely that there was some misclassification due to recall bias.

7.2.7.3 Smoking (age 26)

The smoking habits of cohort members, collected when they were aged 26, were categorised as: 'non-smoker' (37%, 624/1,690 of G1 parents), 'current smoker' (39%, 651/1,690 of G1 parents) and 'ex-smoker' (13%, 219/1,690 of G1 parents). Data on smoking habits were available for 88% (1,494/1,690) of G1 parents.

Table 7.4 Criteria used to classify physical activity (Kuh & Cooper, 1992).

Type of physical activity	**Most active**	**Less active**	**Inactive**
Physical activity during the working day.	Either 1) over half the day spent walking or 2) frequently lifts and carries heavy things.	Not classified in the most active or inactive groups.	At least half of the day sitting down.
Sports recreational activities: List of 27 activities e.g. badminton, swimming, yoga, exercises such as press ups at home, dancing, football, jogging etc.	Five or more times in the previous month.	1-4 times in previous month.	No reported activity in previous month.
Cycling and walking.	Either 1) normally rides or walks to work for at least ½ hour (round trip) or 2) 12 rides or walks of ½ hour in leisure time in previous month.	Either 1) Normally rides or walks for less than ½ hour or 2) 1-11 rides or walks of ½ hour in leisure time in previous month.	Does not normally ride or walk and no reports of riding or walking in leisure time in previous month.
Heavy gardening and DIY: List of 10 heavy activities (e.g. digging earth, chopping wood, brick-laying, moving heavy objects, etc.)	Five or more times in the previous month.	1-4 times in previous month.	No reported activity in previous month.

7.3 Description of the intergenerational dataset

7.3.1 G1 Parents

The parents included in this study comprised 1,690 members of the British 1946 birth cohort (746 men, 944 women), and their spouses or partners, who became parents from 1965 to 1975 (aged 19 to 29) and whose G2 offspring were included in the second generation survey. A further 1,117 G1 men and 937 G1 women went on to become parents by the age of 32 (Kiernan & Diamond, 1983) but were not included in this sample of G1 parents.

A comparison of the demographic characteristics and cognitive ability scores between the parents (*n*=1,690) and cohort members who did not become parents by age 29, or who were lost to follow-up (*n*=3,672), was made to determine whether or not the parents included in the intergenerational dataset were representative of all subgroups of the population born in 1946 in England and Wales (table 7.5). More women than men were included in the parent sample. There were also more parents from a non-manual social class background (χ^2 test: $p<0.001$). Furthermore, parents had spent more years in full-time education (χ^2 test for trend: $p<0.001$) compared with non-parents. There were no differences between the two groups on cognitive ability at ages eight, 11, 15 and 26 years.

Table 7.5 Demographic characteristics and cognitive ability scores of the baseline population, those British 1946 birth cohort members who became parents from 1965 to 1975, and those who did not become parents by age 26, or who were lost to follow-up (non-parents).

	All cohort members (*n*=5,362)		Parents (*n*=1,690)		Non-parents (*n*=3,672)		Parents vs. non-parents
Demographic characteristics *(%)*							
Sex							
Men	2,815	*(53)*	746	*(44)*	2,069	*(56)*	
Women	2,547	*(47)*	944	*(56)*	1,603	*(44)*	$p<0.001^a$
Social class							
Missing	*1,534*	*(28)*	*36*	*(2)*	*1,498*	*(41)*	
I & II Professional & Managerial	604	*(11)*	252	*(15)*	352	*(10)*	
IIINM Skilled non-manual	1,270	*(24)*	616	*(36)*	654	*(18)*	$p<0.001^b$
IIIM Skilled manual	652	*(12)*	242	*(14)*	410	*(11)*	
IV Partly skilled & Unskilled	1,302	*(24)*	544	*(32)*	758	*(21)*	
Missing	*1,534*	*(28)*	*36*	*(2)*	*1,498*	*(41)*	
Manual	1,954	*(36)*	786	*(47)*	1,168	*(32)*	
Non-Manual	1,874	*(36)*	868	*(51)*	1,006	*(27)*	$p<0.001^a$
Education (age 26)							
Missing	*930*	*(17)*	*50*	*(3)*	*880*	*(24)*	
No qualification	1,765	*(33)*	652	*(39)*	1,113	*(30)*	
Vocational	144	*(3)*	63	*(4)*	81	*(2)*	$p<0.001^b$
Ordinary	1,072	*(20)*	438	*(26)*	634	*(17)*	
Advanced	1,040	*(19)*	377	*(22)*	663	*(18)*	
Degree level	411	*(8)*	110	*(7)*	301	*(8)*	
Missing	*930*	*(17)*	*50*	*(3)*	*880*	*(24)*	
Ordinary	2,981	*(56)*	1,153	*(68)*	1,828	*(50)*	
Advanced	1,451	*(27)*	487	*(29)*	964	*(26)*	$p<0.001^a$
Cognitive ability: Mean z-score ***(SD)***							
Age 8	0.00	*(1)*	0.02	*(0.9)*	0.02	*(1.0)*	$p=0.1^c$
Age 11	0.00	*(1)*	0.01	*(0.9)*	-0.01	*(1.0)*	$p=0.7^c$
Age 15	0.00	*(1)*	-0.03	*(0.9)*	0.02	*(1.0)*	$p=0.1^c$
Age 26	0.00	*(1)*	0.04	*(0.9)*	-0.04	*(1.0)*	$p=0.07^c$

p-values are for $^a\chi^2$ tests, $^b\chi^2$ tests for trend or ^{c} *t*-tests. Analysis ignores missing data.

The mean age at which mothers gave birth to their second generation offspring was 20 years (age range 13 to 31 years). Maternal age at childbirth was associated with cognitive ability and education in that parents who delayed having their first child until they were 20 years or older, had higher mean cognitive ability scores. Furthermore, 20% of teenage mothers had completed advanced education or above, compared with 41% of older mothers (χ^2 test: p<0.001). Significantly more wives of manual workers gave birth to their first child during their teenage years compared with those who were 20 years or older (412 vs. 246, χ^2 test: p<0.001). These findings are consistent with previous analyses of British 1946 birth cohort members up until age 32, which showed that men and women who became parents at young ages tended to have manual jobs while those in non-manual jobs delayed having their first child. This study also reported that better than average educated men and women tended to have their first child at a later age (Kiernan & Diamond, 1983), a trend also noted in G1 parents.

As expected (Kuncel, *et al.*, 2004; Tong, *et al.*, 2007), G1 childhood cognitive ability had a graded relationship with social class in childhood (G0 paternal social class) and adulthood, and own educational attainment at age 26. The mean z-score decreased incrementally across the social hierarchy with those in classes IV & V having the lowest mean cognitive scores and the lowest proportion to benefit from advanced education (figures 7.3 to 7.5). The mean cognitive ability scores of G2 offspring were higher than those of the G1 parents. This is consistent with the Flynn effect (Flynn, 1984).

Just 3% (56/1,690) of parents were unmarried (divorced, single, widowed) when their first-born offspring were born.

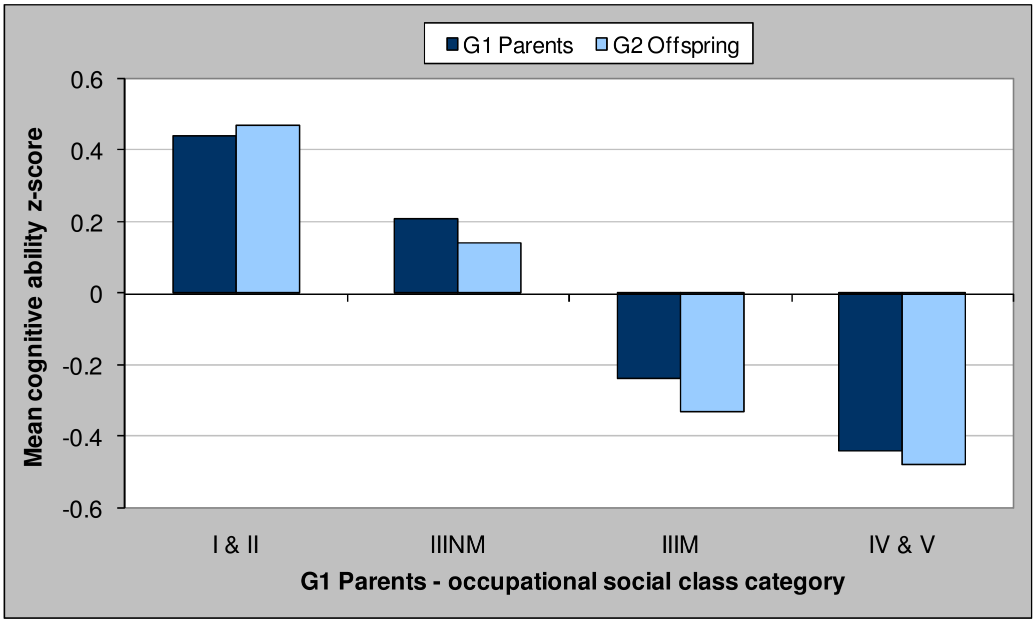

Figure 7.3 Mean cognitive ability z-scores at age eight for parents and offspring by G1 social class.

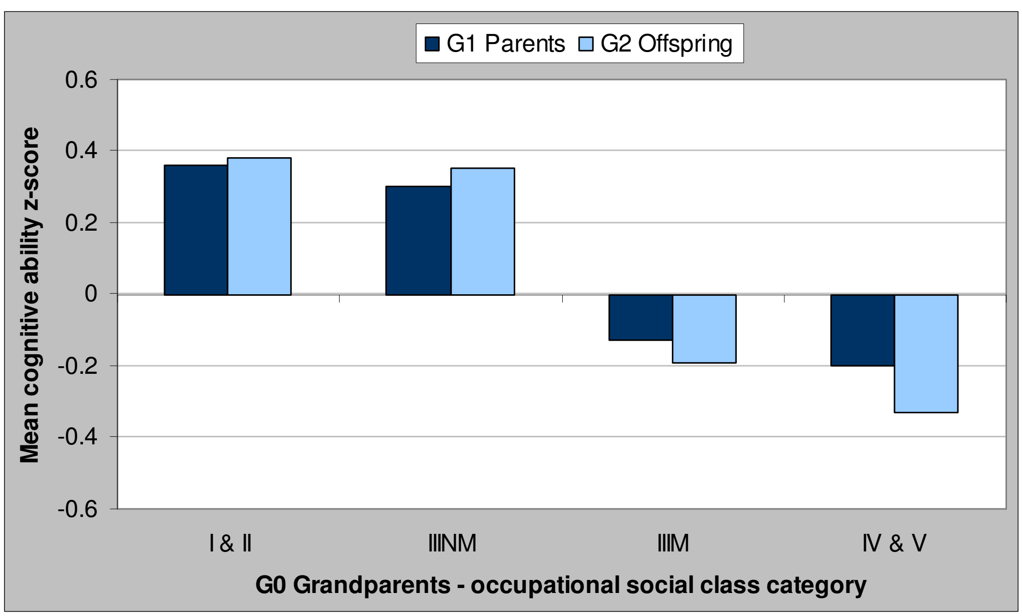

Figure 7.4 Mean cognitive ability z-scores at age eight for parents and offspring by G0 social class.

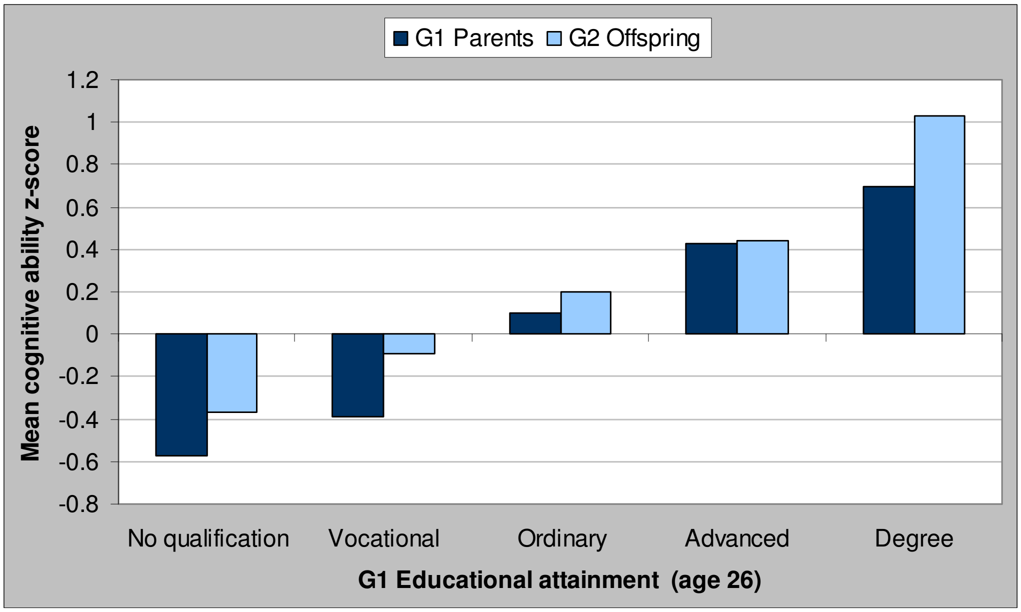

Figure 7.5 Mean cognitive ability z-scores at age eight in parents and offspring by G1 educational attainment.

7.3.2 G2 Offspring

A total of 1,690 G2 offspring were included in the intergenerational dataset. Of the sample, 52% (874/1,690) were boys.

The relationships between cognitive ability, social class and education in offspring reflect those observed in the parental generation (figures 7.3 to 7.5). Children from middle-class and professional families scored higher in cognitive ability tests than children from manual class families. Similarly, children with at least one G1 parent who had achieved a minimum of one advanced level qualification (A-level) or equivalent did better in cognitive tests compared with those whose parents had no qualifications (figure 7.5).

7.3.3 Intergenerational correlations in cognitive ability

G1 parental and G2 offspring cognitive ability at age eight was significantly positively correlated (r=0.38, p<0.001, table 14.1 in appendices), suggesting some intergenerational continuity in ability, but also discontinuity in cognitive ability between the generations.

Although accurate examination of intergenerational associations requires assessment of parents and children at comparable points in the life course, restricting analyses to parental ability at age eight raises the question of whether or not parents whose cognitive ability scores improved or deteriorated beyond early childhood were misrepresented in terms of cognitive ability. For example, any findings indicating that parenting or social mobility was associated with intergenerational improvements in cognitive scores could be attributable to improvements in parental ability beyond age eight. However, G1 ability scores at ages eight, 11 and 15 years were strongly correlated (all r's>0.7, p<0.001). This indicates that cognitive ability remained stable across early childhood and adolescence for most of G1 parents. To ascertain whether or not changes in parental ability scores across this seven-year period affected the cognitive development of their G2 children, parents were divided into three trajectory groups: 1) improvers who moved up ability quartiles between ages eight and 15 years, 2) fallers who moved down ability quartiles between ages eight and 15 years, and 3) those who remained stable. No association between offspring ability scores and the G1 parental trajectory group was found using linear regression models (β=-0.01, *p*=0.7). This suggests that continuities and discontinuities in cognitive ability between G1 and G2 at age eight are unlikely to have been influenced by any changes in the relative position of parental ability scores between ages eight and 15.

Parental social class in childhood and adulthood, parental educational attainment by age 26 and maternal age at childbirth were all related to cognitive ability in both generations (table 14.2 in appendices). This indicates that the confounding or mediating effects of these variables must be taken into account when analysing intergenerational relationships between G1 parents and G2 offspring.

7.4 Missing data

The intergenerational dataset included 1,690 parents and their first-born offspring. A number of these parent-offspring pairs were missing data for key variables as a result of non-response and 'don't know' replies. Since missing data may introduce ambiguity into the analysis owing to uncertainty over the nature of the lost information (Allison, 2002), it is important to consider adopting different approaches to deal with such situations.

One of the most common methods is listwise deletion by which means individuals with missing data are eliminated from analyses. The disadvantages of such an approach are that the remaining cases may not be representative of the population, and that a listwise deletion could result in a substantial reduction in sample size. Another approach is to treat missing data as another category – that is, rather than exclude individuals, a further category for missing data or non-responders is included in the analyses (Greenland & Finkle, 1995). This method might lead to residual confounding, especially when used for missing confounders. Another common strategy is to use single imputation of the overall mean, an appropriate subgroup mean or a regression estimate for those with missing data. However, such strategies are known to reduce variability and may over estimate test statistics, since missing data individuals are usually atypical and therefore difficult to estimate. In longitudinal data, the 'last observation carried forward' (LOCF) method is commonly used to reduce loss of information over the course of time. This entails imputation of values for data not recorded at a particular time date but which may be available at an earlier or later date. This method is acceptable if measurements are expected to be relatively constant over time. One of the more advanced methods of dealing with missing data is maximum likelihood estimation where missing data are imputed several times (e.g., using regression imputation) to produce several different complete-date estimates of the parameters. The parameter estimates from each imputation are then combined to give an overall estimate of the complete-date parameters as well as reasonable estimates of standard errors (Allison, 2002). Overall, these methods do not offer a solution to the problem of loss of data. They may, however, be used as a 'best option' approach to ensure that the least possible bias is introduced (Allison, 2002).

In these analyses, the LOCF method was used to maximise the available data on occupational social class for the G0 generation (see section 7.2.1.1). Using data collected when G1 parents were aged four, 11 or 15 increased the completeness of G0 social class from 85% to 97%. This method assumes that social class was relatively stable across the 11-year period. Correlation coefficients of 0.9 (all p's<0.001) between the three scores confirmed that this was in fact the case.

Listwise deletion was applied to deal with incomplete data on G1 and G2 cognitive ability, G0 and G1 social class and G1 parental educational attainment. This resulted in a 30% (516/1,690) loss of parent-offspring pairs from the intergenerational dataset (figure 7.6). Excluding individuals with no valid data on these variables may have raised the mean values for parental cognitive ability and education through selection bias, since it has been shown that British 1946 birth cohort members with fewer years of education and lower cognitive scores were more likely to be missing data (Wadsworth, *et al.*, 1992). However, examination of the 516 individuals with missing information on these variables revealed no significant differences in ability scores, educational attainment or social class between those with and those without missing data. The only exception was that more parents from a manual social class background were missing ability scores than those with complete data on cognitive ability.

Seventy four per cent (1,244/1,690) of parents had complete data for all eight measurements of parenting. There were no differences in social class (G0 and G1), educational attainment or cognitive ability between those parents with and those without missing data. Listwise deletion of potential confounders and other covariates reduced the sample size further for some analyses (figure 7.6), except for the path model analysis, which used maximum likelihood estimates and therefore included the complete intergenerational dataset.

7.5 Statistical analyses

Statistical analyses were undertaken by means of STATA™ v9 (StataCorp, TX, USA). In most cases the outcome variable – offspring cognitive ability – was continuous and therefore the appropriate model was linear regression. For analyses of binary outcomes, for example, predictors of corporal punishment, odds ratios were calculated using logistic regression. When examining the consequences of social mobility, multinomial logistic regression was used to take into account the ordinal outcome variables. The latent variable modelling programme, AMOS 4.01 (Arbuckle, 1999), was utilised for path model analyses in chapter nine. These methods are discussed in greater detail in the relevant chapters.

The results of regression analyses were reported as standardised or beta (β) coefficients. These represent the estimate of an analysis performed on variables that have been standardised to have a mean of 0 and a standard deviation of 1. Standardisation allows for a fair comparison of the predictive power of variables measured on disparate ranges or expressed in non-comparable units of measurement (Gelman & Hill, 2007) (e.g., cognitive ability measured as a z-score and education based upon a binary variable representing ordinary and advanced). The beta coefficient represents the estimated average change in standard deviation. Therefore a beta coefficient of 0.25 indicates that for a one standard deviation increase in the independent variable, the estimated outcome variable increases by 0.25 standard deviations.

The interpretation of findings did not rely exclusively on significant *p*-values ($p<0.05$) but also considered the magnitude of associations and confidence intervals in order to avoid misinterpretation of findings based upon a single *p*-value or effect estimate (Smith, 2003).

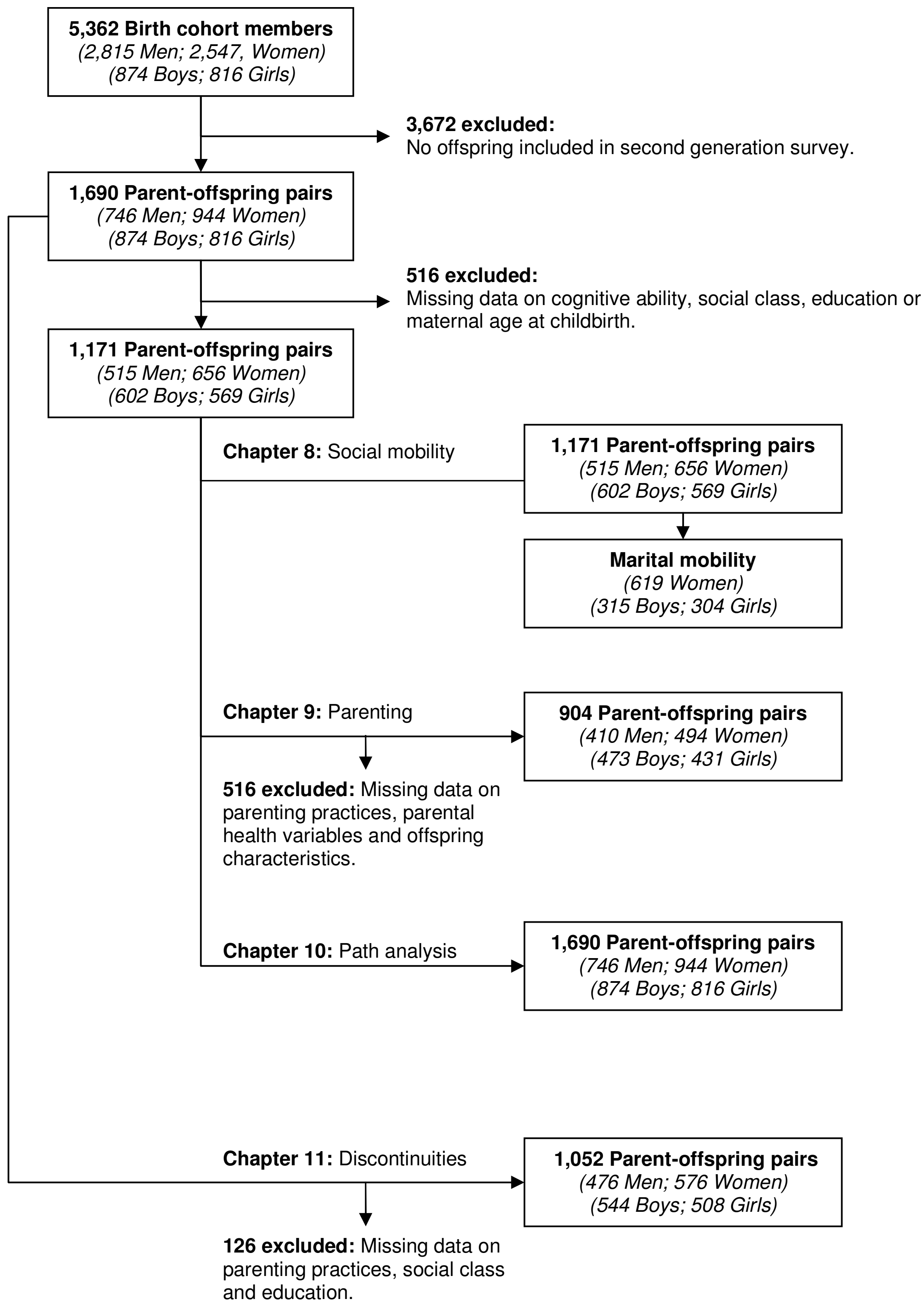

Figure 7.6 Missing data profile for analyses of the intergenerational dataset.

8. Social mobility and intergenerational associations in cognitive ability

8.1 Introduction

Cognitive scores have repeatedly been shown to have modest correlations between generations, in this (section 7.3.3) and other cohorts, of approximately 0.4 (Guo & Harris, 2000; Lawlor, *et al.*, 2005; Plomin & Craig, 2001). The next step in examining these intergenerational relationships is to clarify some of the mechanisms that may be involved in continuities and discontinuities in cognitive ability. Intergenerational social mobility is one plausible intervening mechanism that may confer cognitive advantage or disadvantage on successive generations through pathways determining the occupational attainment of the parents.

Social mobility from one generation to the next represents the difference between a person's current occupation, income or wealth, and that of the family that raised that person. It may also be seen as the extent to which an individual's circumstances during childhood are reflected in his or her success in later life, or alternatively, the extent to which that person is able to succeed by virtue of individual talent and motivation (Blanden, *et al.*, 2005). Cognitive ability and education are two factors associated with social mobility that may enable individuals to escape from the low social class of their parents, or to allow those who grow up in privileged homes to benefit from the advantages inherent in their family backgrounds (Deary, *et al.*, 2005). Conversely, disadvantaged social backgrounds may predispose individuals to poor cognitive development and school failure, which may in turn place them at risk of downward mobility or of an inability to escape from the poor social class into which they were born. Collectively, these factors may affect the cognitive development of the succeeding generation

8.2 Specific objectives of the chapter

This chapter examines the extent to which intergenerational social mobility of G1 parents predicts cognitive ability in the next generation, and how far it explains intergenerational associations in cognitive ability. Three hypotheses are tested:

- Parents who remain in the manual social class of their G0 fathers are the most disadvantaged of these groups in terms of educational attainment and cognitive development, and are therefore the most likely to place their offspring on a continuing negative trajectory for poor cognitive outcomes.
- G2 offspring perform better on cognitive ability tests if their G1 parents are upwardly mobile or remain stable in the non-manual social class of their G0 fathers, compared with those whose parents remain in the stable manual class of their G0 fathers.
- Intergenerational social mobility in G1 parents mediates part of the association between G1 cognitive ability and G2 cognitive ability.

Based upon these hypotheses, this chapter addresses the following research questions:

1. Does childhood cognitive ability and educational attainment predict the chance and direction of intergenerational social mobility of G1 parents?
2. Is G1 parental social mobility related to G2 offspring cognitive ability?
3. Is the effect of G1 intergenerational social mobility on G2 offspring IQ accounted for by G1 cognitive ability?

8.3 Measures

Two measures of social mobility were used – occupational mobility and marital mobility. Occupational mobility is the extent to which the status or type of job a person achieves by a certain point in life resembles that of his or her father or mother (Case & Paxson, 2006). Occupational social class is considered to be one of the most useful markers of an individual's social advantages and disadvantages, likely income and material conditions, and health and lifestyle (Kuh *et al*., 2004). Marriage provides a second kind of occupational mobility for women through movement from father's occupation to husband's occupation, otherwise known as marital mobility (Tyree & Treas, 1974).

One of the drawbacks of analysing social mobility in this way is that there is no straightforward way of incorporating the occupations of both parents into the intergenerational design. Thus occupational mobility is limited to father-son or father-daughter mobility. Previous studies of intergenerational occupational mobility have largely been restricted to men on the grounds that women have an irregular attachment to employment and that their social position is usually based upon the economically active head of the household, which in most instances was the husband (Blane, *et al*., 1999; Nettle, 2003). This means that members of the same family are assumed to occupy a single position and that men, women and children living together in a family are assumed to have similar interests, to share similar life chances, and to have the same standard of living. In the context of life course epidemiology, this may not be true since a mother who is working part-time because of childcare commitments may have different aspirations for her offspring as a result of her family background or employment history (Sorensen, 1994). These analyses therefore used women's own occupation at age 26 rather than a household measure to assign adult social class.

8.3.1 Occupational mobility

Intergenerational occupational mobility was assessed by comparing movement between occupational social class of G0 fathers when G1 parents were aged 11 (origin) and the occupational social class of G1 parents at age 26 (attained). A four-class schema of the Registrar General's classification (I & II, IIINM, IIIM, IV & V) was used and therefore movement of up to three social class categories was possible.

Upward mobility was defined as movement to a higher social class by age 26 compared with the social class of G0 fathers. This included individuals who moved into the professional class (I & II) from classes IIINM, IIIM or IV & V. Downward mobility was defined similarly, as movement to a lower social class compared with the G0 father's social class. The rest were classed as stable non-manual (non-manual social class – I & II or IIINM – in both childhood and adulthood) and stable manual (manual social class – IIIM or IV & V – in both childhood and adulthood).

8.3.1.1 Study sample

These analyses were restricted to 1,171 parent-offspring pairs for whom there were complete data on G1 and G2 cognitive ability, G0 and G1 social class (i.e. social mobility category), G1 educational attainment and maternal age at childbirth. This included 515 G1 men and 656 G1 women.

8.3.2 Marital mobility

Marital mobility in G1 women was defined as movement from a G0 father's occupational social class when G1 mothers were aged 11, to a husband's class when G1 mothers were aged 26.

Upward mobility was defined as marriages to men whose social classes, when G1 women were aged 26, were higher than those of their G0 fathers. Downward marital mobility was defined similarly as marriage into lower social classes compared with those of their G0 fathers. The remainder were classed as stable non-manual (non-manual social class in both childhood and adulthood) and stable manual (manual social class in both childhood and adulthood).

8.3.2.1 Study population

These analyses included 619 mother-offspring pairs for whom there were complete data on G1 and G2 cognitive ability, social mobility category, G1 educational attainment and maternal age at childbirth. The occupations of the wives of G1 fathers were not known and therefore marital mobility in men could not be assessed.

8.4 Analyses

8.4.1 Mobility matrix

Intergenerational occupational and marital mobility were first described by inspecting a mobility matrix of G0 father's social class and G1 social class, which characterises movement as outflow and inflow mobility (Goldthorpe *et al.*, 1980). Outflow mobility represents the percentage of G1 parents from a given origin class in each destination class, and is interpreted as row percentages. Inflow mobility represents the proportion of G1 parents in a given class at age 26 who originated in each class of origin, and is interpreted as column percentages.

8.4.2 Predictors of intergenerational social mobility

To examine the effect of G1 cognitive ability and educational attainment, as well as maternal age at childbirth, on the chance and direction of intergenerational occupational and marital mobility, odds ratios were calculated using a series of polytomous logistic regression models. The polytomous logistic model is a useful tool for regression analysis with multinomial responses (Agresti, 2002). The two outcomes of interest – occupational and marital mobility – had four categories representing social mobility: stable non-manual, upward, downward and stable manual. Those in the stable manual category were employed as the reference group. Multinomial logistic regression assumes proportional odds, with the impact of predictors assumed to be the same at each possible threshold of the scale (Hosmer & Lemeshow, 2000). Odds ratios greater than one indicated a higher likelihood of the outcome of interest compared with the reference group. Conversely, odds ratios below one indicated a diminished relative probability. The independent variables in these analyses were parental cognitive ability at age eight, parental educational attainment by age 26 (dichotomised to ordinary vs. advanced) and maternal age at childbirth (dichotomised to $\leq$ 19 years vs. $\geq$ 20 years).

8.4.3 Social mobility and offspring cognitive ability

Linear regression models were used to examine the effect of parental occupational and marital mobility on offspring cognitive ability. The results were presented as standardised beta coefficients which allowed for comparison of the strength of the relationship across genders and mobility types. Coefficients with a non-significant *p*-

value were deemed to be not significantly different from zero – that is, no statistically significant association existed, although proper interpretation of the effect estimate took the magnitude of the standardised coefficient into account.

For these analyses, the two independent variables – occupational and marital mobility – had four categories representing social mobility: stable non-manual, upward, downward and stable manual. Those in the stable manual category were employed as the reference group. The dependent variable was offspring cognitive ability at age eight.

8.4.4 Social mobility and intergenerational associations

Hierarchical linear regression analyses were used to examine the effect of parental social mobility on intergenerational associations in cognitive ability. In hierarchical multiple regression, the number of independent variables entered into the model and the order in which they are entered is predetermined and based upon logical or theoretical considerations (Gelman & Hill, 2007). In these analyses, following unadjusted models examining the intergenerational association between parental and offspring cognitive ability (model 1), parental social mobility was added to the models (model 2). Finally, parental education and maternal age at childbirth were entered as covariates in model 3. These analyses aimed to identify (i) whether or not parental social mobility significantly decreased the unadjusted association between parental and offspring cognitive ability and (ii) whether or not parental educational attainment accounted for any effect of parental mobility on intergenerational relationships in cognitive ability.

Likelihood ratio tests (LRT) examined whether or not there was a statistically significant difference between model 1 and model 2. Significant *p*-values for the LRT would indicate that parental social mobility significantly reduced the intergenerational association and therefore played a role in the transmission of cognitive ability between G1 parents and G2 offspring.

8.4.4.1 Structural zeros

These regression models may be affected by the fact that certain types of movement are impossible. For example, G1 parents born into classes I & II could not move up and those born into classes IV & V could not move down. Such prespecified cell values are known as structural zeros, since data includes cells whose frequencies are known before any data are collected. Structural cells can be avoided when fitting a model so that the calculation of the model table frequencies proceeds as though the structural cells are absent from the table and their values have no influence on the calculation of the other frequencies (Gilbert, 1993).

To determine whether or not the effects of restricted mobility patterns in the extreme classes affected the results, models using structural zeros were calculated. Similar techniques have been employed to examine patterns of mobility related to health selection (Bartley & Plewis, 1997; Manor, *et al.*, 2003). Since the results from models including structural zeros were not markedly different (table 14.3 in appendices), the results from the original regression models are presented.

8.4.5 Stratification by G1 sex

Owing to the marked differences existing in the labour market between men and women during the 1960s when G1 parents were first employed (Halsey & Webb, 2000), it was anticipated that the effects of cognitive ability and educational attainment on social mobility would differ by sex – that is, there would be an interaction effect. Interaction exists when the effect of an independent variable (e.g., cognitive ability) on a dependent variable (e.g., mobility) differs on the value of a third variable (e.g., sex). To analyse interaction, it is necessary to introduce interaction parameters into the regression model to determine whether the terms significantly improve model fit over and above the case where no interaction parameters are included – that is, compared with the model which assumes that the effect of education or cognitive ability is constant between sexes (James, 2001). Statistically this was tested by way of a likelihood ratio test.

8.5. Results

8.5.1 Mobility matrix

8.5.1.1 Occupational mobility

The full social mobility matrix of G0 father's social class by G1 social class, making use of six of the Registrar General's occupational social classes, revealed some empty cells and some with very small numbers. Nobody had moved from G0 father's social class I or II to G1 social class V. Only one man and one woman had moved from social class VI to I. To avoid distortion of results due to small cell frequencies, social classes I and II and social classes IV and V were combined for future analyses, leaving four groups.

Tables 8.1 and 8.2 show the outflow and inflow percentages for G1 men and women. The squares running from the top left to bottom right show the proportions for each class who were intergenerationally stable – that is, remained in the same social class as their G0 fathers. The cells to the left of the squares represent the proportion of G1 parents who moved up in position compared with their G0 fathers' social class, and the proportion who moved down compared with their class of origin are to the right of the squares.

During the childhood of G1 parents, approximately 60% of G0 fathers were employed in manual occupations. By age 26, when G1 parents were classified according to their own occupations, the proportion of G1 parents in non-manual positions had increased, with a corresponding reduction in the size of the manual classes to 53% of men and 25% of women. Approximately one-third of G1 parents remained in the same social class as their G0 fathers (42% men; 32% women) and of these, just under two-thirds of G1 men were stable manual and just over one-third of G1 women were stable manual. G1 fathers in social classes I & II, and IIIM were most likely to remain in the same social class as their G0 fathers while G1 mothers in skilled non-manual positions (IIINM) were most likely to remain stable.

Women experienced more upward mobility than men (48% for women and 38% for men). This was largely attributable to G1 women moving into skilled non-manual positions (IIINM) from the manual class (IIIM) of their G0 fathers. For example, 60%

of G1 women with skilled manual class origins and 42% from partly-skilled class origins moved up to the skilled non-manual class compared with approximately 12% of G1 men. This particular type of short-range upward mobility may account for the fact that more women than men were upwardly mobile. In contrast, upward mobility in men was largely attributable to the movement from skilled non-manual work to professional and managerial occupations (56% of men with IIINM class origins), and movement from partly-skilled or unskilled manual occupations to skilled manual positions (46% of men with IV & V class origins).

Approximately 20% of G1 parents were downwardly mobile (19% for men; 21% for women). In women, this downward movement was largely accounted for by a shift from the professional and managerial occupations of their G0 fathers to skilled non-manual work (46% of women with class I & II origins). Overall, 28% of G1 men and 45% of G1 women had crossed the divide between non-manual and manual occupations.

Examining inflow percentages, the proportion of individuals who remained stable was almost always higher than the proportion drawn from any other class category; the most striking example being that almost half of G1 women from partly and unskilled manual positions remained in that social class. Movement between the extremes was limited. For example, looking down the first column of table 8.1, a greater proportion of G1 fathers from non-manual backgrounds reached classes I & II compared with those from partly-skilled and unskilled manual backgrounds (69% vs. 31% respectively). Approximately one-fifth of G1 parents (20% of men; 22% of women) moved two or more classes in either direction, as can be seen in figure 8.1.

8.5.1.2 Marital mobility

Approximately one-third of G1 mothers married into the same occupational social class as their G0 fathers (table 8.3). Of the remaining women, 41% married into a higher social class and 23% moved down in social position through marriage. Upward marital mobility was dominated by movement from partly-skilled and unskilled manual positions to skilled non-manual employment, while downward mobility was dominated by movement from class IIIM to classes IV & V and from classes I & II to class IIINM. This pattern of movement reflects the mobility matrix seen in G1 men (table 8.1).

Table 8.1 Occupational mobility in G1 fathers: G0 father's social class by own social class at age 26.

G0 Father's social class	Own social class: I & II	IIINM	IIIM	IV & V	All
I & II Professional & managerial occupations.	67 (57) (40)	21 (18) (28)	26 (22) (13)	4 (3) (6)	118 (100) (23)
IIINM Skilled occupations (non-manual).	49 (56) (29)	15 (17) (20)	19 (22) (9)	5 (6) (7)	88 (100) (17)
IIIM Skilled occupations (manual).	35 (19) (21)	20 (11) (27)	101 (56) (49)	25 (14) (37)	181 (100) (35)
IV & V Partly-skilled & unskilled occupations.	17 (13) (10)	18 (14) (24)	59 (46) (29)	34 (27) (50)	128 (100) (25)
All	168 (33) (100)	74 (14) (100)	205 (40) (100)	68 (13) (100)	515 (100) (100)

Values are numbers; first percentage (in brackets) represents outflow; second percentage (in brackets) represents inflow.
Individuals in the boxes are intergenerationally stable, those to the right are downwardly mobile and those to the left are upwardly mobile.
Outflow mobility = percentage from different class origins arriving at each destination (row percentages).
Inflow mobility = percentage in each class from different class origins (column percentages).

Table 8.2 Occupational mobility in G1 mothers: G0 father's social class by own social class at age 26.

G0 Father's social class	**Own social class** I & II	IIINM	IIIM	IV & V	All
I & II Professional & managerial occupations.	63 (43) (42)	68 (46) (20)	7 (5) (11)	9 (6) (9)	147 (100) (22)
IIINM Skilled occupations (non-manual).	34 (30) (23)	64 (56) (19)	10 (9) (16)	7 (6) (7)	115 (100) (18)
IIIM Skilled occupations (manual).	31 (13) (21)	142 (60) (42)	27 (11) (44)	35 (15) (34)	235 (100) (36)
IV & V Partly-skilled & unskilled occupations.	23 (14) (15)	66 (42) (19)	17 (11) (28)	53 (33) (51)	159 (100) (24)
All	151 (23) (100)	340 (52) (100)	61 (9) (100)	104 (16) (100)	656 (100) (100)

Values are numbers; first percentage (in brackets) represents outflow; second percentage (in brackets) represents inflow.
Individuals in the boxes are intergenerationally stable, those to the right are downwardly mobile and those to the left are upwardly mobile.
Outflow mobility = percentage from different class origins arriving at each destination (row percentages).
Inflow mobility = percentage in each class from different class origins (column percentages).

Table 8.3 Marital mobility in G1 mothers: G0 father's social class by husband's social class when G1 women were aged 26.

	Husband's social class				
G0 Father's social class	**I & II**	**IIINM**	**IIIM**	**IV & V**	**All**
I & II Professional & managerial occupations.	80 (57) (38)	23 (16) (25)	31 (22) (14)	7 (5) (8)	141 (100) (23)
IIINM Skilled occupations (non-manual).	49 (45) (23)	17 (15) (19)	33 (30) (15)	11 (10) (12)	110 (100) (18)
IIIM Skilled occupations (manual).	54 (25) (25)	34 (16) (37)	90 (41) (40)	39 (18) (44)	217 (100) (35)
IV & V Partly-skilled & unskilled occupations.	30 (20) (14)	17 (11) (19)	72 (48) (32)	32 (21) (36)	151 (100) (24)
All	213 (34) (100)	91 (15) (100)	226 (37) (100)	89 (14) (100)	619 (100) (100)

Values are numbers; first percentage (in brackets) represents outflow; second percentage (in brackets) represents inflow.
Individuals in the boxes are intergenerationally stable, those to the right are downwardly mobile and those to the left are upwardly mobile.
Outflow mobility = percentage from different class origins arriving at each destination (row percentages).
Inflow mobility = percentage in each class from different class origins (column percentages).

Figure 8.1 Occupational mobility in G1 parents. The proportion who were upwardly mobile (1 to 3); stable (0); and downwardly mobile (-1 to -3).

8.5.2 Predictors of intergenerational social mobility

Examination of the differences in parental cognitive ability and educational level by occupational and marital mobility category (figures 8.2 & 8.3) revealed that G1 parents categorised as stable non-manual performed better on cognitive ability tests compared with all other mobility groups. Those parents who remained in the manual positions (stable manual) of their G0 fathers had the lowest cognitive ability scores. In terms of educational attainment, G1 parents who were upwardly mobile had completed more years in education with 49% of men achieving advanced level (A-level) qualifications or the equivalent compared with 29% who were stable non-manual and 9% who were stable manual ($\chi 2$ test, $p<0.001$). Likewise, G1 mothers who married into a higher social class had the highest levels of education, and those mothers remaining in manual social classes, the least years of education (44% and 2% respectively completing advanced education, $\chi 2$ test, $p<0.001$). Overall, G1 parents remaining intergenerationally stable in manual occupations were the most disadvantaged in terms of educational achievement and cognitive ability compared with all other mobility categories.

Logistic regression models in which social mobility categories were treated as multinomial outcomes, and parental cognitive ability and education, and maternal age at childbirth were inserted as independent variables, were used for the next step of analysis. Preliminary analyses revealed that there was evidence of interaction between the effects of G1 sex and G1 cognitive ability (LRT = 11.77, df = 3, $p = 0.008$), and G1 sex and G1 educational attainment (LRT = 14.14, df = 3, $p = 0.003$) on G1 social mobility, thus indicating that stratification by parental sex was necessary. Cognitive ability had a greater affect on downward mobility in women compared with men while education played a larger part in determining which women remained stable in the non-manual social class into which they were born. These effects are illustrated in figures 8.4 and 8.5.

The predictors of social mobility in table 8.4 show that parental cognitive ability and educational attainment were positively related to upward occupational and marital mobility. For example, the chance of upward occupational mobility in G1 men, compared with those who remained in the stable manual group, increased by 149% (OR=2.49; 95% CI: 90% - 230%) for each unit increase in cognitive ability z-score. Parents who were categorised as stable non-manual benefited the most from increasing cognitive ability in that their odds of remaining stable in a non-manual social class between childhood and adulthood were approximately threefold (OR=4.16 for men; OR=4.47 for women; OR=2.89 for marital mobility) that of the reference group. Similar trends were seen when viewing education in that the chances of parents remaining in the non-manual social class of their G0 fathers improved with increasing education relative to the stable manual reference group.

The chances of parents remaining stable in non-manual positions or being upwardly mobile increased if mothers were 20 years of age or older when they gave birth to their G2 offspring. Alternatively, G1 mothers who were teenagers when they gave birth to their first-born offspring were more likely to be downwardly mobile.

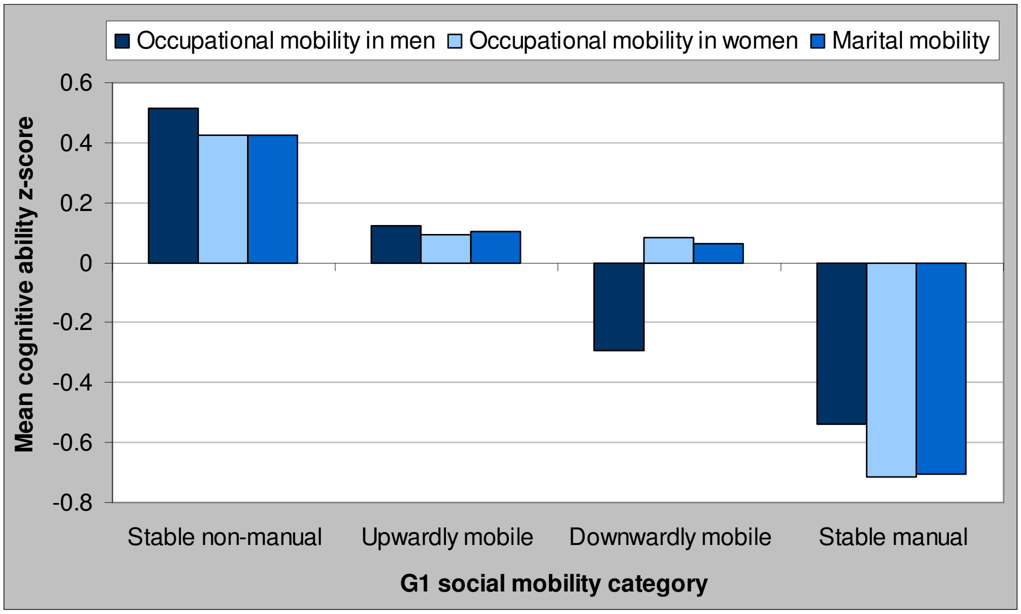

Figure 8.2 Mean cognitive ability z-scores at age eight for G1 parents by social mobility category.

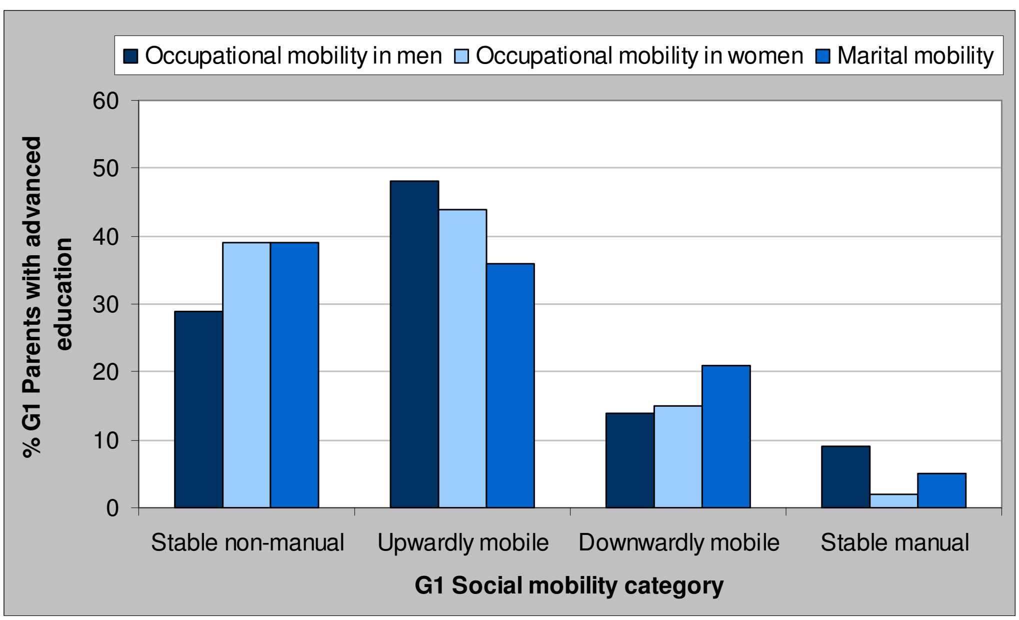

Figure 8.3 The proportion of G1 parents with advanced education at age 26 by social mobility category.

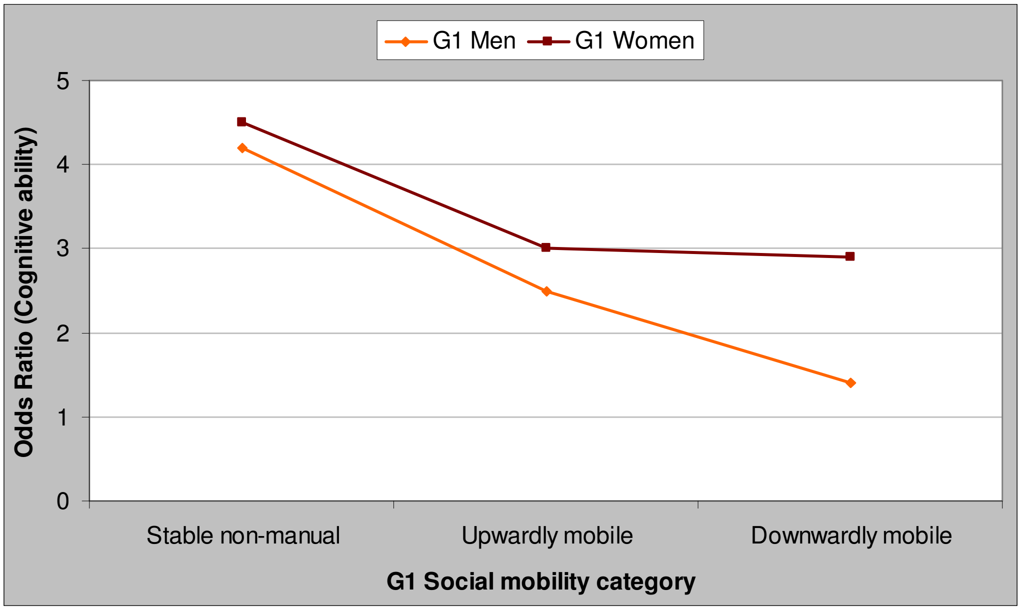

Figure 8.4 The odds of membership of each social mobility category by cognitive ability in G1 parents.
(LRT=11.77, df=3, p=0.08)

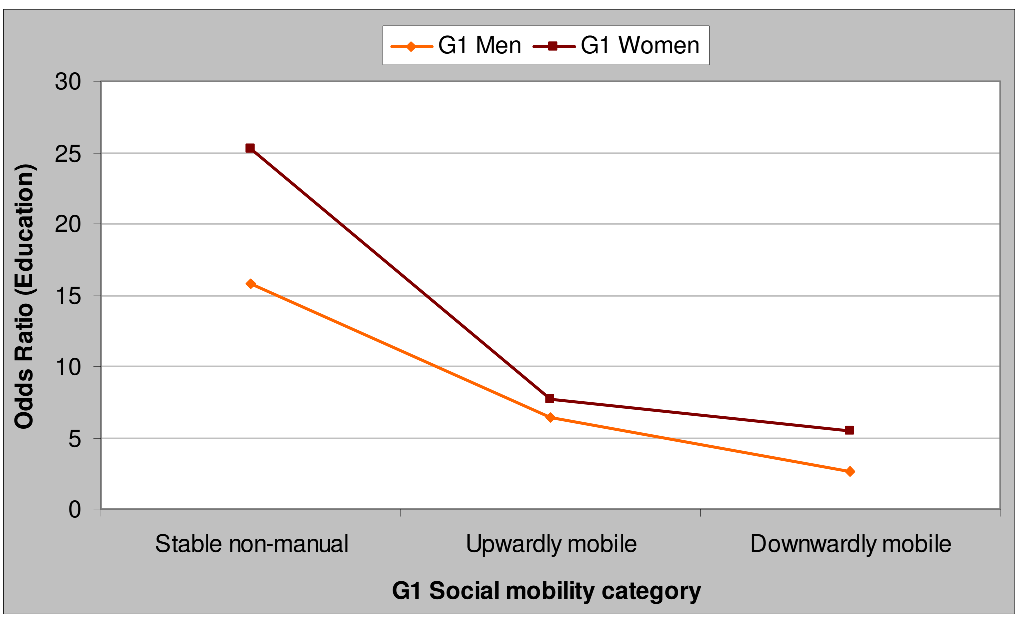

Figure 8.5 The odds of membership of each social mobility category by educational attainment in G1 parents.
(LRT in test for interaction=14.4, df=3, p=0.003).

Table 8.4 Unadjusted odds ratios and 95% confidence intervals representing the likelihood of intergenerational social mobility in G1 parents, according to cognitive ability, educational attainment and maternal age at childbirth.

Social mobility category	Occupational mobility [a]						Marital mobility [a]		
	***G1 MEN* (*n*=515)**			***G1 WOMEN* (*n*=656)**			***G1 WOMEN* (*n*=619)**		
	OR	[95% CI]	*p*-value	OR	[95% CI]	*p*-value	OR	[95% CI]	*p*-value
Stable non-manual									
G1 Cognitive ability (age 8) [b]	4.16	[2.9;6.0]	*<0.001*	4.47	[3.1;6.5]	*<0.001*	2.89	[2.1;3.9]	*<0.001*
G1 Education (age 26) [c]	15.82	[7.9;31.9]	*<0.001*	25.27	[7.6;84.2]	*<0.001*	26.64	[11.2;63.3]	*<0.001*
Maternal age at childbirth [d]	2.85	[1.6;5.0]	*<0.001*	4.20	[2.3;7.6]	*<0.001*	2.87	[1.6;5.0]	*<0.001*
Upwardly mobile									
G1 Cognitive ability (age 8) [b]	2.49	[1.9;3.3]	*<0.001*	3.00	[2.1;4.2]	*<0.001*	1.48	[1.2;1.9]	*0.002*
G1 Education (age 26) [c]	6.40	[3.6;11.5]	*<0.001*	7.67	[2.3;25.0]	*<0.001*	4.60	[2.0;10.4]	*<0.001*
Maternal age at childbirth [d]	2.01	[1.3;3.1]	*0.002*	2.67	[1.6;4.5]	*0.03*	1.84	[1.2;2.9]	*0.006*
Downwardly mobile									
G1 Cognitive ability (age 8) [b]	1.43	[1.0;1.9]	*0.03*	2.98	[2.1;4.2]	*<0.001*	1.41	[1.1;1.8]	*0.02*
G1 Education (age 26) [c]	2.57	[1.3;5.0]	*0.006*	5.50	[1.6;18.9]	*0.007*	4.69	[2.0;11.7]	*<0.001*
Maternal age at childbirth [d]	1.24	[0.7;2.1]	*0.4*	1.90	[1.1;3.4]	*0.03*	1.46	[0.9;2.4]	*0.1*

[a] Reference category was those G1 parents who remained, or married into, the same manual occupational social class as their G0 fathers (stable manual).
[b] Odds per unit increase in standard deviation.
[c] Odds of mobility in parents with advanced education compared with those with ordinary education.
[d] Odds of mobility in parents where the maternal age at childbirth was ≥ 20 years compared with ≤ 19 years.

8.5.3 Social mobility and offspring cognitive ability

Multiple linear regression models (table 8.5) confirmed the hypothesis that G2 children whose parents were upwardly mobile or remained stable in higher social classes (i.e. were stable non-manual) performed better on cognitive ability tests compared with those whose parents were born into the lowest class and remained in that class through to early adulthood (i.e. were stable manual). The strength of this intergenerational association was strongest amongst parents who remained stable in the non-manual occupations of their G0 fathers (all β's>0.30; $p<0.001$), compared with those G2 children whose parents were stable manual.

The intergenerational effects of marital mobility reflected the relationship between occupational mobility and offspring cognitive ability – that is, ability scores were higher in children whose mothers belonged to the stable non-manual, upward or downward mobility groups compared with those in the stable manual group (table 8.5).

Table 8.5 Standardised beta (β) coefficients representing the mean difference in G2 cognitive ability z-score by social mobility category.

Social mobility category	Occupational mobility				Marital mobility	
	G1 MEN **(*n*=518)**		***G1 WOMEN*** **(*n*=656)**		***G1 WOMEN*** **(*n*=619)**	
	β	*p*-value	β	*p*-value	β	*p*-value
Stable non-manual	0.31	*<0.001*	0.33	*<0.001*	0.36	*<0.001*
Upward	0.29	*<0.001*	0.20	*0.001*	0.19	*<0.001*
Downward	0.14	*0.006*	0.17	*0.002*	0.08	*0.1*

Reference category was those G1 parents who remained, or married into, the same manual occupational social class as their G0 fathers (stable manual).

8.5.4 Social mobility and intergenerational associations

For the final research question in this chapter, multivariate linear regression was applied to investigate the impact of social mobility on relationships between parent and offspring cognitive ability. The hypothesis being tested was that the association between G1 parental and G2 offspring ability was diminished when G1 social mobility was taken into account. This was examined separately for occupational mobility in men and women, and marital mobility (table 8.6).

Cognitive ability of G1 fathers was positively associated with offspring ability, with beta coefficients indicating an increase of 0.38 standard deviations units in offspring ability for every one standard deviation unit increase in paternal ability z-score. Controlling for occupational mobility in model 2 reduced the intergenerational association somewhat (β=0.38 to β=0.31, $p<0.001$) but of particular importance was that compared with fathers in the stable manual group, upward mobility and stability in non-manual occupations independently influenced offspring cognitive ability (β=0.18, $p<0.001$). Although these effect sizes were almost half that of paternal cognitive ability (β=0.18 and β=0.31 respectively), the influence of intergenerational mobility on offspring ability was confirmed by a significant likelihood ratio test ($p<0.001$) which indicated that there was a statistically significant difference between the unadjusted model (model 1) and the adjusted model (model 2). Furthermore, the intergenerational effects of upward mobility and stability in non-manual positions remained after adjustment in model 3 for the potential confounding effects of education and maternal age at childbirth.

Similar associations were observed in the occupational mobility of women, with the notable exception that membership of the stable non-manual mobility group, but not the upwardly mobile group, was associated with an increase in offspring cognitive ability compared with the reference group. A further difference between occupational mobility in men and women was that maternal education was positively associated with offspring ability independent of maternal cognitive ability, social mobility category and maternal age at childbirth (model 3).

The influence of marital mobility on intergenerational associations in cognitive ability reflected those seen in occupational mobility in G1 men – that is, membership of the upwardly mobile and stable non-manual groups was positively associated with offspring cognition independent of the effects of their own cognitive ability. One difference was that education continued to exert a positive effect on offspring ability in model 3, over and above the effects of social mobility. These findings point towards a role for maternal education in facilitating the transfer of cognitive skills between generations.

There was no evidence that downward mobility of G1 parents affected the cognitive development of G2 children.

The total variance in offspring ability accounted for by social mobility (model 2) was approximately one-quarter of that explained by parental cognitive ability (model 1, 4% and 14% respectively) when the class destination was measured according to the social class of G1 men (occupational mobility) or the social class of the husbands of G1 women (marital mobility). Occupational mobility of G1 women explained negligible amount of variance in offspring ability (R^2=0.01, p=0.007).

Table 8.6 Standardised beta (β) coefficients representing the mean difference in G2 cognitive ability z-score per unit increase in G1 cognitive ability z-score. Unadjusted effects shown in model 1 are progressively adjusted for G1 intergenerational social mobility (model 2), G1 educational attainment by age 26 and maternal age at childbirth (model 3).

	Model 1 G2 Cognitive ability		**Model 2 + G1 Social mobility**		**Model 3 + Control variables**	
	β	*p*-value	β	*p*-value	β	*p*-value
OCCUPATIONAL MOBILITY						
***G1 Men* (*n*=515)**						
G1 Cognitive ability (age 8)	0.38	*<0.001*	0.31	*<0.001*	0.25	*<0.001*
G1 Social mobility category [a]						
Stable non-manual			0.18	*<0.001*	0.14	*0.006*
Upward			0.18	*<0.001*	0.14	*0.006*
Downward			0.10	*0.04*	0.09	*0.06*
G1 Education (age 26) [b]					0.07	*0.1*
Maternal age at childbirth [c]					0.16	*<0.001*
LRT: Model 1 vs. Model 2			$\chi2$ =16.27	*<0.001*		
R^2	0.14	*<0.001*	0.18	*<0.001*	0.20	*<0.001*
R^2 change			0.04	*<0.001*	0.02	*<0.001*
***G1 Women* (*n*=656)**						
G1 Cognitive ability (age 8)	0.38	*<0.001*	0.34	*<0.001*	0.28	*<0.001*
G1 Social mobility category [a]						
Stable non-manual			0.16	*0.004*	0.10	*0.05*
Upward			0.08	*0.04*	0.01	*0.5*
Downward			0.05	*0.3*	0.04	*0.4*
G1 Education (age 26) [b]					0.18	*<0.001*
Maternal age at childbirth [c]					0.14	*<0.001*
LRT: Model 1 vs. Model 2			$\chi2$ =12.06	*0.007*		
R^2	0.15	*<0.001*	0.16	*<0.001*	0.21	*<0.001*
R^2 change			0.01	*0.007*	0.05	*<0.001*
MARITAL MOBILITY (*n*=619)						
G1 Cognitive ability (age 8)	0.39	*<0.001*	0.33	*<0.001*	0.26	*<0.001*
G1 Social mobility category [a]						
Stable non-manual			0.25	*<0.001*	0.17	*<0.001*
Upward			0.14	*0.005*	0.10	*0.02*
Downward			0.04	*0.4*	0.01	*0.7*
G1 Education (age 26) [b]					0.15	*<0.001*
Maternal age at childbirth [c]					0.14	*<0.001*
LRT: Model 1 vs. Model 2			$\chi2$ =32.91	*<0.001*		
R^2	0.15	*<0.001*	0.19	*<0.001*	0.23	*<0.001*
R^2 change			0.04	*<0.001*	0.04	*<0.001*

[a] Reference category was those G1 parents who remained, or married into, the same manual occupational social class as their G0 fathers (stable manual).
[b] Mean difference in parents with advanced education compared with those with ordinary education.
[c] Mean difference in parents where the maternal age is ≤ 20 years compared with ≥ 19 years.
Each model was adjusted for variables in the preceding model.

8.6. Discussion

8.6.1 Main findings

Parents who were upwardly mobile and those who remained stable in the non-manual positions of their own fathers conveyed the greatest benefit to the next generation in terms of cognitive development compared with those parents who were downwardly mobile, or those who remained in the stable manual group. These intergenerational effects explained part of the relationship between parental and offspring cognitive ability, with modest contributions towards the explained variance in offspring ability of 4%. The effects were greatest for G1 fathers who repeated the non-manual occupational status of their own fathers and for G1 mothers who married into the same non-manual class of their own fathers. The educational attainment of mothers, but not fathers, was shown to exert a strong influence on cognitive outcomes in the next generation, over and above the effects of occupational and marital mobility. These gender-specific effects may be explained by the different patterns and predictors of intergenerational social mobility in G1 parents.

8.6.2 Explanation of findings

Just over half of parents were intergenerationally mobile. Upward mobility was more common, even among those born into the lower classes, while downward movement across the whole range of social classes was much less common. Upward occupational mobility in men was dominated by entry to professional and managerial jobs and this improvement in social standing is likely to have been associated with improvements in income, family living conditions and educational opportunities, all of which may have benefited the cognitive development of their children. Similarly, marriage into classes I & II may have had similar benefits for the intellectual development of the next generation. In women, advancement into skilled non-manual positions accounted for most of their upward mobility and these positions may not have conveyed the same advantages in terms of offspring development compared with the class I & II professions held by men. This may explain why the occupational status of women had less of an influence on offspring ability than that of their husbands. These findings are consistent with previous studies showing that the effects of marital mobility are similar to male occupational mobility compared with female occupational mobility (Abbott & Sapsford, 1987) and reflect Goldthorpe's argument that women tend to remain dependent on men even when employed, as shown by studies of women's economic dependency (Sorensen, 1994). The employment of women may have been complicated by motherhood in that their type of employment (e.g. part-time or full-time) and their levels of earnings would have been predicted by the timing of motherhood in their life courses, and the time elapsed since the birth of the most recent child (Nettle, 2003). Maternal educational attainment, however, may have been less dependent on childbirth and although women who started having children at a younger age were selected for lower educational and occupational attainment (see section 7.3.1), the effect of maternal education on offspring ability was independent of maternal age at childbirth in these analyses. This is not to say that paternal education was unimportant in the intergenerational transmission of cognitive ability, but rather that its effect was most probably indirect through its influence on occupational attainment.

Overall, these findings indicate that upward occupational mobility and stability in non-manual occupations by G1 fathers conferred cognitive advantages on the next generation, but in mothers educational attainment was of greater importance to offspring ability. The improvement or maintenance of a privileged social status by fathers may have enabled their children to benefit from material and cultural advantages, such as better schooling, access to social networks and an intellectually-stimulating home environment, which in turn enhanced their cognitive development. Increasing levels of education may have equipped mothers to provide cognitive stimulation and encouragement, which have been shown to promote intellectual development in children (Guo & Harris, 2000; Maughan, *et al.*, 1998).

8.6.3 Comparison with other studies

The patterns of mobility found in G1 parents are consistent with a study of intergenerational mobility of men in England and Wales by Goldthorpe, *et al.*, (1980) which found that by 1972, when G1 parents were aged 26, there was increasing 'room at the top' and substantially more upward compared with downward mobility. The driving force behind this change may have been the expansion of professional and managerial occupations compared with a decline in manual occupations from the early 1950s as a result of the changing structure of industry, which saw a marked reduction in manufacturing (Halsey & Webb, 2000). Census data for Britain reveal that the number of employees in manufacturing fell by 43% between 1966 and 1991, whereas the numbers in both professional and managerial jobs tripled

(Breen & Goldthorpe, 1999). There was an associated rise in the number of clerical appointments, particularly for women, so that skilled non-manual employment moved from being predominantly male in the 1930s to predominantly female in the 1960s (Halsey & Webb, 2000). These patterns are broadly consistent with those reported in a later born cohort, the British 1958 birth cohort, in which approximately half the men were found to have undergone social mobility, mostly via upward movement into the skilled non-manual and professional classes (Saunders, 1997).

However, it has been shown that intergenerational mobility (defined according to family income), fell markedly between 1958 and a British cohort born in 1970. Following a comparison of intergenerational mobility in the UK, Europe and North America, Blanden, *et al*., (2005) reported that the reason for this decline may have been due to the increasing relationship between family income and educational attainment between these cohorts in that additional opportunities to remain in education beyond the ages of 16 and 18 years disproportionately benefited those from more advantaged backgrounds (i.e. those from classes I & II). Education was perhaps the way that individuals prepared for the new demands from employers for numeracy and literacy skills compared with the declining requirement for on-the-job training schemes. With educational opportunities, most notably university participation, being more restricted to affluent families in later born cohorts (Blanden *et al*., 2005), it is likely that the potential for upward mobility by way of education was reduced.

The findings presented here are in agreement with analyses of the British 1958 birth cohort (Nettle, 2003) and a Scottish cohort (Deary, *et al*., 2005) which showed education and cognitive ability to be important predictors of the chance and direction of social mobility. Furthermore, these data show that intergenerational social mobility plays a role in the transmission of intellectual ability between generations. Although the current findings represent a specific population at a particular time – that is, Britons born during educational reforms and entering the labour force during a period of massive increases in non-manual jobs – the overall relationships between education, cognitive ability and social mobility remained comparable with other studies.

8.6.4 Limitations

These findings, however, should be considered in light of certain limitations introduced as a result of the measures of SEP and social mobility that were applied. Assigning social class according to the Registrar General system is relatively crude since very little is known about the specific occupational skills that benefit cognitive ability (Richards & Sacker, 2003). Furthermore, the difficulty has already been stressed of measuring occupational status in women who have recently become mothers. Occupational social class measures are considered less useful as a measure of SEP for women of child-bearing age compared with men, since many mothers work part-time or even move to the margins of the labour force as the demands of their families change. Here such mothers are often assigned an occupational class that might not reflect their true SEP (Nettle, 2003). This is evidenced in a detailed and large-scale study of the lifetime work histories of women in 1985 which found that 51% of women returning to work after having a child changed social class with 37% moving down and 14% moving up. Furthermore, part-time workers were more likely to be downwardly mobile (Martin & Roberts, 1984). A further topic requiring thought, when considering mobility in women during this period, is the fact that comparing the occupations of women with those of their fathers is not ideal – given the sex differences in occupational structure as well as the changes in labour force participation that have occurred over the decades following the birth of G1 parents (Nettle, 2003). Unfortunately, it is difficult to predict the effects of these issues, if any, in this cohort.

8.6.5 Strengths

These findings augment the few studies (Deary, *et al.*, 2005; Nettle, 2003) to have examined intergenerational social mobility using prospective longitudinal data to show the importance of education and cognitive ability in upward occupational mobility. Furthermore, these analyses extend the findings to include women, and in so doing draw attention to some interesting gender differences – namely, the unique contribution of maternal education and paternal employment status to offspring cognitive ability.

8.6.6 Conclusions

Upward occupational and marital mobility and persistence in non-manual occupations explained a small, yet significant part of the intergenerational association between parent and offspring cognitive ability, over and above the effects of parental education and maternal age at childbirth. In women, the effects of intergenerational changes in occupation on offspring ability were fully explained by their levels of education. The educational attainment of fathers had important indirect effects on offspring ability through its influence on the chance and direction of occupational mobility. An observation of mobility trends between the 1958 and 1970 British birth cohorts reveals that educational attainment has risen slightly since the parents included in these analyses were born (Blanden *et al*., 2005). However, it was shown that these gains were concentrated among children of high-income backgrounds and therefore interventions directed towards equal access to education might be the key to improving social mobility. Parental education may influence offspring cognitive development in a number of ways. For example, it might influence the decisions parents make on the importance of education for their children, as well as the parenting practices that they adopt. These issues are explored in the next chapter.

9. Parenting practices and intergenerational associations in cognitive ability

9. 1 Introduction

So far, this work has shown that an improvement in social status across the life course of parents positively influences the cognitive development of their offspring. The focus of this chapter will turn towards parenting practices, which have consistently been associated with socioeconomic circumstances (Cairns, *et al.*, 1998; Lempers, *et al.*, 1989; McLeod & Shanahan, 1993) and may therefore work alongside social mobility in influencing intergenerational associations in cognitive ability.

There is modest yet consistent evidence that a wide range of parenting practices are associated with offspring cognitive development. Cohort studies indicate that harsh discipline may hinder it (Estrada *et al.*, 1987), while children who benefit from parental interest in, and enthusiasm for, their education (Douglas, 1967), maternal affection (Guo & Harris, 2000; Wadsworth, 1986) and nurturance (Andersson, *et al.*, 1996) as well as cognitively-stimulating environments (Guo & Harris, 2000; Tamis-LeMonde, *et al.*, 2004; Wadsworth, 1986) achieve higher cognitive ability test scores and do well at school. Such children are also more likely, as parents, to be enthusiastic and encouraging in relation to their own children's education (Wadsworth, 1986). It follows, therefore, that parenting practices may play an important role in the transmission of cognitive skills from one generation to the next.

It is also important to consider the role of parental characteristics, which may be direct predictors of poor cognitive outcomes in offspring (e.g. social background, education) as well as being indirect predictors of ability outcomes through pathways that determine parenting behaviour. For example, it is possible that the child-rearing skills of one generation may be related to parenting practices in the next, and thereby exert indirect influences on the cognitive development of third generation offspring. Previous work on the British 1946 birth cohort found that those members who experienced the effects of parental divorce, separation or death during childhood, were significantly more likely to have less affectionate relationships with their first-born child (i.e. G2 offspring) (Wadsworth, 1985). Of particular relevance is the finding that these second-generation children achieved significantly poorer scores on cognitive ability tests at age eight. This suggests that continuities in parenting practices may be related to the frequently-observed associations in cognitive ability across generations.

Parental mental health is another factor that contributes to differences in parenting behaviours (Lovejoy, *et al.*, 2000) and may therefore indirectly have an impact on the cognitive development of the next generation. It has been suggested that mental illness diminishes parental ability to provide a developmentally appropriate learning context (Oyserman, *et al.*, 2005) and predisposes parents to rely on methods of harsh and coercive discipline and to demonstrate reduced sensitivity towards their children (Bor & Sanders, 2004). In the same way, it is conceivable that adult health may also affect parenting practices. Although there is no direct evidence to support this notion, childhood IQ has been shown to influence the adoption of health behaviours in later life, including smoking initiation (Kubicka, *et al.*, 2001), alcohol consumption (Batty, *et al.*, 2006), diet and exercise (Batty, *et al.*, 2007). These lifestyle choices may in turn affect parenting behaviours. Healthy parents, for example, are more likely to be able and inclined to spend time interacting with their children in cognitively-stimulating activities. On the other hand, parental health may impact occupational success and therefore have an indirect effect on offspring cognitive development through family income which affords the provision of an intellectual home environment.

Another important consideration is that associations between parenting practices and children's cognitive achievements might be affected by the characteristics of individual children. For example, the interactions of fathers with their offspring have been shown to vary with children's gender (Andersson, *et al.*, 1996) and temperament (Estrada *et al.*, 1987; Scarr, 1985). These analyses therefore took into account a wide range of grandparental, parental and offspring characteristics in assessing the role of parenting practices on cross-generational associations in cognitive ability.

9. 2 Specific objectives of the chapter

The overall aim of this chapter is to examine the impact of parenting practices on intergenerational associations in cognitive ability. To this end, the predictors of parenting practices are explored and the consequences of these behaviours on the cognitive development of the next generation are examined. This is followed by an assessment of how far the parenting practices of G1 parents explain parent-offspring cognitive ability associations. Four hypotheses are tested:

- The educational and social background of G1 parents, their health status, as well as aspects of the parenting that they themselves received, affect the ways that they parent their G2 children.
- G1 parenting behaviours are directly related to offspring cognitive development. G2 offspring perform better on cognitive ability tests if their parents provide both an intellectually-stimulating and affectionate home environment, and interest in their school activities. Conversely, offspring are at risk of poor cognitive development if their G1 parents apply coercive discipline practices or corporal punishment.
- The effects of these parenting practices predict offspring ability beyond the contribution of parental cognitive ability, thus confirming a role for parenting behaviour in the intergenerational transmission of intellectual ability.
- There is an indirect effect of G0 child-rearing practices on the cognitive development of G2 offspring through the influence of G0 parenting practices on equivalent G1 parenting practices.

Based upon these hypotheses, this chapter considers these research questions:

1. To what extent do G1 parental characteristics (cognitive ability, education, maternal age at childbirth, social mobility, mental health, and physical health) predict subsequent parenting practices?
2. To what extent does G0 parental interest in the school activities of G1 parents and the affectionate relationship between G0 parents and G1 children affect how G1 parents parented their own G2 offspring? (i.e. are there intergenerational continuities in parenting behaviours?)
3. Are G2 offspring characteristics, such as frequency of temper tantrums and whether or not they smacked their parents, related to the parenting practices of G1 parents?

4. Are G1 parenting practices associated with G2 childhood cognitive ability, independently of G1 parental cognitive ability?

9. 3 Measures

9.3.1 G0 and G1 parenting practices

Nine measures of G0 and G1 parenting practices were examined for their part in the intergenerational transmission of cognitive ability. These measures, summarised in table 9.1, included maternal and paternal parenting behaviours.

9.3.2 Offspring characteristics

It is important to differentiate between continuities driven by characteristics of the parental generation and continuities driven by the offspring (Rutter, 1998). A number of G2 characteristics were therefore also assessed to determine whether the offspring's reactions to rearing experiences affected the parenting practices of their G1 parents, and if so, whether or not these affected the intergenerational association in cognitive ability. These included mothers' reports on the following:

- G2 offspring was highly strung at age four (dichotomised to no vs. yes).
- G2 offspring had frequent temper tantrums at age four (dichotomised to no vs. yes)
- G2 offspring frequently got angry with parents at age eight (dichotomised to no vs. yes).
- G2 offspring frequently tried to smack or hurt mother at ages four and eight (dichotomised to no vs. yes).

Table 9.1 Summary of G0 and G1 parenting measures.

Parenting measure	Questionnaire item(s) or rating used	Score
G0 Grandparents		
Parental interest	Teacher reports of G0 interest in the school activities of G1 parents when they were aged eight.	0-50
Maternal affection	Ratings by G1 parents of how affectionate their G0 mothers were, ranging from 1 (very like this) to 4 (very unlike this).	0-4
Paternal affection	Ratings by G1 parents of how affectionate their G0 fathers were, ranging from 1 (very like this) to 4 (very unlike this).	0-4
G1 Parents		
Intellectual environment (age 8)	• Mother regularly took books out of the library. • Father regularly took books out of the library. • Parents read for pleasure. • Child regularly took books out of the library.	0-4
Cognitive stimulation (age 4)	• Parents taught child to count. • Parents taught child to write. • Parents taught child the alphabet. • Parents taught child their colours.	0-4
Affection (ages 4 and 8)	• Mother was affectionate towards child • Father was affectionate towards child	0-4
Parental interest (age 8)	Based upon summed score of parental reports of the frequency of teacher-parent contacts and teacher-parent communication.	0-4
Parental aspirations (age 8)	Parental wishes that child should remain in school beyond minimum leaving age, and hopes and aspirations for further education.	0-4
Coercive discipline (ages 4 and 8)	• Parents told child they would not love him/her. • Parents disagreed about discipline practices. • Parents used discipline inconsistently. • Parents frightened child with a policeman. • Parents threatened to use a stick. •	0-4
Corporal punishment (ages 4 and 8)	G1 parents smacked G2 offspring in response to bad behaviour.	0 or 1

See sections 7.2.4 and 7.2.5 for a full description of these measures.

9.4 Analyses

9.4.1 Predictors of G1 parenting practices

Linear regression models examined variations in G1 parenting practices according to a range of grandparental, parental and offspring characteristics. G1 parenting measures were entered individually as dependent variables ranging along a 5-point continuum. The higher the score, the higher the level of cognitive stimulation, intellectual environment, affection, parental interest, aspirations and coercive discipline. Standardised beta coefficients were calculated so that associations between different measures of parenting could be compared. For corporal punishment, odds ratios were calculated using logistic regression to determine the likelihood of parents smacking their children as a form of punishment, according to each independent variable.

The independent variables included: G0 and G1 social class for the head of household (dichotomised to manual vs. non-manual), parental cognitive ability, parental social mobility (stable non-manual, upward, downward and stable manual, with those in the stable manual category used as the reference group), parental education (dichotomised to ordinary vs. advanced), maternal age at childbirth (dichotomised to $\leq$ 19 years and $\geq$ 20 years), parental physical (chronic health, physical activity, smoking) and mental health (psychiatric disorder, neuroticism, extraversion, postnatal depression), and offspring characteristics: sex; offspring was highly strung; had frequent temper tantrums; smacked parents and got angry with parents (all dichotomised to no vs. yes).

9.4.1.1 Intergenerational continuities in parenting

Similarities between parenting practices used in the grandparental (G0) and parental (G1) generation were examined using linear regression analyses. G0 parenting practices (parental interest, maternal and paternal affection) were entered as independent variables and G1 parenting practices (parental interest and affection) as dependent variables.

Ideally, the items used to measure parenting should be identical between generations (Chen & Kaplan, 2001) but this was not possible, since the items asked of G1 parents were not available for their G0 parents. Nevertheless, attempts were made to approximate the parental reports of involvement and affection by making use of the available data. However, the shortcomings of these measures are acknowledged. The similarities and differences in the parenting measures used for each generation are summarised in table 9.2.

Table 9.2 Measures used to assess intergenerational continuity in parenting practices between G0 grandparents and G1 parents.

	G0 parents → G1 children	G1 parents → G2 children
Parental interest		
Data	Prospective.	Prospective.
Respondent	Teachers of G1 children at age eight.	G1 mothers and wives of G1 fathers.
Instrument	Self-completed questionnaire.	Semi-structured questionnaire completed when G2 offspring were aged eight.
Affection		
Data	Retrospective.	Prospective.
Respondent	G1 parents at age 43.	G1 mothers and wives of G1 fathers when G2 offspring were aged eight.
Instrument	Parental Bonding Instrument (care dimension).	Semi-structured questionnaire completed when G2 offspring were aged eight.

See sections 7.2.4 and 7.2.5 for a full description of these measures.

9.4.2 Parenting practices and offspring cognitive ability

The relationships between G1 parenting behaviours and G2 cognitive ability were examined using linear regression models. G1 parenting practices (cognitive stimulation, intellectual environment, parental affection, parental interest, parental aspirations and coercive discipline) were included as independent variables while the outcome of interest was offspring cognitive ability measured at age eight.

9.4.3 Parenting practices and intergenerational associations

The extent to which the associations between parental and offspring cognitive ability were explained by parenting practices was assessed by way of hierarchical multiple linear regression. These analyses examined whether or not G1 parental cognitive ability, entered as the independent variable, continued to make a significant contribution to G2 offspring cognitive ability (i.e. the dependent variable) after adjustment for the intergenerational effects of G1 parenting practices.

Likelihood ratio tests assessed whether or not there existed a statistically significant difference between model 1, assessing the direct relationship between parent and offspring cognitive ability, and model 2, which included G1 parenting practices. A significant reduction in the parent-offspring ability association between model 1 and model 2 would indicate that parenting practices explained part of the intergenerational association. A range of control variables, shown to be important predictors of parenting practices in univariate analyses (section 9.5.1), were adjusted for in model 3.

9.4.4 The effects of parent and offspring sex

Considering that much of the literature on parenting practices focuses on maternal behaviours with minimal emphasis on the role of the father, little is known of paternal contributions to parenting. It is therefore likely that the antecedents and consequences of parenting practices may vary by parental sex. Likewise, there is conflicting evidence for a modifying effect of offspring sex on the relationship between maternal child-rearing practices and the cognitive abilities of children (see section 2.2.4.3).

To determine whether or not effects of the predictors of parenting practices under examination varied by G1 sex, tests for interaction (described in section 8.4.5) were undertaken for each of the independent variables. Associations between parenting practices and offspring cognitive ability were also examined for possible interaction effects of G1 and G2 sex. Where statistically significant differences were identified, effect estimates are reported stratified by sex.

9.4.5 Study sample

Initial unadjusted associations were examined in 702 parent-offspring pairs for which there were complete data on all G0, G1 and G2 characteristics included in the analyses. Predictors not shown to be significantly associated with any parenting practices were subsequently dropped from the analyses. Similarly, parenting practices not associated with parental or offspring cognitive ability were excluded from further examination on the basis that they did not support the hypothesised pathway – that is, they were unable to mediate intergenerational associations in cognitive ability. These included G1 parental interest, smoking, corporal punishment at age four and maternal age at childbirth. Dropping these variables for the multivariate analyses (section 9.5.3) increased the sample size, through reduction of missing data points, to 904 parent-offspring pairs.

9.5. Results

9.5.1 Predictors of G1 parenting practices

The range of scores (0-4) for each parenting measure were roughly normally distributed, with those for cognitive stimulation slightly skewed towards the right (i.e. more parents than not engaged their children in cognitively-stimulating tasks) and those for coercive discipline were slightly skewed to the left as fewer parents reported responding to unfavourable behaviour in this way.

Linear regression analyses revealed that parental cognitive ability was associated with all parenting measures in the expected direction (table 9.3). Parents with higher ability scores were more likely to stimulate their children cognitively with learning-associated tasks at age four and by taking them to the library at age eight (i.e. fostering an intellectual environment). For example, for each standard deviation unit increase in the G1 cognitive ability, the quality of the intellectual environment changed by one-quarter of a standard deviation unit (β=0.25, p<0.001). Higher parental ability scores were also associated with greater affection and interest in their offspring's schooling in terms of interest in, and aspirations for, their future. Such parents were also less coercive in response to misbehaviour.

Similar trends were observed in parents with further or higher education, those where the head of household was employed in a non-manual occupation, as well as those who were upwardly mobile or stable non-manual, and in families where the mothers were aged 20 or older when giving birth to G2 offspring. In addition, the association between own social class and parenting practices was much weaker than that of the head of household measure. This may reflect the occupational underachievement of the mothers as a result of their commitments to child care (discussed in section 8.6.2).

Intergenerational associations between G0 social class and G1 parenting practices reflected those seen between G1 social class and parenting behaviours, although associations were generally weaker. Maternal age at childbirth was not associated with any parenting practices.

Higher levels of exercise were associated with higher levels of stimulation, affection and parental interest, as well as greater aspirations and a better intellectual environment. Parents classified as 'most active' were also less likely to use coercive discipline strategies ($\beta=-0.18$, $p<0.001$). The smoking habits of G1 parents and their overall health ratings at age 36 did not influence their parenting practices.

Mental illness was associated with poorer parenting practices, particularly in women. Mothers with higher neuroticism scores were more likely to employ coercive discipline ($\beta=0.25$, $p<0.001$) while those with high extraversion scores were less involved in the school activities of their children ($\beta=-0.14$, $p=0.005$). Contradictory to previous findings, postnatal depression did not affect maternal parenting behaviours (Lovejoy, *et al.*, 2000). One explanation for this may be that information on postnatal depression was based on retrospective self-reports which, in some instances, were collected over 30 years after the birth of G1 offspring.

Offspring characteristics affected the levels of coercive discipline more than any other parenting measure. Parents used more coercion to discipline children who were highly strung, had frequent temper tantrums or interacted with them by smacking them or becoming angry with them. An alternative explanation might be that G2 offspring with these characteristics resulted in the G1 parents using more coercive discipline techniques. The exact mechanism of this relationship is not possible to determine from these data. There was some indication that coercive discipline was imposed slightly less on girls than boys. This supports previous assertions that parents may advocate less punishment for girls than boys engaging in similar misbehaviour (Carter & Welch, 1981). One other notable difference by offspring sex was that parents were less interested in the schooling of their child if their first-born offspring was a boy ($\beta=-0.11$, $p=0.002$).

Looking at the standardised effect estimates (β), parental education, social class of the head of household, and cognitive ability contributed the most to differences in parenting practices. These parental characteristics exerted the greatest influence on the quality of the intellectual environment and coercive discipline practices (β's = ±0.25, all p's <0.001).

More than 90% of parents reported using corporal punishment (age four: 889/904, 97%; age eight: 820/904, 91%). This form of punishment was not related to parental cognitive ability when G2 offspring were aged four (OR=0.91, p=0.7), but by age eight for every one-unit increase in standardised ability score, the likelihood of parents imposing corporal punishment decreased by 30% (OR=0.60; 95% CI: 0.5-0.8, p<0.001; table 9.4). Other factors that predicted the likelihood of G1 parents inflicting corporal punishment included their social background and educational attainment at age 26, and whether or not their G2 children had frequent temper tantrums or smacked them. There was also some evidence that psychiatric disorder decreased the chances of parents smacking their children as a form of punishment (OR=0.59, p=0.05), although this effect estimate only just met conventional cut-offs for statistical significance.

9.5.1.1 Intergenerational continuities in parenting practices

Consistent with previous findings in the British 1946 birth cohort (Wadsworth, 1986), G0 parental interest was positively associated with improved scores on cognitive ability tests in G1 parents at age eight (β=0.22, p<0.001). However, there was little evidence to suggest that the level of parental interest reported for G0 grandparents predicted similar behaviours in the next generation of G1 parents (β=0.09, p=0.06; table 9.5).

The level of affection shown by G1 parents towards their G2 offspring was not associated with the degree of affection shown between G0 grandparents and G1 parents when they were children. Furthermore, G0 affection was not related to G1 cognitive ability in childhood (maternal affection: β=0.07, p=0.4; paternal affection: β=0.06, p=0.3).

This lack of intergenerational continuity in parenting behaviours refutes the hypothesis that G0 child-rearing practices indirectly affect G2 IQ through their association with G1 parenting practices.

Table 9.3 Standardised beta (β) coefficients representing the mean difference in G1 parenting practices by G0 grandparental, G1 parental and G2 offspring characteristics (*n*=702; Men: *n*=311, Women: *n*=391).

	Cognitive stimulation		**Intellectual environment**		**Affection**		**Parental interest**		**Aspirations**		**Coercive discipline**	
	β	*p*-value	β	*p*-value	β	*p*-value	β	*p*-value	β	*p*-value	β	*p*-value
G0 Characteristics												
Social class [a]	0.08	*0.01*	0.14	*<0.001*	0.02	*0.5*	0.07	*0.06*	0.10	*0.008*	-0.19	*<0.001*
G1 Characteristics												
Cognitive ability (age 8) [b]	0.11	*0.001*	0.25	*<0.001*	0.12	*<0.001*	0.15	*<0.001*	0.17	*<0.001*	-0.26	*<0.001*
Social class (hoh) [a]	0.08	*0.02*	0.24	*<0.001*	0.14	*<0.001*	0.11	*0.004*	0.13	*<0.001*	-0.31	*<0.001*
Social class (own) [a]	0.06	*0.07*	0.10	*<0.001*	0.08	*0.01*	0.09	*0.07*	0.04	*0.05*	-0.13	*<0.001*
Social mobility												
Stable non-manual	0.11	*0.008*	0.20	*<0.001*	0.05	*0.3*	0.21	*<0.001*	0.15	*0.002*	-0.31	*<0.001*
Upward	0.08	*0.05*	0.21	*<0.001*	0.16	*<0.000*	0.22	*<0.001*	0.24	*<0.001*	-0.29	*<0.001*
Downward	0.07	*0.1*	0.12	*0.005*	0.06	*0.2*	0.11	*0.03*	0.15	*0.003*	-0.15	*0.001*
Education (age 26) [c]	0.15	*0.000*	0.25	*<0.001*	0.03	*0.06*	0.07	*0.05*	0.17	*<0.001*	-0.27	*<0.001*
Maternal age at childbirth [d]	0.02	*0.6*	0.01	*0.7*	0.04	*0.3*	0.03	*0.3*	0.00	*0.5*	-0.08	*0.1*
G1 Physical health												
Chronic illness (age 20-25) [e]	0.00	*0.9*	-0.05	*0.1*	-0.07	*0.07*	0.01	*0.7*	0.00	*0.8*	-0.03	*0.4*
Physical activity (age 36) [f]												
Less active	0.10	*0.009*	0.07	*0.09*	0.06	*0.1*	0.05	*0.2*	0.08	*0.04*	-0.08	*0.04*
Most active	0.11	*0.004*	0.18	*<0.001*	0.15	*<0.001*	0.11	*<0.001*	0.12	*0.001*	-0.18	*<0.001*

Mean difference in: [a]manual vs. non-manual; [b]per unit increase in standard deviation; [c]ordinary vs. advanced education; [d] ≤ 19 years vs. ≥ 20 years; [e]parents without vs. parents with a chronic illness; and [f] parents who were inactive vs. parents who were most active and less active.
hoh=head of household.

Table 9.3 Standardised beta (β) coefficients representing the mean difference in G1 parenting practices by G0 grandparental, G1 parental and G2 offspring characteristics (n=702; Men: n=311, Women: n=391) (continued).

	Cognitive stimulation		**Intellectual environment**		**Affection**		**Parental interest**		**Aspirations**		**Coercive discipline**	
	β	*p*-value	β	*p*-value	β	*p*-value	β	*p*-value	β	*p*-value	β	*p*-value
Smoking (age 26) [a]												
Ex-smoker	*-0.04*	*0.3*	*-0.11*	*0.003*	*-0.02*	*0.7*	*-0.03*	*0.5*	*-0.09*	*0.02*	0.02	*0.008*
Current smoker	*0.01*	*0.8*	*0.04*	*0.6*	*0.03*	*0.5*	*0.04*	*0.3*	*-0.01*	*0.9*	*0.10*	*0.6*
G1 Mental health												
Psychiatric disorder (age 15-32) [b]												
Mild	0.02	*0.5*	0.07	*0.04*	0.03	*0.4*	0.05	*0.1*	0.07	*0.03*	0.04	*0.2*
Severe	0.00	*0.9*	0.07	*0.03*	-0.01	*0.8*	0.00	*0.9*	-0.05	*0.1*	0.00	*0.9*
Neuroticism (age 26) [c]	-0.03	*0.3*	0.01	*0.8*	-0.07	*0.05*	-0.04	*0.3*	-0.02	*0.4*	**M:** 0.10 **F:** 0.25	*0.09* *<0.001*
Extraversion (age 26) [c]	0.03	*0.4*	-0.07	*0.07*	0.08	*0.01*	**M:** -0.03 **F:** -0.14	*0.7* *0.005*	0.03	*0.4*	-0.04	*0.3*
Postnatal depression [d]	0.01	*0.9*	0.01	*0.9*	0.09	*0.1*	-0.06	*0.3*	0.08	*0.2*	-0.02	*0.7*
G2 Characteristics												
Sex [e]	0.01	*0.7*	0.05	*0.2*	0.02	*0.5*	-0.11	*0.002*	-0.07	*0.04*	-0.09	*0.02*
Highly strung (age 4) [f]	0.00	*0.9*	-0.03	*0.4*	-0.10	*0.003*	0.04	*0.3*	0.05	*0.2*	0.17	*<0.001*
Frequent temper tantrums (age 4) [f]	-0.01	*0.9*	-0.05	*0.2*	-0.04	*0.2*	0.00	*1.0*	0.01	*0.8*	0.16	*<0.001*
Smacks parents (age 4) [f]	0.02	*0.4*	0.01	*0.9*	0.06	*0.1*	-0.06	*0.1*	0.03	*0.4*	0.10	*0.008*
Smacks parents (age 8) [f]	-0.07	*0.04*	-0.04	*0.3*	-0.09	*0.009*	0.01	*0.8*	0.00	*1.0*	0.15	*<0.001*
Gets angry with parents (age 8) [f]	0.07	*0.03*	0.02	*0.6*	0.01	*0.7*	0.02	*0.6*	0.03	*0.4*	0.14	*<0.001*

Mean difference in: [a]non-smokers vs. ex and current smokers; [b]parents with no psychiatric disorders vs. those with mild and severe disorders; [c]per unit increase in extraversion and neuroticism score; [d]mothers with no postnatal depression vs. those with postnatal depressive symptoms; [e]parents of boys vs. girls; and parents whose G2 children who were not temperamental vs. those who were. M=Males; F=Females.

Table 9.4 Odds ratios and 95% confidence intervals representing the likelihood of G1 parents using corporal punishment to discipline their G2 offspring according to G0, G1 and G2 characteristics (*n*=702; Men: *n*=311, Women: *n*=391).

	Corporal punishment age 4			Corporal punishment age 8		
	OR	[95% CI]	*p*-value	OR	[95% CI]	*p*-value
G0 characteristics						
Social class [a]	0.41	[0.2;0.9]	*0.05*	0.85	[0.5;1.3]	*0.4*
G1 factors						
Cognitive ability (age 8) [b]	0.91	[0.6;1.4]	*0.7*	0.60	[0.5;0.8]	*<0.001*
Social class (hoh) [a]	0.46	[0.2;1.2]	*0.1*	0.53	[0.3;0.9]	*0.02*
Social class (own) [a]	0.32	[0.1;1.0]	*0.05*	0.70	[0.4;0.9]	*0.06*
Social mobility						
Stable non-manual	0.27	[0.0;1.3]	*0.1*	0.63	[0.2;1.6]	*0.3*
Upward	0.56	[0.1;2.6]	*0.5*	0.48	[0.3;1.4]	*0.09*
Downward	0.72	[0.1;4.3]	*0.7*	0.68	[0.3;1.8]	*0.4*
Education (age 26) [c]	0.50	[0.2;1.2]	*0.1*	0.51	[0.3;0.9]	*0.01*
Maternal age at childbirth [d]	2.93	[0.7;13.2]	*0.2*	1.44	[0.4;4.1]	*0.7*
G1 Physical health						
Chronic illness (age 20-25) [e]	0.83	[0.2;2.9]	*0.8*	1.10	[0.4;2.1]	*0.8*
Physical activity (age 36) [f]	0.73	[0.4;1.2]	*0.2*	0.93	[0.7;1.2]	*0.6*
Less active	1.44	[0.4;4.9]	*0.6*	0.91	[0.5;1.6]	*0.7*
Most active	0.58	[0.2;1.4]	*0.3*	1.04	[0.6;1.8]	*0.9*
Smoking (age 26) [g]	0.78	[0.4;1.4]	*0.4*	0.82	[0.6;1.1]	*0.3*
Ex-smoker	1.91	[0.7;5.2]	*0.2*	1.12	[0.7;2.1]	*0.5*
Current smoker	0.60	[0.2;1.5]	*0.3*	0.70	[0.4;1.3]	*0.3*
G1 Mental health						
Psychiatric disorder (age 15-32) [h]						
Mild	1.28	[0.5;3.0]	*0.6*	0.59	[0.4;0.9]	*0.05*
Severe	1.19	[0.2;9.2]	*0.9*	0.54	[0.2;1.5]	*0.2*
Neuroticism (age 26) [i]	1.01	[0.9;1.1]	*0.8*	1.06	[1.0;1.1]	*0.07*
Extraversion (age 26) [i]	0.98	[0.9;1.1]	*0.8*	1.06	[0.9;1.1]	*0.2*
Postnatal depression [j]	2.56	[0.5;12.3]	*0.2*	2.33	[0.7;7.4]	*0.1*
G2 characteristics						
Sex [k]	0.50	[0.2;1.2]	*0.1*	0.91	[0.5;1.5]	*0.7*
Highly strung [l]	2.79	[0.9;8.3]	*0.07*	1.03	[0.6;1.8]	*0.9*
Frequent temper tantrums [l]	3.49	[1.3;9.0]	*0.01*	2.33	[1.4;3.9]	*0.002*
Smacked parents (age 4) [l]	0.81	[0.3;1.9]	*0.6*	1.90	[1.2;3.1]	*0.02*
Smacked parents (age 8) [l]	0.43	[0.2;1.2]	*0.1*	1.33	[0.6;3.2]	*0.05*
Got angry with parents	0.25	[0.1;0.9]	*0.03*	1.11	[0.7;1.9]	*0.7*

Odds ratios representing the likelihood of parents using corporal punishment in [a] manual vs. non-manual; [b]per unit increase in standard deviation; [c] ordinary vs. advanced education; [d] ≤ 19 years vs. ≥ 20 years; [e] parents without vs. parents with a chronic illness; and [f] parents who were inactive vs. parents who were most active and less active; [g]non-smokers vs. ex and current smokers; [h]parents with no psychiatric disorders vs. those with mild and severe disorders; [i]per unit increase in extraversion and neuroticism score; [j] mothers with no postnatal depression vs. those with postnatal depressive symptoms; [k]parents of boys vs. girls and [l]parents whose G2 children who were not temperamental vs. those who were.

Table 9.5 Standardised beta (β) coefficients representing the mean difference in G1 parenting practices by G0 parenting behaviours (*n*=702).

G0 Parenting practices	G1 Parenting practices			
	Parental interest		Affection	
Parental interest	0.09	*0.06*		
Maternal affection			0.01	*0.6*
Paternal affection			-0.02	*0.6*

9.5.2 Parenting practices and offspring cognitive ability

Tests for interaction between parenting behaviours and offspring sex revealed that child-rearing practices did not affect the cognitive outcomes of G2 boys and girls differently (all p's>0.1), and accordingly these analyses were not stratified by offspring sex.

The results in table 9.6 confirm the hypothesised associations between G1 parenting behaviours and offspring IQ. Cognitively-stimulating tasks, an intellectual home environment, parental affection and aspirations emerged as predictors of improved cognitive ability in second-generation children. Conversely, coercive discipline and corporal punishment at age eight were negatively related to offspring ability. G1 parental interest had no affect on the cognitive development of G2 offspring.

Table 9.6 Standardised beta (β) coefficients representing the mean difference in G2 offspring cognitive ability z-scores.

	G2 Cognitive ability	
	β	*p*-value
G1 Parenting practices		
Cognitive stimulation	0.12	*0.002*
Intellectual environment	0.35	*<0.001*
Affection	0.09	*0.01*
Parental interest	0.04	*0.2*
Aspirations	0.17	*<0.001*
Coercive discipline	-0.27	*<0.001*
Corporal punishment (age 4)	-0.07	*0.06*
Corporal punishment (age 8)	-0.09	*0.01*

9.5.3 Parenting practices and intergenerational associations

Cognitive stimulation, the provision of an intellectual environment, parental aspirations and the use of coercive discipline by fathers were independently associated with offspring ability in the expected directions, after the contribution of parental cognitive ability was taken into account (model 2, table 9.7). These parenting practices reduced the association between parental and offspring cognitive ability by one-third (β=0.35 to β=0.23, LRT: χ^2=110.96, p<0.001), thereby demonstrating their roles in the intergenerational transmission of cognitive ability. Furthermore, the cross-generational effects of parenting, although somewhat attenuated, continued to explain unique variances in offspring cognitive ability after a range of control variables were added to the hierarchical regression in model 3.

G1 affection and corporal punishment were no longer related to offspring cognitive ability once the effects of cognitive stimulation, intellectual environment and aspirations had been taken into account in model 2.

The control variables that remained independently associated with offspring cognitive ability in the final model included social class of the head of household, and the education of the mother at childbirth. Three measures of offspring temperament (frequent temper tantrums and smacked parents at age eight) were also inversely related to their own cognitive ability. Social mobility no longer directly affected intergenerational ability associations.

An examination of the standardised beta coefficients in the final model showed that the strength of the relationship between the quality of the intellectual environment and offspring ability was similar, if not slightly stronger, than that between G1 and G2 cognitive ability (β=0.20 and β=0.18 respectively, both p's<0.001). Cognitive stimulation and parental aspirations exerted a more moderate influence on offspring ability with the effect estimates being less than half (aspirations: β=0.06, p=0.03; coercive discipline: β=-0.16, p=0.05) that of the intellectual environment.

The total variance in offspring ability accounted for by parental cognitive ability (model 1) and parenting practices (model 2) was roughly equal at 12% (R^2=0.12 and 0.24 respectively). Together, the predictors included in model 3 explained approximately 28% of the variance in offspring cognitive ability (R^2=0.28, p<0.001), of which social class and education accounted for 3%.

9.5.4 Combinations of parenting practices

In light of these findings, the effects of different combinations of parenting practices (e.g. G1 parents who provided a highly stimulating intellectual environment but had low aspirations for their G2 children) on offspring ability were examined using linear regression. These analyses were restricted to parenting practices found to be significantly associated with G2 ability in adjusted analyses (table 9.7) – that is, cognitive stimulation, intellectual environment, parental aspirations and coercive discipline. Parents with scores on these parenting variables (which ranged from 0 to 4) of 3 or 4 were defined as high scorers and those with scores of 0 or 1 were defined as low scorers. The combinations examined are listed in table 9.8. The number of G1 parents with each combination of parenting practices varied greatly from 3 (high coercive discipline, low cognitive stimulation) to 496 (high cognitive stimulation, low coercive discipline).

Adjusted analyses (table 9.8) show that combinations of high and low scores on measures of the intellectual environment, cognitive stimulation and aspirations had the expected positive and negative effects on offspring ability respectively. G1 parents who provided a highly stimulating intellectual environment together with high levels of cognitive stimulation or high aspirations provided the greatest benefit to G2 offspring in terms of cognitive development (β=0.18, p<0.001). Similarly, high scores on measures of intellectual environment and parental aspirations coupled with low levels of coercive discipline were significantly positively associated with offspring ability (β= 0.19, p<0.001).

In contrast, the positive effects of high scores for intellectual environment, cognitive stimulation and parental aspirations were negated by high levels of coercive discipline (e.g. high intellectual environment, high coercive discipline β=0.05, p=0.8). It also appears that the positive effects of a highly intellectual environment on offspring ability were diminished if G1 parents had low aspirations (β= -0.07, p=0.1) or provided little or no cognitive stimulation (β=0.01, p=0.7). Similarly, high levels of cognitive stimulation in the absence of an intellectual environment adversely affected G2 ability scores (β= -0.09, p=0.003).

Table 9.7 Standardised beta (β) coefficients representing the mean difference in G2 offspring cognitive ability z-scores by G1 parental cognitive ability z-scores. Unadjusted effects shown in model 1 are progressively adjusted for parenting measures (model 2) and control variables (model 3). (*n*=904: Men: *n*=410; Women: *n*=494).

	Model 1 G1 Cognitive ability		**Model 2 + Parenting measures**		**Model 3 + Control variables**	
	β	*p*-value	β	*p*-value	β	*p*-value
G1 Cognitive ability	0.35	*<0.001*	0.23	*<0.001*	0.18	*<0.001*
G1 Parenting measures						
Cognitive stimulation			0.07	*0.01*	0.06	*0.04*
Intellectual environment			0.24	*<0.001*	0.20	*<0.001*
Affection			0.02	*0.6*	0.00	*1.0*
Aspirations			0.08	*0.02*	0.06	*0.03*
Coercive discipline			**M:** -0.19 **F:** -0.08	*<0.001* *0.06*	**M:** -0.16 **F:** -0.01	*0.05* *0.8*
Corporal punishment (age 8)			-0.03	*0.4*	-0.01	*0.6*
Control variables						
G0 Social class					0.02	*0.6*
G1 Social class (hoh)					0.13	*<0.001*
G1 Social class (own)					0.04	*0.4*
G1 Social mobility						
Stable non-manual					0.00	*0.9*
Upwards					0.07	*1.0*
Downwards					0.03	*0.5*
G1 Education					**M:** 0.02 **F:** 0.11	*0.7* *0.03*
G1 Illness					0.01	*0.7*
G1 Physical activity					0.05	*0.1*
G1 Psychiatric disorder					0.03	*0.3*
G1 Neuroticism					0.04	*0.2*
G1 Extraversion					0.03	*0.2*
G2 Sex					0.02	*0.5*
G2 Highly strung					-0.06	*0.06*
G2 Frequent temper tantrums					-0.06	*0.04*
G2 Smacked parents (age 4)					0.04	*0.2*
G2 Smacked parents (age 8)					-0.07	*0.02*
G2 Got angry with parents					0.01	*0.6*
LRT: Model 1 vs. Model 2			$\chi2$ = 110.96	*<0.001*		
R^2	0.12	*<0.001*	0.24	*<0.001**	0.28	*<0.001*
R^2 change			0.12	*<0.001*	0.04	*<0.001*

**R^2 cognitive stimulation=0.1; R^2 intellectual environment=0.7; R^2 aspirations=0.2; R^2 coercive discipline=0.2.
Each model was adjusted for variables in preceding model.
M=Males; F=Females.

Table 9.8 Standardised regression coefficients (β) representing the mean difference in G2 offspring cognitive ability z-scores by different combinations of parenting practices (*n*=904).

Parenting practices		***n*** [a]	**β** [b]	***p*-value**
High-high				
Intellectual environment	Cognitive Stimulation	350	0.18	*<0.001*
Intellectual environment	Aspirations	313	0.18	*<0.001*
Intellectual environment	Coercive discipline	44	0.05	*0.8*
Cognitive stimulation	Aspirations	466	0.09	*0.003*
Cognitive stimulation	Coercive discipline	100	-0.02	*0.6*
Aspirations	Coercive discipline	74	0.00	*1.0*
Low-low				
Intellectual environment	Cognitive Stimulation	49	-0.06	*0.4*
Intellectual environment	Aspirations	97	-0.07	*0.1*
Intellectual environment	Coercive discipline	133	-0.06	*0.06*
Cognitive stimulation	Aspirations	15	-0.09	*0.004*
Cognitive stimulation	Coercive discipline	18	-0.05	*0.1*
Aspirations	Coercive discipline	162	-0.01	*0.7*
High-low				
Intellectual environment	Cognitive stimulation	11	0.01	*0.7*
Intellectual environment	Aspirations	52	0.07	*0.1*
Intellectual environment	Coercive discipline	326	0.19	*<0.001*
Cognitive stimulation	Intellectual environment	243	-0.09	*0.003*
Cognitive stimulation	Aspirations	182	0.00	*0.9*
Cognitive stimulation	Coercive discipline	496	0.07	*0.03*
Aspirations	Intellectual environment	161	-0.05	*0.1*
Aspirations	Cognitive stimulation	7	0.00	*1.0*
Aspirations	Coercive discipline	409	0.11	*0.001*
Coercive discipline	Intellectual environment	66	-0.08	*0.1*
Coercive discipline	Cognitive stimulation	3	0.00	*1.0*
Coercive discipline	Aspirations	29	-0.02	*0.5*

[a] *n* represents the number of G1 parents reporting different combinations of parenting practices.
[b] Standardised beta coefficients are adjusted for G0 social class, G1 social class, G1 social mobility, G1 education, G1 illness, G1 physical activity, G1 psychiatric disorder, G1 neuroticism, G1 extraversion, G2 sex, G2 frequent temper tantrums, G2 smacked parents, G2 got angry with parents.

9.6. Discussion

9.6.1 Main findings

Several important findings relating to the contribution of parenting practices to the intergenerational transmission of cognitive ability emerged. The quality of the intellectual environment provided by G1 parents was the most influential parenting measure affecting the cross-generational association, with effects on offspring cognitive ability equalling those of parental cognitive ability. The magnitude of the negative association between coercive discipline and offspring cognitive ability for G1 fathers was almost as great. Parental aspirations and cognitive stimulation also influenced the cognitive development of G2 offspring, but the effect was half that of the intellectual environment. These effects were seen over and above the influence of parental cognitive ability, thus demonstrating the role for parenting in the transfer of IQ between generations.

9.6.2 Explanation of findings

How might parenting practices influence the intellectual development of children? Parents who engaged their preschool children in cognitively-stimulating activities, such as teaching them the alphabet, may also have given them more information and feedback about their attempts to solve problems as a result of their educational background. Similarly, those parents who encouraged an intellectual environment through their own reading habits and facilitation of trips to the library were more likely to be from a privileged social background which enabled them to provide better educational opportunities and greater resources for learning. Parents who had themselves benefited from educational and occupational success were more likely to have placed greater value on achievement, and therefore had higher aspirations for their offspring. Parental expectation has been seen to influence socialisation behaviours and parent-child interaction patterns (Hill, 2001) and it may be that parents engaged and supported their children in solving problems as a means of realising their ambitions in relation to the future success of their offspring. Together, these factors may have encouraged the flow of information across the generations, therefore positively influencing offspring cognitive development.

Conversely, coercive discipline could have reduced opportunities for learning by discouraging the child to persist in problem solving, and limiting the frequency and quality of positive and reciprocal parent-child interactions. Furthermore, coercive parent-child interactions may teach children negative interpersonal styles of behaviour that interfere with academic performance and peer relationships (Bor & Sanders, 2004). The stress associated with coerciveness may also impair the regulation of the HPA axis thereby affecting the biological pathways involved in cognitive development (McEwen & Seeman, 1999). This negative effect of coercion was seen only in fathers. While it is not possible from these analyses to determine the reason for this gender-specific effect, the findings suggest that the nature of disciplinary interactions between parents and their children may vary according to parental sex. If this is the case, genetic effects may be implicated, but this would require further investigation by way of a genetically-driven study design, such as an adoption study (Plomin & Spinath, 2004).

It is interesting to observe that the measure of intellectual environment, which represents the reading habits of the parents and offspring, appears to have a greater influence on offspring ability compared with cognitive stimulation that involves parents actively engaging with their children in teaching them important skills such as counting. This may be for a number of reasons. Learning to read is a critical milestone for children in that reading skills are the foundation for academic success. Educational research focusing on the social context of literacy development identified the importance of book reading as a family routine for the later acquisition of literacy skills by children (Sulzby & Teale, 1991). Many economically disadvantaged children have difficulty in the early years of school, in large part due to their failure to learn to read (Gee, 2001). The measure of the intellectual environment may therefore reflect not only the reading culture in the home but also the economic circumstances that enable parents to provide access to books and other literary material. Studies have shown that the potential language and cognitive gains from early reading cannot be completely achieved through other important development-promoting activities in the home, such as talking (Snow, *et al.*, 1998), and this might explain why the literary home environment was observed to be more important for offspring cognitive ability than cognitive stimulation. It may also be that parents who promote good reading habits by setting an example and encouraging their offspring to read, are teaching them important non-cognitive skills, such as motivation and perseverance (Farkas, 2003). Children who read regularly may, as a result, be more inquisitive and this may increase the number of parent-child interactions that promote intellectual development. Parents who respond encouragingly to these early forms of learning confer value on the acquired skills which in turn may lead to a self-reinforcing motivation to learn.

There was some evidence that offspring cognitive development was hampered by child behaviours, specifically frequent temper tantrums and the smacking of parents. This supports Rutter's assertion of reciprocity, which suggests that the temperament of the child can affect reactivity to specific parenting behaviours and thereby moderate the effects of parenting on children (Rutter, 1985). It may also be that parents of children who respond to them aggressively are less inclined or less able to engage in intellectually-stimulating tasks and undertake outings.

When offspring were aged eight, more than 97% of parents reported smacking their children. Despite the fact that the use of corporal punishment has declined since these data were collected in the 1960s (approximately 80% of parents reported using corporal punishment in 1968 compared with 26% in 1999 (Nobes, *et al.*, 1999), these figures are high. The most likely explanation is in the definition used. Questions on corporal punishment were left to the mother to define what smacking meant. Furthermore, no information was collected on the frequency or severity of smacking, which probably resulted in misclassification of this measure. This means that parents who smacked their child once a year and those who hit their child every day would have been grouped together. Thus, any conclusions drawn on the possible effects of corporal punishment are of limited value.

The findings offered little support for the hypothesis that continuity in parenting practices across generations affects offspring cognitive development – that is, that G0 grandparents' child-rearing practices influenced the cognitive development of their G2 grandchildren through the influence of G0 parenting practices on equivalent G1 parenting practices. Two reasons may account for this lack of association. Intergenerational links necessarily involve two parents and usually several children. These analyses examined links between only one parent and one child and it is possible that the effects of upbringing experienced by one parent may be accentuated or mitigated by the negative or positive qualities of the other parent (Rutter, 1989). Furthermore, rigorous examination of intergenerational continuities in parenting was not possible, since the measures of parenting were not uniform across generations. For example, the measure of G0 parental interest was based upon teacher-reports, while in G1 parents, it was self-reported. The latter may not have distinguished between school visits initiated by the parent and those for which the parent was asked to meet a teacher for poor behaviour or underachievement. In addition, the measures of affection used for G0 parents were based upon retrospective reports by G1 parents 30 years later. Such recollections tend to be subject to distortion of memory, current perceptions or emotional states and behaviours (Chen & Kaplan, 2001) and therefore might not offer the best method of measuring intergenerational continuities in parenting practices.

The effects of parental social mobility on intergenerational IQ associations, reported in chapter eight, were no longer present once parenting practices were included in the models. This suggests that social mobility may play a more indirect role in the transmission of cognitive skills between generations. Upward mobility and stability in non-manual social classes may therefore be important for the development of certain parenting behaviours (reported in section 9.5.1) but not directly implicated in the transfer of cognitive ability.

That social class and maternal education had important effects on offspring ability over and above the affects of parenting practices, suggests that these factors may mediate other pathways leading to cognitive development. Social status, for example, may influence peer relationships and access to health facilities (Morris, *et al.*, 2005) while education is known to influence parental choice of schooling (Chevalier & Lanot, 2002).

Post-hoc analyses of different combinations of parenting practices indicated that the intergenerational effects of different parenting measures may have been diminished or enhanced in the presence of other parenting behaviours. For example, the benefit of an intellectual environment was diminished in parents who had low aspirations for their G2 children. This would suggest that it was the absence of positive parenting practices and not just the presence of negative parenting behaviours that adversely affected offspring cognition. This is consistent with Baumrind's authoritative and authoritarian parenting typologies which represent similar levels of parental control but in the presence and absence of parental warmth and child input respectively (Baumrind, 1991).

9.6.3 Comparison with other studies

Given the diverse range of studies on parenting and cognitive ability, all of which employ their own definitions of parenting, it is impossible to make any direct comparisons with existing evidence. Nevertheless, these findings support previous studies which have shown that cognitively-stimulating activities such as museum visits, the presence of books and magazines (Guo & Harris, 2000), and parents' own reading habits and whether or not they engaged in reading activities with their children (Cairns, *et al*., 1998; Maughan, *et al*., 1998; Wadsworth, 1986) to be important factors in the promotion of cognitive development. These effects may not be restricted to childhood, as evidenced from a study of more than 7,000 members of the Whitehall II Study which showed that the effects of parental expectation, warmth and strictness on cognitive outcomes persisted into adulthood (Singh-Manoux, *et al*., 2006).

Although two studies (Cairns, *et al*., 1998; Maughan, *et al*., 1998) reported that the benefits of parental reading habits were restricted to girls, no gender differences were found in this sample. The findings for coercive discipline support the one study (Kagan & Freeman, 1963) to have shown an inverse association between coerciveness and offspring cognitive ability in early childhood. However, in this research the measure of coercive discipline was poorly defined so it is not possible to make any firm comparisons.

Many of the regression studies linking parenting practices to offspring cognitive ability (reviewed in section 2.2.4) failed to take account of the confounding effects of parental SEP (Douglas, 1967; Wadsworth, 1986), parental cognitive ability (Cairns, *et al*., 1998; Douglas, 1967; Maughan, *et al*., 1998; Tamis-LeMonde, *et al*., 2004; Wadsworth, 1986) and parental education (Andersson, *et al*., 1996; Douglas, 1967). In particular, previous results from the British 1946 birth cohort showing positive associations between (G0) parental interest in the schooling of G1 children and cognitive ability (Douglas, 1967), and the description of the affectionate relationship between G1 mothers and G2 offspring and vocabulary and reading scores (Wadsworth, 1986), failed to adjust for social background and parental ability. This could account for the lack of findings in relation to the measures of parental interest and affection found in these analyses.

The lack of effect of corporal punishment on offspring ability contradicts the study by Smith and Brookes-Gunn (1997) which found evidence that persistent harsh discipline reported by mothers and observed during home interviews was associated with lower scores on the Stanford-Binet Intelligence test in girls. The concern raised by many health professionals with regard to research on corporal punishment is that no clear distinction is made between non-abusive corporal punishment and harmful, abusive behaviours (Gershoff, 2002). The latter is undoubtedly associated with many detrimental cognitive and psychosocial outcomes (Pears & Fisher, 2005; Weiss, *et al*., 1992). It may therefore be the case that corporal punishment at the severe end of the spectrum, where the distinction between discipline and abuse is unclear, might impede intellectual development but given the available measures this was impossible to examine in these analyses.

The amount of variance in cognitive ability accounted for by parenting practices in previous studies was typically modest compared with the contribution of maternal cognitive ability and social class. In Andersson *et al*. (1996) for example, nurturance explained 3% of the variance in verbal ability while maternal cognitive ability accounted for 15% of the total variance. In these analyses, cognitive stimulation, parental aspirations and coercive discipline contributed equally moderately to the variance in offspring ability (1%, 2% and 2% respectively), but the quality of the intellectual environment explained 7% of the total variance in offspring cognitive ability. This exceeded the contribution of social class and education to offspring ability, which was 3%.

9.6.4 Limitations

In addition to the restrictions imposed by the subjective measure of corporal punishment, further misclassification bias may have been introduced as a result of measures applied and the method of data collection. The parenting measures relied solely on reports from mothers on how they and their husbands interacted with their children and disciplined them, rather than using home observations (e.g. Olson & Kaskie, 1992; Tamis-LeMonde, *et al*., 2004). Self-report measures could possibly result in attenuated associations, since respondents may be unwilling to report socially undesirable information, thereby reducing confidence in the validity and reliability of the measurement (Simons, *et al*., 1991). Nevertheless, recent research has shown that there is a correspondence between the self-reported child-rearing attitudes of mothers and their actual child-rearing behaviours (Dekovic, *et al*., 1991;

Kochanska, *et al*., 1989). Such single-informant reports can also lead to misclassification bias as a result of the particular respondent's personality or disposition. For example, interpretations of what counts as affection may be determined by a mother's own experience as well as the perceived social norms of what counts as an affectionate relationship.

Missing data may also affect results. Response bias at the individual level may have underestimated the magnitude of the effects of parental social class and education on offspring cognitive development since 'missingness' was more common in parents from lower social class groups. Such parents were also less likely to have provided information on parenting practices. It is difficult to determine the effects of missing data on the size and direction of inferences drawn, but subsequent analyses (chapter ten) adopt a maximum likelihood approach in an attempt to overcome this difficulty.

The degree to which these results will replicate by utilising different measures of parenting and with respondents of different ages, is not known. The fact that the results reported here support a number of previous studies that have made use of similar measures of parenting (Cairns, *et al*., 1998; Guo & Harris, 2000; Kagan & Freeman, 1963; Maughan, *et al*., 1998), suggest that such replication may in fact occur.

9.6.5 Strengths

An important strength is that these analyses made use of multigenerational, longitudinal data to examine a question that has not previously been considered – that is, the extent to which parenting practices explain intergenerational associations in cognitive ability. The quality of the intellectual environment, cognitive stimulation, parental aspiration and coercive discipline were all found to be independently associated with offspring ability and were therefore identified as potential mediators of cognitive ability associations across generations. In addition, these analyses controlled for a wide range of grandparental, parental and offspring characteristics and thus attempted to avoid alternative confounding explanations.

A further strength of this work is that models take into account the life course events of mothers and fathers. Previous studies of the effects of parenting on offspring cognitive ability have been mostly limited to mothers, so that gender-specific effects, such as the role of coercive discipline in fathers, could not be identified. In similar vein, few studies have considered the reciprocal effects between parenting practices and child behaviour. Aspects of offspring temperament, including frequency of temper tantrums and smacking of parents, were shown to be associated with parenting behaviours and in turn influenced the intergenerational transmission of cognitive ability.

9.6.6 Conclusions

Intergenerational associations in cognitive ability were shown to be partly mediated by parenting practices. The quality of the intellectual environment, cognitive stimulation and parental aspirations were all found to be beneficial to the cognitive development of children, while coercive discipline practices in fathers were associated with poorer cognitive outcomes. These effects were seen over and above the cross-generational influences of parental social class and education, as well as the possible confounding effects of parental physical and mental health and offspring temperament.

These findings add to a growing body of evidence suggesting that environments which do not facilitate cognitive development at a young age place children at an early disadvantage. The implications of this result for improving the early intellectual development of children by intervention in parenting practices and discipline techniques, have been assessed in several intervention programmes in the UK (Roberts & Hall, 2000) and in the USA (Hubbs-Tait, *et al.*, 2002). Although they offer promising results in the short-term, these gains showed rapid attrition once interventions were withdrawn. Further understanding of the pathways involved in parenting and intergenerational associations in cognitive ability might well help to focus interventions on more distal factors, such as education, that could perhaps improve the possibilities of success. These pathways will be explored in greater detail in the next chapter by way of path model analysis.

10. Paths between parental and offspring ability

10.1 Introduction

The intergenerational relationship between parental and offspring cognitive ability has been widely reported (Guo & Harris, 2000; Lawlor, *et al*., 2005; Plomin & Craig, 2001). Findings in this thesis have already made clear that parenting practices might account for some of this association. It has also been shown that a range of factors across the parents' life course, such as social background and education, influence parenting behaviours. The next step is to identify the ways that these factors interact along the parental life course to mediate the transfer of cognitive skills across generations. To this end, path model analysis was employed to examine multiple pathways through which cognitive ability might be transferred from parents to children.

10.2 Methods

10.2.1 Path analysis

Path analysis represents an extension of simple regression modelling of one dependent variable on an independent variable. It allows for the analysis of more complicated models where there are several final dependent variables and those where there are several intervening variables (Loehlin, 2004). Although path models can neither be used to establish causality nor even to determine whether or not a specific model is correct, they can determine whether the data are consistent with a prespecified theory-driven model (Streiner, 2005).

10.2.2 Theoretical model

The theoretical model on which the analyses in this chapter are based (figure 10.1) provides a framework that aims to move beyond the simple quantification of the association between G1 parental and G2 offspring cognitive ability, to a fuller understanding of factors that potentially mediate this relationship. The proposed mediating variables are: G1 educational attainment, social class (determined according to the employment of the head of household), and parenting practices.

The theoretical model allows parental cognitive ability to affect each of the mediating mechanisms and these in turn are allowed to affect offspring cognitive ability. In this way path model analysis allows both the direct and indirect effects of parental cognitive ability on offspring ability to be assessed. It is hypothesised that part of the effect of G1 cognitive ability on G2 cognitive ability is mediated by G1 parenting behaviours. Also included in the framework is G0 social class, given the evidence that social background is an important determinant of childhood cognition (Feinstein, 2003) as well as child-rearing behaviours (Cairns, *et al.*, 1998). Although no direct effects of G0 social class on G2 offspring have been found so far in this thesis, it is hypothesised that G0 social class might influence the cognitive development of G2 offspring via its effect on G1 SEP and parenting practices.

In the interests of parsimony, only the most highly correlated and theoretically relevant predictors of parenting practices and G2 cognitive outcomes were included. Since G1 parental interest, affection and corporal punishment had no impact on offspring ability in regression models adjusted for G1 ability (table 9.7), these measures were excluded from the analyses. Moreover, given that no intergenerational continuities in parenting practices between the G0 and G1 generation were found, G0 parental interest was not included.

Previous regression analyses in chapter nine also showed little effect of G1 social mobility, G1 physical and mental health variables, offspring temperament, own occupational social class, and maternal age at childbirth on offspring ability once parenting practices, social class and education had been accounted for (table 9.7). These factors were accordingly excluded from the theoretical model.

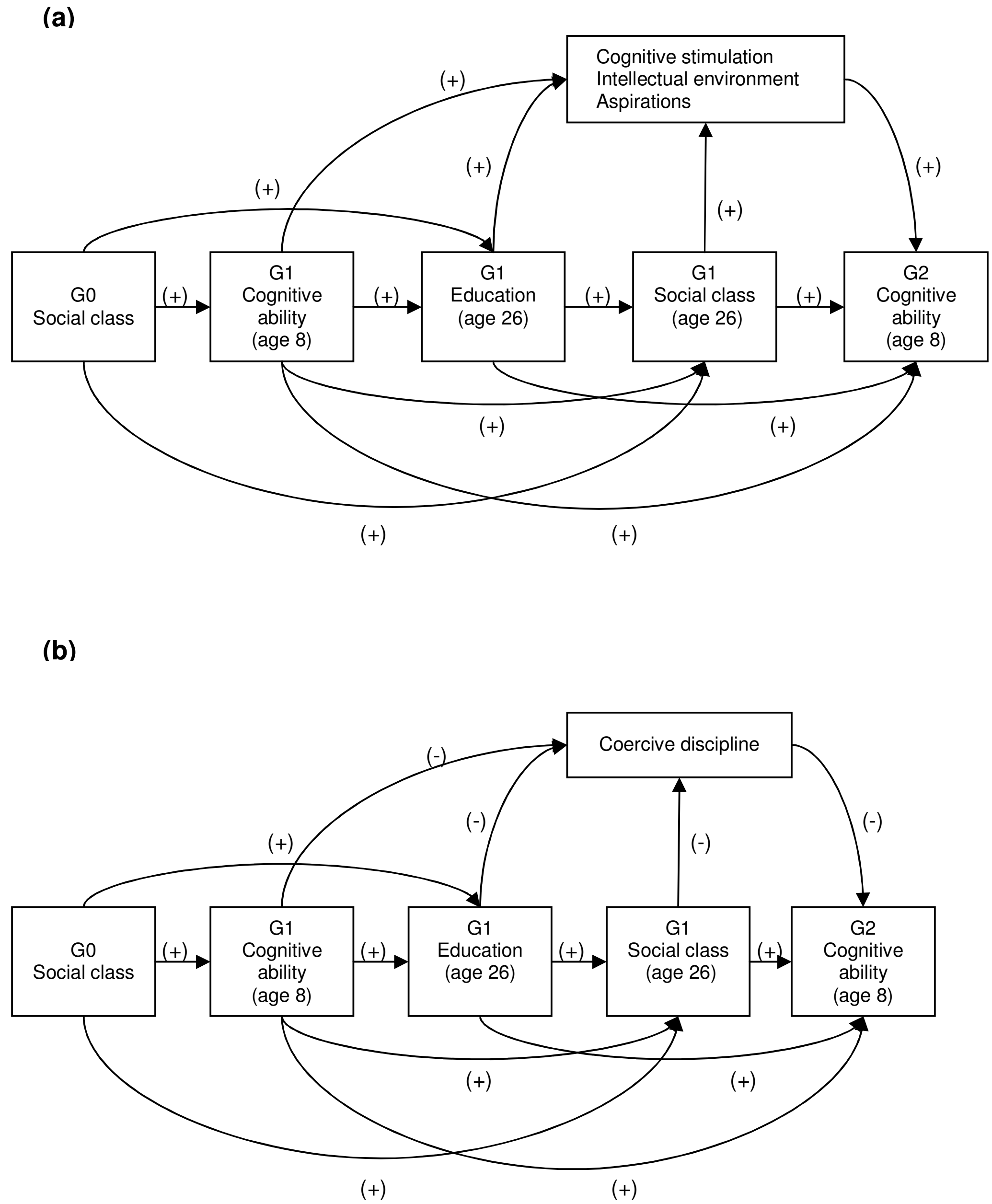

Figure 10.1 Theoretical models for path analyses of intergenerational associations between cognitive ability in G1 parents and G2 offspring.
Plus or minus signs in brackets indicate the anticipated direction of the relationship between variables. **(a)** G1 cognitive ability, education and social class at age 26 were hypothesised to be positively associated with cognitive stimulation, the quality of the intellectual environment and parental aspirations. These parenting practices were hypothesised to positively influence G2 cognitive development. **(b)** Coercive discipline was expected to be inversely associated with parental ability, education and social class and to be detrimental to G2 offspring cognitive ability.

10.3 Analyses

In the path analysis framework, dependent variables are termed endogenous and independent variables exogenous. The extension lies in the fact that the model allows for intervening endogenous variables (e.g. G1 education) that are affected by exogenous variables (e.g. G0 social class) which in turn also affect other endogenous variables. The rationale for these terms is that the factors that influence exogenous variables are determined outside the model being tested, whereas those factors affecting the endogenous variables exist within the model itself (Streiner, 2005).

Results are summarised in path diagrams where the strength of the associations between endogenous and exogenous or intervening endogenous variables, are represented by beta coefficients. These beta coefficients are partial regression coefficients quantifying the strength of the association between two variables if all else is held constant in the model (Streiner, 2005). These are interpreted in the same way as standardised beta coefficients between a dependent variable and an independent variable in regression analyses – that is, they reflect the impact on the outcome variable of a change of one standard deviation in the predictor variables. All paths in the path diagram are assumed to be statistically independent and since the path coefficients are fully standardised, they are comparable within models and between them.

10.3.1 Estimating the model

The latent variable modelling programme, AMOS 4.01 (Arbuckle, 1999) was used to evaluate the theoretical model in figure 10.1. The AMOS programme allows maximum likelihood estimating based upon incomplete data. This is known as full information maximum likelihood (FIML). This is a theory-based approach based upon the direct maximisation of the likelihood of all the observed data, not just the data from cases with complete information which is the approach used in listwise deletion. FIML estimates will tend to be more reliable than those obtained using listwise deletion estimates (Sacker, *et al.*, 2002) and several studies have shown maximum likelihood imputation used by AMOS to have the least bias. In one example, Byrne (2001) compared the output from an incomplete data model with output from a complete data sample and found that maximum likelihood imputation yielded similar chi-squared and fit measures despite 25% data loss in the incomplete data model. By utilising FIML, all 1,690 G1 parents and their G2 offspring could be included in the analyses (746 G1 men; 944 G1 women).

10.3.2 Assumptions

Since path analysis is an extension of multiple linear regression, many of the same assumptions hold good for the two techniques. Associations between variables must be linear. Path analysis also requires that there should be no interaction between variables, and for the endogenous variables to be continuous. If variables are ordinal, a minimum of five categories are required (Hox, 2000; Streiner, 2005). For these analyses, educational attainment, social class and parenting practices were included as categorical variables with no fewer than five categories. Furthermore, Streiner (2005) recommends a minimum of 10 cases for every parameter estimated, which the sample size of 1,690 adequately fulfils.

10.3.3 Model generation

A model generating approach was adopted to fit optimal models for each of the four G1 parenting practices – cognitive stimulation, intellectual environment, parental aspirations and coercive discipline. In utilising this technique, the initial theory-driven reference model (figure 10.1) was successively modified and retested until on a combination of statistical and theoretical criteria an optimal fit was obtained. To this end, non-significant paths, as represented by regression coefficients with *p*-values >0.05 were deleted in accordance with a theory trimming approach to model generation (Anderson, *et al*., 2002). Model generation and theory trimming was continued in AMOS until an optimal fit was gained.

10.3.4 Model fit

Several criteria were used to assess the fit of the model to the data. The chi-squared statistic is usually applied as a 'goodness-of-fit' index, for which a non-significant *p*-value indicates that the model corresponds to the data. However, with large sample sizes, even trivial discrepancies between data and model can give large chi-squared values, small *p*-values and unwarranted model rejection (Loehlin, 2004). For this reason, two alternative fit indices were also used to evaluate the fit of the models. The root mean square error of approximation (RMSEA) gives a measure of the discrepancy in fit per degrees of freedom and is therefore insensitive to sample size. A value of ≤0.05 is considered to indicate a close fit, ±0.08 a mediocre fit, and ≥0.10 a poor fit (Steiger, 1990). The final index used to asses model fit was the comparative fit index (CFI), which is normally tested against a minimum criterion value of 0.95 (Sacker, *et al.*, 2002).

10.3.5 Stratification by G1 sex

A multi-group analysis was used to examine possible interaction effects in the data. Of specific interest was whether or not the path models varied by parental or offspring sex. To this end, the reference model was estimated separately for G1 men and G1 women with the hypothesis that the regression weights were the same for the two groups. These models allowed the distribution of variables to be different for G1 mothers and fathers and G2 boys and girls while requiring the linear dependencies among the variables to be group-invariant. Significant *p*-values for the chi-squared test provided evidence that these pathways were not the same for G1 men and women, thus indicating an interaction effect. All models were therefore estimated separately for G1 fathers and G1 mothers. There was no evidence that pathways differed by offspring sex.

10.4 Results

10.4.1 Overall findings

For three measures of G1 parenting – intellectual environment (figures 10.2 & 10.3), parental aspirations (figures 10.4 & 10.5) and coercive discipline in fathers (figure 10.6) – the models satisfactorily fitted the data and thus provided empirical evidence in support of the theoretical model (RMSEA=0.00-0.04; CFI ≥ 0.99). The 'goodness-of-fit' measures for the models of cognitive stimulation and coercive discipline in mothers showed that the data did not fit the theoretical model well, and therefore no results are presented.

The accompanying tables (tables 10.1 to 10.5) present the complete results from the fitted final models including the unstandardised (b) and standardised (β) regression coefficients, the standard error estimates of the unstandardised regression coefficients, and the tests of statistical significance of the null hypothesis that each unstandardised regression coefficient equals zero. The unstandardised b-weights are used with the data in their original units of measurement. The standardised β-weights after each variable has been standardised to have a mean of zero and a standard deviation of one. The arrows in the far left column indicate the direction in which the effect operates. For instance, the first line of results in table 10.1 is for the effect of G0 social class on G1 cognitive ability at age eight. An increase in one standard deviation in G0 social class is associated with an increase in 0.34 standard deviations in G1 ability. The R^2 value summarises the proportion of variance in G2 cognitive ability accounted for by the collective set of predictors. The broken lines in the figures denote pathways where the estimates were not significantly different from zero at the 95% level and were therefore omitted from the path model.

The strength of relationship between G1 parental cognitive ability and G2 offspring cognitive ability was approximately 0.2 (p<0.001) for all models. The strongest internal path in all models was from G1 cognitive ability in childhood to G1 educational attainment at age 26, with β-coefficients of approximately 0.5 (p<0.001). In G1 fathers, the path between educational attainment and adult occupation was almost as strong (β=0.39, p<0.001). This was not unexpected, since childhood cognitive ability is a known predictor of educational achievement (Deary, *et al.*, 2007; Kuncel, *et al.*, 2004) and occupational attainment has been shown to be largely dependent on academic qualifications (Nettle, 2003). In women, the association between educational attainment and adult social class was less marked (β=0.26, p<0.001) although still significantly positive. This might reflect the fact that the measure used for social class was that of the occupational status of the head of household, which in this cohort was predominantly the husband. As hypothesised, G0 social class was positively associated with G1 cognitive ability, education and occupation, thus indicating an indirect effect of G0 social class on G1 parenting behaviours and subsequently G2 cognitive outcomes.

Consistent with the findings from regression analyses in chapter nine, the quality of the intellectual environment provided by G1 parents and parental cognitive ability exerted approximately equal effects on offspring ability (β=0.20). The effects of maternal education and paternal social class on G2 cognition were almost as great, while the associations between parental aspirations and offspring ability were more modest (β=0.08 and β=0.10), with effect estimates almost one-third of that of parental ability and half that of G1 social class. Overall, the models explained between 19% and 27% of the variance in G2 cognitive ability.

10.4.2 Intellectual environment

Parental cognitive ability and SEP variables were positively associated with the quality of the intellectual environment, as well as with offspring cognitive ability (figures 10.2 & 10.3). One notable exception was that the educational attainment of G1 fathers had no direct influence on offspring cognitive ability. The model revealed that the effect of paternal education on G2 cognition was mediated via the occupation of the fathers as well as the quality of the intellectual environments that they provided for their G2 offspring. The occupational status of the head of household was not related to the intellectual home environment provided by G1 mothers.

10.4.3 Aspirations

For parental aspirations, similar trends were observed. Education of mothers but not fathers was associated with offspring ability, while social class was related to the aspirations of G1 men only. One unexpected finding was that the cognitive ability of fathers was not related to hopes for the educational success of their G2 children.

Instead, the effects of paternal cognitive ability on this parenting measure operated via education and social class.

10.4.4 Coercive discipline

The model including coercive discipline practices in G1 fathers (figure 10.6) demonstrated a substantive negative effect on cognitive outcomes in G2 offspring (β=-0.16, p<0.001). Low levels of G1 paternal education contributed most to the development of these methods of discipline (β=-0.26, p<0.001), while childhood cognitive ability had insignificant effects.

10.4.5 Direct and indirect effects

Path coefficients may be used to decompose correlations in the path model into direct and indirect effects, corresponding to direct and indirect paths reflected in the arrows in the model (Loehlin, 2004). Considering the pathway between G1 and G2 cognitive ability in figure 10.2, the indirect effects were calculated by multiplying the path coefficients for each path between the two variables:

G1 cognitive ability → G1 education → G1 social class → G2 cognitive ability:
(0.45) x (0.39) x (0.17) = 0.029
G1 cognitive ability → G1 education → G1 social class → intellectual environment → G2 cognitive ability:
(0.45) x (0.39) x (0.12) x (0.21) = 0.004
G1 cognitive ability → Intellectual environment → G2 cognitive ability:
(0.12) x (0.21) = 0.025
G1 cognitive ability → G1 education → intellectual environment → G2 cognitive ability:
(0.45) x (0.16) x (0.21) =0.015
G1 cognitive ability → G1 social class → intellectual environment → G2 cognitive ability:
(0.21) x (0.12) x (0.20) = 0.005
G1 cognitive ability → G1 social class → G2 cognitive ability:
(0.21) x (0.17) = 0.036
Total indirect effect: (0.029) + (0.004) + (0.024) + (0.014) + (0.005) + (0.036) = 0.112

The indirect effect was then added to the direct effect of G1 cognitive ability on G2 cognitive ability (0.25) to yield a total effect of 0.36.

In all models, the total effect of G1 parental cognitive ability on G2 cognitive ability was approximately 0.36. The total indirect effect of education was much stronger in G1 women compared with G1 men. For instance, in the models examining parental aspirations, the total effect of education on G2 offspring cognitive ability was 0.09 for fathers and 0.26 for mothers (figures 10.4 & 10.5).

Comparisons of the output from an incomplete data model with the output from a complete data sample showed that FIML imputation yielded very similar path coefficients as well as chi-square and fit measures despite 58% data loss in the incomplete model (figures 14.1 to 14.5 in appendices).

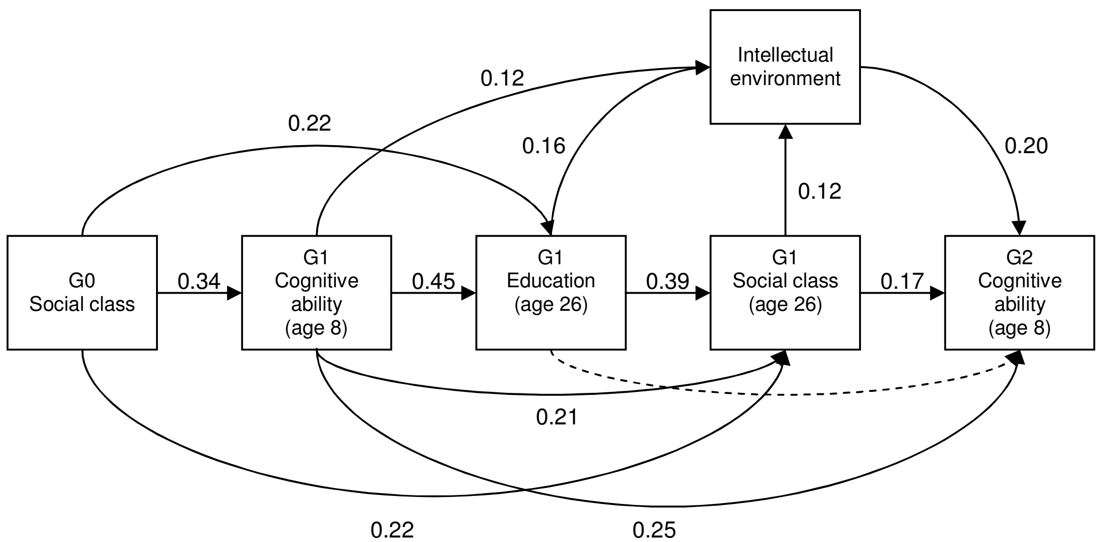

Figure 10.2 Path diagram for the model predicting intergenerational associations in cognitive ability between G1 parents and G2 offspring mediated by the intellectual environment provided by G1 fathers.

Table 10.1 Unstandardised (b) and standardised (β) estimates for the path diagram representing intergenerational associations in cognitive ability between G1 parents and G2 offspring mediated by the intellectual environment provided by G1 fathers (*n*=746).

Dependent variables	←	**Independent variables**	**b**	**SE**	***p*-value**	**β**
G1 Cognitive ability (8)	←	G0 Social class	0.30	0.03	***	0.34
G1 Education (26)	←	G0 Social class	0.30	0.05	***	0.22
G1 Education (26)	←	G1 Cognitive ability (8)	0.70	0.05	***	0.45
G1 Social class (26)	←	G1 Education (26)	0.28	0.03	***	0.39
G1 Social class (26)	←	G1 Cognitive ability (8)	0.23	0.04	***	0.21
G1 Social class (26)	←	G1 Social class (4)	0.21	0.03	***	0.22
Intellectual environment	←	G1 Education (26)	0.14	0.05	0.002	0.16
Intellectual environment	←	G1 Cognitive ability (8)	0.16	0.07	0.01	0.12
Intellectual environment	←	G1 Social class (26)	0.14	0.06	0.02	0.12
G2 Cognitive ability (8)	←	G1 Cognitive ability (8)	0.26	0.05	***	0.25
G2 Cognitive ability (8)	←	Intellectual environment	0.16	0.03	***	0.21
G2 Cognitive ability (8)	←	G1 Social class (26)	0.16	0.04	***	0.17
G2 Cognitive ability (8)	←	G1 Education (26)	Non-significant path dropped			
Model fit						
χ^2 (d*f*)			7.0	(3)	0.07	
RMSEA [90% CI]			0.04	[0.00;0.08]		
CFI			0.99			
R^2			0.22			
Total effect (direct + indirect effects) on G2 cognitive ability of:						
G1 Cognitive ability (8)			0.36			
G1 Education (26)			0.11			
G1 Social class (26)			0.19			

*** p<0.001

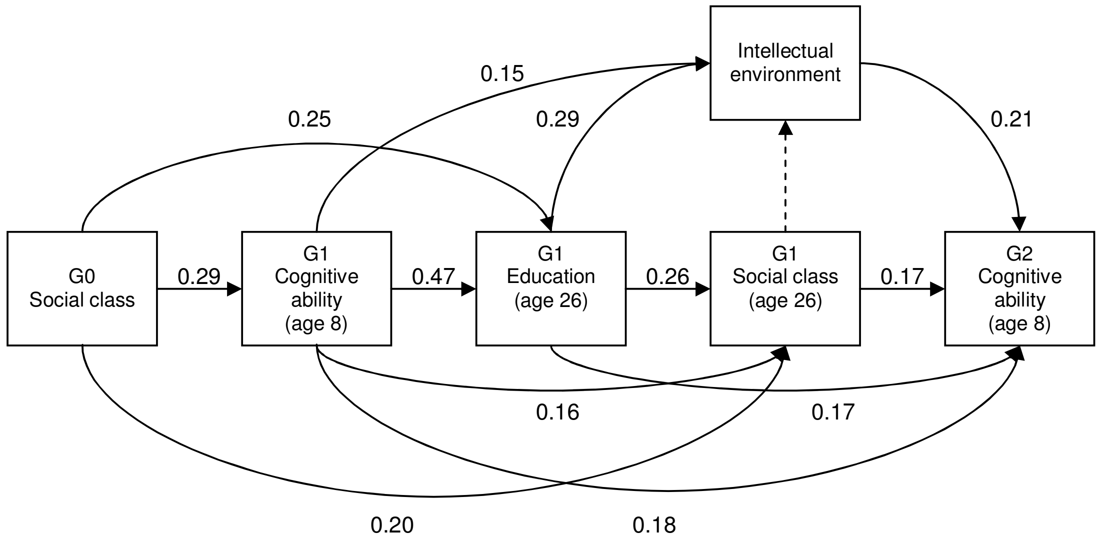

Figure 10.3 Path diagram for the model predicting intergenerational associations in cognitive ability between G1 parents and G2 offspring mediated by the intellectual environment provided by G1 mothers.

Table 10.2 Unstandardised (b) and standardised (β) estimates for the path diagram representing intergenerational associations in cognitive ability between G1 parents and G2 offspring mediated by the intellectual environment provided by G1 mothers (*n*=944).

Dependent variables	←	Independent variables	b	SE	*p*-value	β
G1 Cognitive ability (8)	←	G0 Social class	0.25	0.03	***	0.29
G1 Education (26)	←	G0 Social class	0.30	0.03	***	0.25
G1 Education (26)	←	G1 Cognitive ability (8)	0.64	0.04	***	0.47
G1 Social class (26)	←	G1 Education (26)	0.22	0.03	***	0.26
G1 Social class (26)	←	G1 Cognitive ability (8)	0.18	0.04	***	0.16
G1 Social class (26)	←	G1 Social class (4)	0.20	0.03	***	0.20
Intellectual environment	←	G1 Education (26)	0.27	0.04	***	0.29
Intellectual environment	←	G1 Cognitive ability (8)	0.19	0.06	0.001	0.15
Intellectual environment	←	G1 Social class (26)	Non-significant path dropped			
G2 Cognitive ability (8)	←	G1 Cognitive ability (8)	0.19	0.04	***	0.18
G2 Cognitive ability (8)	←	Intellectual environment	0.16	0.03	***	0.21
G2 Cognitive ability (8)	←	G1 Social class (26)	0.15	0.03	***	0.17
G2 Cognitive ability (8)	←	G1 Education (26)	0.13	0.03	***	0.17
Model fit						
χ^2 (d*f*)			4.3	(3)	0.1	
RMSEA [90% CI]			0.04	[0.00;0.08]		
CFI			0.99			
R^2			0.27			
Total effect (direct + indirect effects) on G2 cognitive ability of:						
G1 Cognitive ability (8)			0.36			
G1 Education (26)			0.28			
G1 Social class (26)			0.17			

*** *p*<0.001

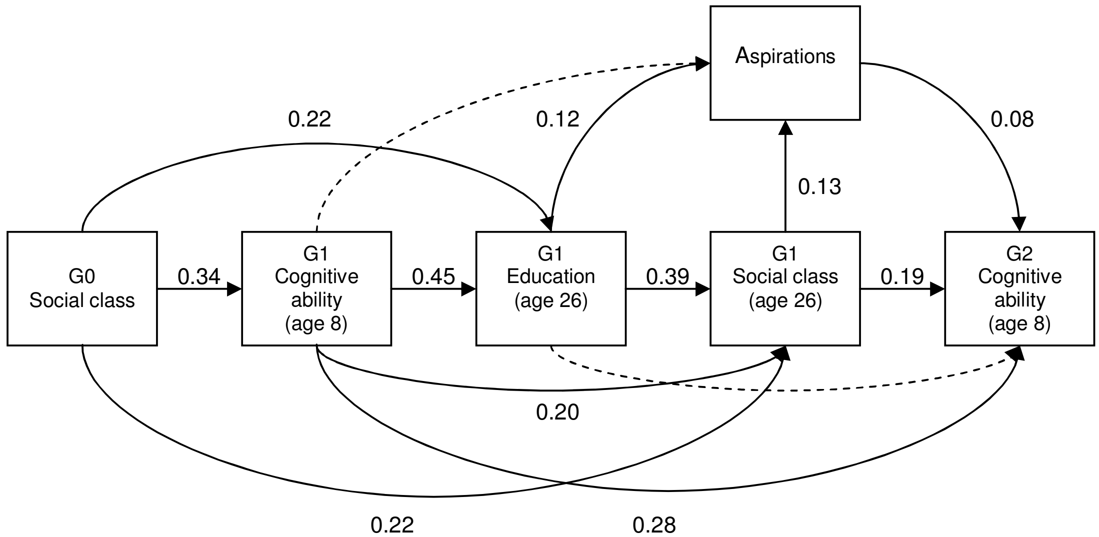

Figure 10.4 Path diagram for the model predicting intergenerational associations in cognitive ability between G1 parents and G2 offspring mediated by the aspirations of G1 fathers.

Table 10.3 Unstandardised (b) and standardised (β) estimates for the path diagram representing intergenerational associations in cognitive ability between G1 parents and G2 offspring mediated by the aspirations of G1 fathers (*n*=746).

Dependent variables	**←**	**Independent variables**	**b**	**SE**	***p*-value**	**β**
G0 Cognitive ability (8)	←	G1 Social class	0.30	0.03	***	0.34
G0 Education (26)	←	G1 Social class	0.30	0.05	***	0.22
G1 Education (26)	←	G1 Cognitive ability (8)	0.70	0.05	***	0.45
G1 Social class (26)	←	G1 Education (26)	0.28	0.03	***	0.39
G1 Social class (26)	←	G1 Cognitive ability (8)	0.23	0.04	***	0.20
G1 Social class (26)	←	G1 Social class (4)	0.21	0.03	***	0.22
G1 Aspirations	←	G1 Education (26)	0.15	0.06	0.01	0.12
G1 Aspirations	←	G1 Cognitive ability (8)	Non-significant path dropped			
G1 Aspirations	←	G1 Social class (26)	0.22	0.08	0.007	0.13
G2 Cognitive ability (8)	←	G1 Cognitive ability (8)	0.30	0.05	***	0.28
G2 Cognitive ability (8)	←	G1 Aspirations	0.05	0.02	0.03	0.08
G2 Cognitive ability (8)	←	G1 Social class (26)	0.18	0.04	***	0.19
G2 Cognitive ability (8)	←	G1 Education (26)				
Model fit						
χ^2 (d*f*)			3.2	(4)	0.5	
RMSEA [90% CI]			0.00	[0.00;0.05]		
CFI			1.00			
R^2			0.19			
Total effect (direct + indirect effects) on G2 cognitive ability of:						
G1 Cognitive ability (8)			0.36			
G1 Education (26)			0.09			
G1 Social class (26)			0.20			

*** *p*<0.001

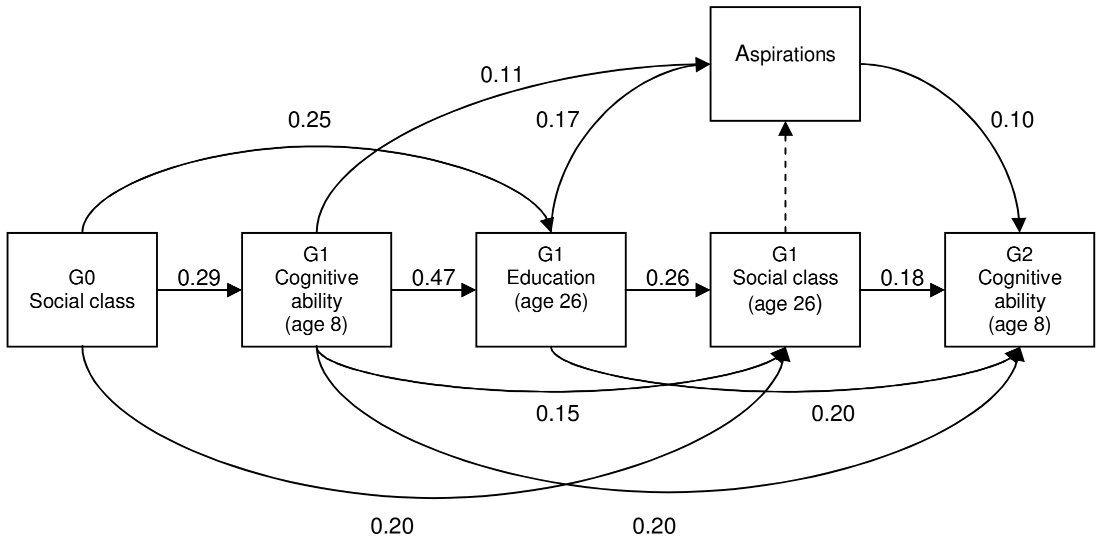

Figure 10.5 Path diagram for the model predicting intergenerational associations in cognitive ability between G1 parents and G2 offspring mediated by the aspirations of G1 mothers.

Table 10.4 Unstandardised (b) and standardised (β) estimates for the path diagram representing intergenerational associations in cognitive ability between G1 parents and G2 offspring mediated by the aspirations of G1 mothers (*n*=944).

Dependent variables	←	**Independent variables**	**b**	**SE**	***p*-value**	**β**
G1 Cognitive ability (8)	←	G0 Social class	0.25	0.03	***	0.29
G1 Education (26)	←	G0 Social class	0.30	0.03	***	0.25
G1 Education (26)	←	G1 Cognitive ability (8)	0.64	0.04	***	0.47
G1 Social class (26)	←	G1 Education (26)	0.23	0.03	***	0.26
G1 Social class (26)	←	G1 Cognitive ability (8)	0.18	0.04	***	0.15
G1 Social class (26)	←	G1 Social class (4)	0.20	0.03	***	0.20
G1 Aspirations	←	G1 Education (26)	0.22	0.06	***	0.17
G1 Aspirations	←	G1 Cognitive ability (8)	0.19	0.08	0.01	0.11
G1 Aspirations	←	G1 Social class (26)	Non-significant path dropped			
G2 Cognitive ability (8)	←	G1 Cognitive ability (8)	0.21	0.04	***	0.20
G2 Cognitive ability (8)	←	G1 Aspirations	0.06	0.02	0.001	0.10
G2 Cognitive ability (8)	←	G1 Social class (26)	0.16	0.03	***	0.18
G2 Cognitive ability (8)	←	G1 Education (26)	0.16	0.03	***	0.20
Model fit						
χ^2 (d*f*)			4.1	(3)	0.3	
RMSEA [90% CI]			0.02	[0.00;0.06]		
CFI			0.99			
R^2			0.25			
Total effect (direct + indirect effects) on G2 cognitive ability of:						
G1 Cognitive ability (8)			0.36			
G1 Education (26)			0.26			
G1 Social class (26)			0.18			

*** *p*<0.001

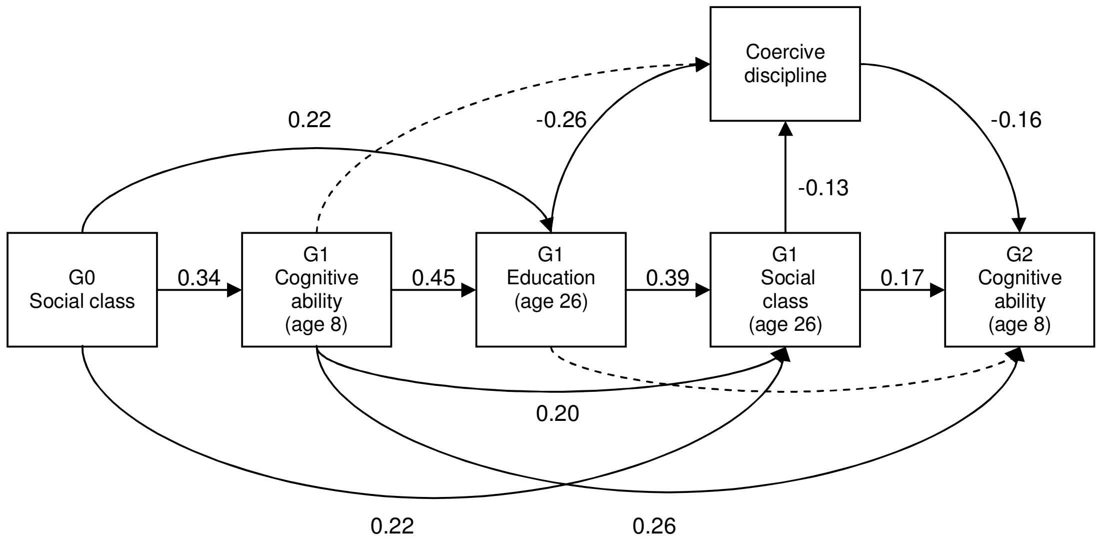

Figure 10.6 Path diagram for the model predicting intergenerational associations in cognitive ability between G1 parents and G2 offspring mediated by the use of coercive discipline by G1 fathers.

Table 10.5 Unstandardised (b) and standardised (β) estimates for the path diagram representing intergenerational associations in cognitive ability between G1 parents and G2 offspirng mediated by the use of coercive discipline by G1 fathers (*n*=746).

Dependent variables	←	Independent variables	b	SE	*p*-value	β
G1 Cognitive ability (8)	←	G0 Social class	0.30	0.03	***	0.34
G1 Education (26)	←	G0 Social class	0.30	0.05	***	0.22
G1 Education (26)	←	G1 Cognitive ability (8)	0.70	0.05	***	0.45
G1 Social class (26)	←	G1 Education (26)	0.28	0.03	***	0.39
G1 Social class (26)	←	G1 Cognitive ability (8)	0.23	0.04	***	0.20
G1 Social class (26)	←	G1 Social class (4)	0.21	0.03	***	0.22
Coercive discipline	←	G1 Education (26)	-0.21	0.04	***	-0.26
Coercive discipline	←	G1 Cognitive ability (8)	Non-significant path dropped			
Coercive discipline	←	G1 Social class (26)	-0.11	0.06	0.08	-0.13
G2 Cognitive ability (8)	←	G1 Cognitive ability (8)	0.27	0.05	***	0.26
G2 Cognitive ability (8)	←	Coercive discipline	-0.13	0.03	***	-0.16
G2 Cognitive ability (8)	←	G1 Social class (26)	0.16	0.04	***	0.17
G2 Cognitive ability (8)	←	G1 Education (26)				
Model fit						
χ^2 (d*f*)			4.4	(4)	0.4	
RMSEA [90% CI]			0.01	[0.00;0.06]		
CFI			1.00			
R^2			0.20			
Total effect (direct + indirect effects) on G2 cognitive ability of:						
G1 Cognitive ability (8)			0.35			
G1 Education (26)			0.12			
G1 Social class (26)			0.19			

*** *p*<0.001

10.5 Discussion

10.5.1 Main findings

Path model analysis was employed to assess a conceptual model for the transfer of cognitive ability from one generation to the next. Consistent with the hypotheses, and with previous regression findings (chapter nine), the path models confirmed the importance of the intellectual environment, parental aspirations and coercive discipline in partly mediating the transmission of cognitive skills from parents to offspring. These models also provided additional information on the pathways that facilitated this intergenerational relationship. Most notably, paternal education was shown to have an indirect effect on offspring cognitive ability through its association with parenting practices. Furthermore, intergenerational effects spanning more than two generations were identified with G0 social background influencing the cognitive development of G2 offspring via a number of pathways involving parental attainment in education and occupation.

10.5.2 Explanation of findings

The indirect effects of G0 social class on G1 parenting practices and consequently G2 cognitive ability were anticipated. The early social background of G1 parents was seen to operate in a cumulative way in that parents born into more advantageous social backgrounds scored higher on cognitive ability tests in childhood and subsequently went on to achieve greater educational and occupational success compared with those parents born into less fortunate socioeconomic circumstances. Collectively, these factors determined their capacity, as parents, to provide a home environment offering appropriate levels of intellectual stimulation and discipline necessary for their young to develop cognitive skills. This suggests that the transfer of cognitive skills from one generation to the next involves a range of different factors across the life course.

Although parenting behaviours and their subsequent effects on the cognitive development of the next generation did not differ by parental sex, some interesting gender-specific effects were found in relation to social class and education. Consistent with findings from regression analyses (section 9.5.3), the education of fathers did not directly affect offspring ability. However, path models showed that paternal education had an important indirect effect on offspring ability that operated via occupational status and parenting skills. It may be, for example, that the intellectual home environment was influenced by the resources available for parents to interact with, and invest in, their children. Thus certain elements of intellectual stimulation could have been 'purchased' with income – for example, books, newspapers and family outings. Education may have equipped parents with the requisite skills with which to encourage and promote the intellectual development of their children. The provision of a literacy environment, for example, might have encouraged similar reading habits in children and in turn supported their academic progress. In the same way, parents with high educational achievements are likely to have had similar aspirations for their offspring's success at school. Alternatively, those parents who failed to attain the necessary educational qualifications to ensure occupational success may have used coercive discipline more frequently due to the increased anxiety and stress associated with low SEP.

It may be that the so-called environmental influence of education is in fact partly genetic in origin. A 'generalist genes' theory has recently been proposed which predicts that most genetic effects for scholastic achievement and cognitive abilities are general rather than specific (Plomin & Kovas, 2005). That is, the genes that affect one area of learning, such as cognitive ability, are largely the same genes that affect other abilities, although there are some genetic effects that are specific to each ability. It is conceivable therefore that parents who have a genetic advantage in terms of cognitive development also go on to achieve higher educational achievements in part due to hereditary factors (Plomin, *et al.*, 2007). The extent of this is impossible to determine from these data.

The child-rearing practices of G1 mothers were not associated with the social class of the head of household. This suggests that while the income associated with the occupational success of the father may well be important for the provision and maintenance of an environment conducive for cognitive development in offspring, it may not be an important determinant of parenting behaviours of mothers. For example, whether or not a mother is able to afford to buy books is unlikely to determine her interest in reading or attitudes to learning. These attributes are likely to be the result of a combination of a range of factors across the life course – such as education and employment history.

One finding from regression analyses not replicated using path model analysis, was the benefit of cognitive stimulation for offspring intellectual development. An examination of initial bivariate associations (table 9.3) might explain this lack of effect. The unadjusted associations between the measure of cognitive stimulation and parental social class and education are relatively weak compared with the effect of SEP variables on the quality of the intellectual environment, parental aspirations and coercive discipline. This suggests that those paths determining the level of cognitive stimulation provided by parents might involve pathways not included in the theoretical model under examination. For example, whether or not mothers taught their children the alphabet might have been determined by their own experience of being taught cognitive skills before starting school.

Another interesting finding was that cognitive ability in fathers was not directly related to their aspirations for the educational success of their offspring. Instead, it was education and social class that largely determined expectations for their children. Fathers who had themselves achieved educational and occupational success had aspirations for their children to repeat or exceed their own achievements. This finding emphasises the importance of education in the pathway that mediates intergenerational associations in cognitive ability.

The direct association between cognitive ability across the two generations remained fairly strong after taking into account other factors such as education and parenting practices. Moreover, the models accounted for less than 30% of variance in offspring ability, thus implying that some other important mediating mechanisms have been excluded from the model. Other potential pathways include the physical environment at home (a safe, high quality environment conducive to learning) (Richards & Wadsworth, 2004); health status (poor health is detrimental to cognitive development) (Pless & Wadsworth, 1989); and child care (amount of non-maternal care) (Guo & Harris, 2000). Genetic effects on cognitive ability may also account for the remaining intergenerational associations (Plomin & Spinath, 2004). Nevertheless, the findings provide initial evidence to suggest some pathways through which parental cognitive ability exerts its influences on intellectual outcomes in the succeeding generation.

10.5.3 Comparison with other studies

This is one of the first studies to examine the pathways through which child-rearing practices mediate the transfer of cognitive skills across generations. In addition to the comparisons with findings from other studies of parenting and cognition already discussed in section 9.6.3, these pathways confirm the importance of parental education for offspring cognitive development shown by a number of researchers (Feinstein, 2003; Jefferis, *et al.*, 2002; Kaplan, *et al.*, 2001; Lawlor, *et al.*, 2005; Wilson, *et al.*, 2005). Furthermore, these analyses are able to show the indirect role of paternal education (via parenting) on cognitive development that previous regression analyses have not been able to identify.

Similar gender differences were found in path analyses of cognitive reserve which found that paths from education to mid-life cognition were stronger in females, and those from own occupation to mid-life cognition were stronger in males (Richards & Sacker, 2003).

The finding that social class indirectly effects offspring cognition via its influence on parenting practices supports findings from the study by Guo and Harris (2000). They used SEM to show that social background (measured according to financial resources) had a highly significant affect on cognitive stimulation and parenting style, and these mediating variables in turn exerted an effect on intellectual development in offspring.

Previous studies have found evidence of a role for parenting in the intergenerational transmission of antisocial behaviour (Dogan, *et al.*, 2007) and aggression (Conger, *et al.*, 2003). Given the link between these behaviours and cognitive development (Nigg & Huang-Pollock, 2003), it is feasible that the findings on parenting and cognitive ability would be replicated in future analyses.

10.5.4 Limitations

Although the results were generally consistent with expectation, several provisos should be noted. The first thing to be said is that the path models are unlikely to be constant over time or across cultures. With the exception of genetic contribution to general ability, which is not known in this cohort but likely to be approximately 0.5 (Plomin & Spinath, 2004), this model is environmental. It is therefore almost certain to vary across different socioeconomic environments and at different points in time.

The FIML approach has been adopted as a ‘best effort’ technique for dealing with the missing data issues raised in section 9.6.4. Comparison with analyses based upon listwise deletion revealed no marked differences in findings. However, bias in the model estimates may still be present and it is difficult to determine the size and direction of these biases.

10.5.5 Strengths

Few other studies have examined the mediating effects of parenting practices on the transmission of cognitive ability across generations. This method has the advantage of being able to identify intervening effects that are not possible by way of regression models. Regression analyses in the previous chapter reported an expected, but uninformative, significant effect of parental cognitive ability on offspring intellectual development. A rather more complicated and informative picture emerged when intervening mechanisms were incorporated into the analysis. The pathways through which G0 social class and paternal education influence offspring ability were identified and the importance of parenting practices in these pathways were confirmed.

10.5.6 Conclusions

Path models provided preliminary evidence that both direct and indirect pathways are involved in transmitting cognitive ability to the succeeding generation, as well as providing support for the hypothesis that these effects that are mediated by parenting practices. It was found that the social and educational backgrounds of parents were associated with the quality of the intellectual environments that they provided for their offspring, and with the aspirations of parents for their children’s educational success, as well as the extent and use of coercive discipline practices.

In parallel with the findings from preceding chapters, the importance of education was emphasised in the part it plays in the transfer of cognitive skills from one generation to the next. Paternal education had a significant indirect influence on offspring ability through its effects on employment status and parenting practices. Furthermore, maternal education was directly and positively associated with offspring ability and also influenced maternal child-rearing practices. In addition to the direct association found between social class and offspring ability, the effects of social background on cognitive development were mediated through differences in parenting that children received and experienced at home.

Path model analysis has therefore clarified some of the pathways between parental and offspring cognitive ability involving parenting behaviours and the home environment. The final question of this thesis turns to the role that specific parenting practices may play in perpetuating different types of continuities and discontinuities in cognitive ability across generations.

11. Intergenerational discontinuities in cognitive ability: the role of parenting

11.1 Introduction

The results so far have demonstrated that certain aspects of parenting, such as those associated with the provision of an appropriate intellectual environment, and aspirations for educational success benefit offspring cognitive development. However, as Winnicot (1965) observed with his concept of 'good enough' parenting, most parents provide an adequate level of stimulation to encourage their child's intellectual development and many use sensible discipline techniques that have no detrimental influence on cognitive development unless used in excess.

This raises the question of whether or not different parenting behaviours contribute to different types of continuities or discontinuities in cognitive ability. For example, parents with high cognitive ability scores may provide adequate and appropriate intellectual stimulation to ensure their children perform equally well in ability tests. Alternatively, if such parents fail to provide a high level of cognitive stimulation and employ high levels of coercive discipline, they may not be providing 'good enough' parenting to prevent their children from scoring lower on cognitive tests than they themselves did. In this way, parents may facilitate continuities in cognitive ability with their offspring scoring similarly high or low on ability tests; or their parenting practices might contribute to discontinuities between generations with an improvement or deterioration in offspring ability. Identifying those things that drive such discontinuities may help target intervention programmes aimed at breaking intergenerational cycles of disadvantage resulting from poor cognitive outcomes in early childhood that could predispose children to poorer educational and occupational success later in life.

11.2 Specific objectives of the chapter

The overall objective of this chapter is to examine whether or not different types of intergenerational continuities and discontinuities in cognitive ability are associated with specific parenting practices. Of particular interest is the parenting received by offspring who out-performed their parents in cognitive ability tests, as well as those who achieved lower ability scores compared with their parents at the same age. These groups – representing intergenerational discontinuities – are considered to be important given the well-established link between cognitive ability and later educational and occupational outcomes. The main aim, therefore, is to identify parenting behaviours that may protect children from replicating the low cognitive ability scores of their parents, or alternatively identifying those aspects of behaviour that predispose children of high-scoring adults to underachieve on cognitive ability tests.

To address these questions, G1 parents and G2 offspring are defined on the basis of their relative performance on cognitive ability tests at age eight and the continuity and discontinuity of these scores between the two generations. Parent-offspring pairs whose ability scores were consistently high or consistently low between generations are categorised as high-high and low-low respectively. Pairs in which the offspring outperformed their parents on cognitive ability tests are designated as 'escapers', while those who underachieved relative to their parents are termed 'fallers'. Parents with mid-range ability scores, regardless of how their offspring performed, comprised the reference group.

Since the focus is on parenting in escapers and fallers, analyses of these groups is aimed at identifying those parenting practices associated with discontinuities towards improvement or deterioration in offspring cognitive ability scores. To this end, two hypotheses are tested for escapers: that the likelihood of each parenting practice in this group is significantly different from i) the reference group and ii) the low-low group. Equivalent hypotheses are tested for fallers – that is, that the likelihood of each parenting practice in this group is significantly different from i) the reference group and ii) the high-high group. These hypotheses differentiated between less restrictive analytical models which included discontinuities involving small to moderate changes in ability between generations, and those involving larger intergenerational shifts representing greater intergenerational differences in cognitive ability.

Two further hypotheses, that the odds of each parenting practice in the high-high group and low-low group are significantly different from the reference group, are also tested. G1 parents in the low-low group are anticipated to be less likely to provide intellectual stimulation and encouragement and more likely to adopt harsh discipline practices. Alternatively, it is expected that G2 offspring in the high-high group are more likely to be brought up in an intellectually-enriched home environment that is low in coercion.

11.3 Method

11.3.1 Quartile transition matrix

To assess different types of continuity and discontinuity in childhood cognitive ability across generations, the age eight ability scores for G1 parents and G2 offspring were grouped by quartiles so that individuals were classified into one of four quartile groups. A quartile transition matrix, obtained by cross-tabulating the quartile groups of G1 and G2 cognitive ability was then used to examine patterns of continuity and discontinuity between generations. This matrix illustrates the observed probability that G2 offspring rank in a particular quartile based upon the quartile position of their G1 parents.

11.3.2 Continuities and discontinuities: the effect of parenting practices

To examine the effect of parenting practices on intergenerational relationships in cognitive ability, the patterns of continuity and discontinuity (described above) were divided into four transition groups, illustrated in table 11.1 and defined as:

1. Low-low: G1 parents and G2 offspring in the bottom cognitive ability quartile.
2. Escapers: G1 parents in the bottom cognitive ability quartile and G2 offspring in the second quartile or higher.
3. High-high: G1 parents and G2 offspring in the top cognitive ability quartile.
4. Fallers: G1 parents in the top cognitive ability quartile and G2 offspring in the third quartile or lower.

Parent-offspring pairs in which the G1 parental ability scores fell into the second or third ability quartile were used as the reference category; this ensured that all escapers and fallers originated from quartile 1 and quartile 4 respectively.

Table 11.1 Definition of groups representing continuity and discontinuity in cognitive ability between G1 parents and their G2 offspring.

<table>
<tr><th rowspan="2">Parental cognitive ability quartile</th><th colspan="4">Offspring cognitive ability quartile</th></tr>
<tr><th>1 (Low)</th><th>2</th><th>3</th><th>4 (High)</th></tr>
<tr><td>1 (Low)</td><td>Low-low</td><td colspan="3">Escapers</td></tr>
<tr><td>2</td><td colspan="4" rowspan="2">Reference group</td></tr>
<tr><td>3</td></tr>
<tr><td>4 (High)</td><td colspan="3">Fallers</td><td>High-high</td></tr>
</table>

Logistic regression was applied to examine the likelihood of different parenting practices being employed in these four transition groups, compared with the reference group. Thus parenting practices were entered as the independent variable and the transition group was the dependent variable. A similar method was used by Feinstein (2003) to assess continuities in cognitive ability within childhood in the British 1970 birth cohort.

All models were adjusted for the possible confounding effects (described in section 7.3.1) of G0 and G1 social class and G1 educational attainment. Parental interest and corporal punishment at age four were excluded from the analyses because of their lack of effect on intergenerational associations in cognitive ability in this cohort (shown in section 9.5). Where there was evidence of an interaction effect between parental sex and parenting behaviour on membership of a transition group (e.g. G1 mothers but not G1 fathers in the high-high group provided more cognitive stimulation compared with the reference group), effects are shown stratified by parental sex.

11.3.3 Study sample

These analyses were restricted to 1,052 parent-offspring pairs for whom there was complete data on G1 and G2 cognitive ability, G0 and G1 social class and G1 educational attainment, and parenting practices.

11.4 Results

11.4.1 Quartile transition matrix

It has already been shown that the correlation coefficient between cognitive ability in G1 parents at age eight and G2 offspring at age eight is approximately 0.34, indicating that there is some continuity but also large measures of discontinuity between generations (section 7.3.3). The quartile transition matrix (table 11.2) provides additional information on transition between generations in terms of cognitive ability. Of the G1 parents who were in the lowest quartile group (group 1), 40% of their G2 children were also in this quartile group. Similarly, 43% of G2 offspring remained in the high quartile group (group 4) of their G1 parents. There was greater long-range movement between the low and high quartile, with 13% of G2 offspring moving up three quartiles, compared with 10% of G2 offspring who achieved cognitive scores in the low quartile compared with their high-scoring G1 parents. These patterns are illustrated in figure 11.1.

Table 11.2 Quartile transition matrix: the number (and per cent) of G1 parents and G2 offspring in each intergenerational ability quartile.

Parental cognitive ability quartile	Offspring cognitive ability quartile									
	1 (Low)		2		3		4 (High)		All	
1 (Low)	106	*(40)*	72	*(27)*	51	*(19)*	34	*(13)*	263	*(100)*
2	70	*(27)*	72	*(27)*	74	*(28)*	47	*(18)*	263	*(100)*
3	60	*(23)*	65	*(25)*	69	*(26)*	69	*(26)*	263	*(100)*
4 (High)	27	*(10)*	54	*(21)*	69	*(26)*	113	*(43)*	263	*(100)*
All	263	*(25)*	263	*(25)*	263	*(26)*	263	*(25)*	1,052	*(100)*

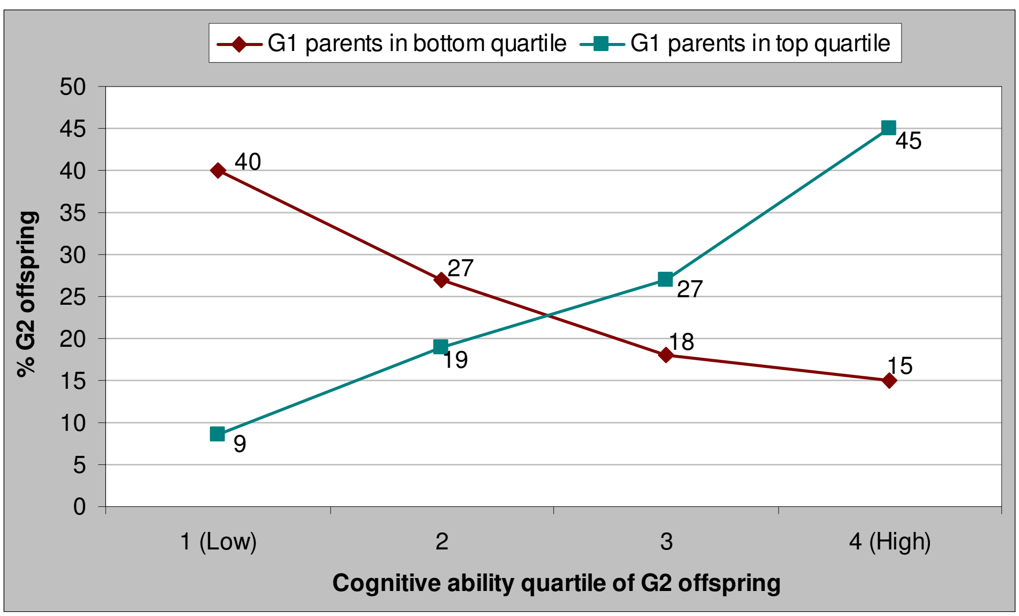

Figure 11.1 Cognitive ability transitions between G1 parents and G2 offspring: quartile position of offspring by quartile position of parents at age eight.

11.4.2 Continuities and discontinuities: the effect of parenting practices

Parents and offspring categorised as escapers and fallers made up 15% (*n*=157) and 14% (*n*=150) of the sample respectively, 10% (*n*=106) of parent-offspring pairs were categorised as low-low and 11% (*n*=113) as high-high (table 11.2 and table 14.4 in appendices). The majority of offspring in the reference category (53%) moved just one quartile position relative to their parents. In contrast, an equivalent proportion of offspring in the escapers and fallers groups (54%) improved or deteriorated by more than two groups. The cognitive ability profiles of the four transition groups (low-low, escapers, fallers, high-high) are illustrated in figure 11.2. As expected, both generations in the references group had mean standardised cognitive ability scores of approximately zero reflecting their positions in the middle of the distribution of cognitive ability scores.

Looking at the distribution of parental characteristics by transition group (figure 11.3), the high-high group comprised more parents who had achieved advanced levels of education and were employed in non-manual positions compared with all other groups. Conversely, the low-low group had the lowest proportion of parents with an advanced level of education and the fewest parents from a non-manual background. Parents in the escapers group tended to be more advantaged in terms of social class and education than the low-low group from which their offspring escaped, but less advantaged than the reference group. Similarly, there was a greater proportion of parents in the fallers group who had non-manual occupations and had achieved an advanced education compared with the reference group, but this group was less advantaged than the high-high group.

Tables 11.3 to 11.5 present the results of logistic regression analyses examining how parenting practices are related to different types of continuities and discontinuities in cognitive ability. The results for each transition group are described separately; odds ratios greater than 1 indicate a higher likelihood of a particular parenting behaviour compared with the comparison group. Conversely, odds ratios below 1 indicate a reduced relative probability.

11.4.2.1 Escapers

The first hypothesis examined whether or not the parenting practices of parents in the escapers were different from those in the reference group. Table 11.3 shows that no differences in parenting practices between the two groups were found. Although there is some indication that corporal punishment was used more frequently by parents in the escapers group, these difference were not significant at conventional levels (OR=1.27; p=0.5).

The second hypothesis was that parents with low cognitive scores whose offspring outperformed them in ability tests were different in terms of their parenting practices compared with parents of children who remained in the lowest ability quartile. Parents in the escapers group were almost 50% more likely to engage in cognitively-stimulating tasks with their offspring (95% CI: 10%; 220%, p=0.05), and also provided a significantly better quality intellectual environment for their children (OR=1.37, 95% CI: 1.1;1.7, p=0.004). Furthermore, paternal aspirations for the school achievements of their offspring were positively related to upward transition of G2 offspring from the lowest cognitive ability quartile of their G1 parents (OR=1.26, 95% CI: 1.1; 2.0, p=0.02).

11.4.2.2 Fallers

The parenting practices of parents in the fallers group were no different from those used by parents in the reference group. Although the likelihood of coercive discipline in the fallers group was less likely at 0.86, it was not significantly lower at conventional levels of $p<0.05$. Corporal punishment conveyed marginal disadvantage in terms of falling from the top ability quartile (OR=0.58, p=0.06).

In comparison with the high-high group, G2 offspring in the fallers group were less likely to be brought up in an intellectual environment by their G1 parents (OR=0.65, 95% CI: 0.5;0.8, $p<0.001$).

11.4.2.3 Low-low

G1 parents in the low-low group were less likely than the reference group to engage in cognitively-stimulating tasks with their G2 offspring by teaching them their colours and the alphabet (OR=0.68, 95% CI:0.5;0.9, p=0.01). They were also less inclined than the reference group to read books regularly or visit the public library and therefore provided a lower quality intellectual environment for their G2 offspring (OR=0.77, 95% CI:0.6;0.9, p=0.007).

11.4.2.4 High-high

In the high-high group, the quality of the intellectual environment provided by G1 parents was up to 70% better than that provided by G1 parents in the reference group (OR=1.35, 95% CI:1.1;1.7, p=0.005).

Parental affection and coercive discipline were not associated with membership of any of the transition groups.

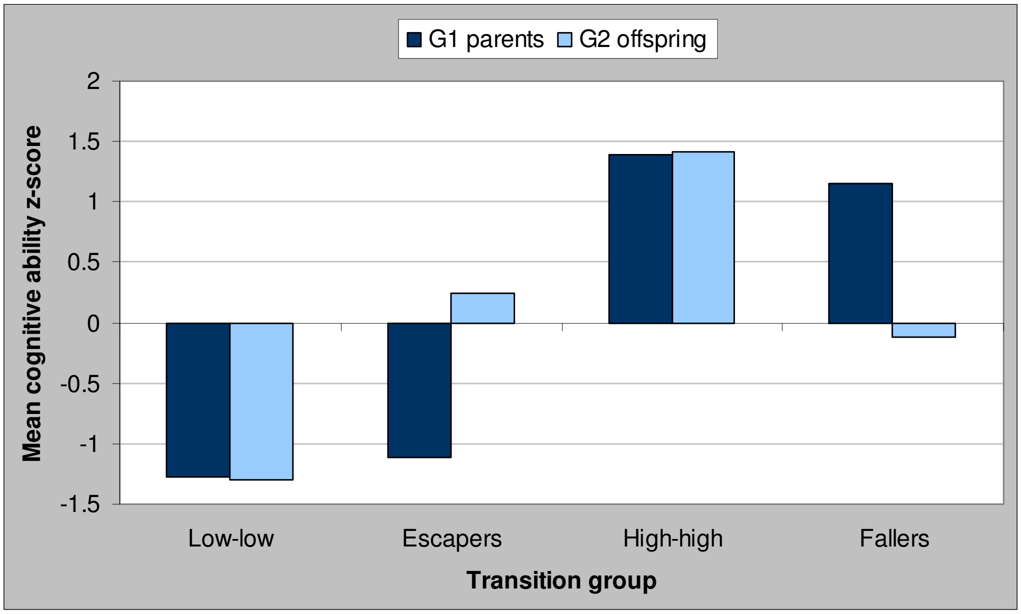

Figure 11.2 Mean cognitive ability z-score for parents and offspring by transition group. (The mean z-score for the reference group was 0 and is therefore not shown on this graph).

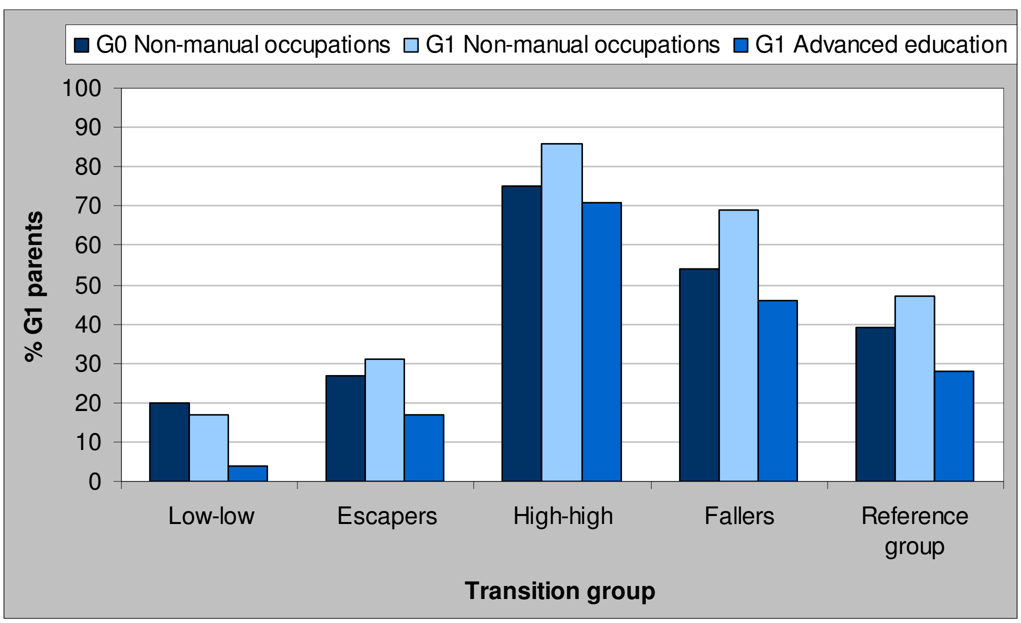

Figure 11.3 The proportion of G1 parents with a non-manual social class (G0 and G1) and advanced education by transition group.

Table 11.3 Odds ratios and 95% confidence intervals for the likelihood of different parenting practices being used by G1 parents in the **escapers** group.

	Odds compared with reference group. *n*=683			Odds compared with low-low group. *n*=263		
G1 Parenting practice	OR	[95% CI]	*p*-value	OR	[95% CI]	*p*-value
Cognitive stimulation	0.97	[0.8;1.2]	*0.7*	1.45	[1.1;2.2]	*0.05*
Intellectual environment	1.00	[0.9;1.2]	*0.9*	1.37	[1.1;1.7]	*0.004*
Affection	0.92	[0.8;1.1]	*0.3*	0.95	[0.8;1.2]	*0.7*
Aspirations	0.98	[0.9;1.1]	*0.7*	**M:** 1.26 **F:** 0.76	[1.1;2.0] [0.6;1.0]	*0.02* *0.07*
Coercive discipline	1.10	[1.0;1.3]	*0.2*	0.94	[0.8;1.2]	*0.6*
Corporal punishment	1.27	[0.6;2.7]	*0.5*	1.40	[0.5;4.3]	*0.6*

All odds ratios are adjusted for G0 and G1 social class and G1 education.
M=Males; F=Females.

Table 11.4 Odds ratios and 95% confidence intervals for the likelihood of different parenting practices being used by G1 parents in the **fallers** group.

	Odds compared with reference group. *n*=676			Odds compared with high-high group. *n*=263		
G1 Parenting practice	OR	[95 %CI]	*p*-value	OR	[95% CI]	*p*-value
Cognitive stimulation	0.92	[0.7;1.2]	*0.5*	0.89	[0.6;1.3]	*0.5*
Intellectual environment	0.99	[0.9;1.2]	*0.9*	0.65	[0.5;0.8]	*<0.001*
Affection	1.01	[0.9;1.2]	*0.9*	0.94	[0.7;1.2]	*0.6*
Aspirations	1.04	[0.9;1.2]	*0.5*	0.94	[0.8;1.1]	*0.5*
Coercive discipline	0.86	[0.7;1.0]	*0.1*	0.98	[0.7;1.3]	*0.9*
Corporal punishment	0.58	[0.3;1.0]	*0.06*	0.92	[0.4;1.9]	*0.8*

All odds ratios are adjusted for G0 and G1 social class and G1 education.

Table 11.5 Odds ratios and 95% confidence intervals for the likelihood of different parenting practices being used by G1 parents in the low-low and high-high groups.

G1 Parenting practice	**Low-low** Odds compared with reference group. *n*=632			**High-high** Odds compared with reference group. *n*=639		
	OR	[95% CI]	*p*-value	OR	[95% CI]	*p*-value
Cognitive stimulation	0.68	[0.5;0.9]	*0.01*	1.09	[0.8;1.5]	*0.6*
Intellectual environment	0.77	[0.6;0.9]	*0.007*	**M:** 1.01	[0.7;1.2]	*0.02*
				F: 1.35	[1.1;1.7]	*0.005*
Affection	0.96	[0.8;1.2]	*0.7*	1.05	[0.9;1.3]	*0.7*
Aspirations	1.00	[0.9;1.1]	*0.9*	1.12	[1.0;1.2]	*0.1*
Coercive discipline	1.16	[1.0;1.4]	*0.1*	0.82	[0.6;1.0]	*0.1*
Corporal punishment	0.86	[0.4;2.1]	*0.7*	0.53	[0.3;1.0]	*0.06*

All odds ratios are adjusted for G0 and G1 social class and G1 education.

11.5 Discussion

11.5.1 Main findings

The intellectual environment in which offspring were raised was identified as an important factor contributing to both continuities and discontinuities in cognitive ability across the whole range of transition groups. Although replication of high and low cognitive scores across generations was associated with a correspondingly high and low quality intellectual environment, of specific interest were the parenting practices associated with intergenerational discontinuities towards lower or higher cognitive ability in the second generation. The quality of the intellectual environment was identified as a distinguishing factor between parent-offspring pairs who persisted in the lowest ability group (i.e. the low-low group) and those where the second generation children achieved improved cognitive outcomes relative to their parents (i.e. escapers). Conversely, a lower quality intellectual environment was identified as a potential risk factor for poorer cognitive outcomes in offspring born to parents with high cognitive ability (i.e. fallers).

The transition quartiles between generations identified a unique role for cognitive stimulation and parental aspirations at the lower range of parental cognitive ability scores. Continuities in low ability scores between parents and offspring were associated with less stimulation compared with the reference group while low-scoring parents whose offspring achieved higher scores than themselves (i.e. escapers) engaged in more cognitively-stimulating tasks with their children compared with those parents whose offspring replicated their poor cognitive outcomes. Aspirations for the future educational and occupational success of their offspring were likewise associated with offspring escape from the low ability quartiles of their parents. This effect was only found in fathers.

11.5.2 Explanation of findings

These findings indicate that parents with the lowest ability scores who nevertheless provide an environment conducive to learning by promoting a reading culture in the home and encouraging visits to the public library might well be ensuring that the cognitive outcomes of their offspring, and conceivably their educational and occupational futures, exceed their own achievements. In contrast, the behaviours of high-scoring parents who fail to provide an intellectual environment may detrimentally affect the cognitive development of their children and this may influence future outcomes, including the chance and direction of social mobility and educational success.

There were some important findings for the at-risk group – that is, the children born to low-scoring parents. Teaching children basic cognitive skills, such as colours or the alphabet, before starting full-time education appeared to offer some protection for offspring against replicating the poor childhood cognitive ability of their parents. The fact that cognitive stimulation was not associated with cognitive development in high-achieving families does not imply that cognitively-stimulating activities between high-scoring parents and their offspring are not important, but rather that cognitive gains seen in children of low-scoring parents might possibly be facilitated in other ways by high-scoring parents as a result of a more advantageous social status and educational achievement. For example, children born into a non-manual social class background whose parents completed degree courses might benefit from an environment rich in learning materials, intellectual outings and activities that are made possible through the family's financial security. This is a factor closely linked to educational attainment (Chevalier & Lanot, 2002). These benefits may be limited or absent in the homes of offspring with low-scoring parents with fewer years of education who were more likely to hold manual positions.

The aspirations of the fathers for the advancement of their children also played an important part in improved cognitive ability between generations. It may be that paternal aspirations are positively associated with their own ambitions to succeed, which becomes self-fulfilling in terms of improved job prospects and an associated increase in income through which more intellectual stimulation and better educational opportunities for their offspring are made possible. That this effect was only evident in fathers may be due to the importance of their roles in determining the social status of their families through their occupations. It is interesting to observe that the effect of the intellectual environment provided by G1 mothers in parent-offspring pairs who persistently achieved high scores (i.e. the high-high group) appeared to be more important than that provided by G1 fathers. This gender-specific effect may be a consequence of the particular parenting behaviours employed to define the measure of an intellectual environment. It is likely that in this cohort of parents born in 1946 the mothers provided most of the daily care for children while the fathers were at work. Visits to the library might therefore have been largely encouraged and initiated by the mothers.

11.5.3 Comparison with other studies

No previous studies have specifically examined the role of parenting practices in intergenerational discontinuities in cognitive ability. There is, however, a body of research that has focused on the benefits of parenting programmes for low-income families (Tamis-LeMonde, *et al*., 2004) and comparisons could be made between these studies and the escapers group. Most notably, many of the intervention studies, discussed in section 2.2, selectively include those children judged at risk of poorer cognitive outcomes owing to their disadvantaged family backgrounds. These studies support the current findings that cognitive stimulation and the provision of intellectually-stimulating tasks are associated with improved cognitive outcomes in early childhood.

11.5.4 Limitations

The quartile-based definitions for the transition groups are somewhat arbitrary and may have created artificial cut-offs in the continuous data. For example, movement across one quartile resulted in a few parents and offspring being categorised in different transition groups when in absolute terms the difference in their cognitive ability scores was very small. This might explain why few differences in parenting practices were found in groups representing intergenerational discontinuities in cognitive ability when comparisons were made with the mid-range or reference group. Nevertheless, these groupings are widely used and understood in policy research to differentiate high-risk groups within a population (Feinstein & Bynner, 2004).

11.5.5 Strengths

While confirming the importance of parental aspirations and intellectual stimulation in cognitive development shown in this (chapter nine) and other studies (Olson & Kaskie, 1992; Tamis-LeMonde, *et al*., 2004), these analyses go a step further. They identify a unique role for cognitive stimulation and the aspirations of fathers in improving the cognitive outcomes of children born to parents who achieved below average in childhood ability tests.

11.5.6 Conclusions

These analyses identified specific parenting behaviours that may benefit children at risk of repeating the poor cognitive scores of their parents. One of the differences between children of parents in the lowest ability group who improved their cognitive scores compared with those children who remained in the low-performing quartile of their parents, was the quality of the intellectual environment in which they were raised. Cognitive stimulation in children considered at risk owing to the low childhood cognitive ability of their parents, as well as the aspirations of fathers for the educational and occupational success of their children, were also shown to provide protection against replication of poor cognitive outcomes in the succeeding generation. At the other end of the spectrum, parents with high ability scores who failed to provide a sufficiently good intellectual environment for their offspring, appeared to diminish the chances of good cognitive outcomes for them. Discontinuities towards reduced cognitive outcomes might place offspring at risk of reduced educational and occupational achievement, while improvement in ability across generations may be advantageous in the breaking of intergenerational cycles of disadvantage.

12. General discussion

12.1 Summary of main findings

This thesis has examined the pathways mediating the association between parental and offspring cognitive ability by using data from two linked longitudinal studies that enabled adjustment for a wide range of confounding factors. Childhood cognition was the focus, given its importance as a precursor for later educational and occupational achievements.

A range of parenting practices, including cognitive stimulation, the quality of the intellectual home environment, parental aspirations and coercive discipline, emerged as important mediators in the transmission of cognitive ability from one generation to the next. Parental education and occupational social class were identified as important factors along these intergenerational pathways. These effects were seen over and above the influence of a range of physical and mental health variables and offspring temperament.

Upward social mobility and stability in non-manual social classes by parents was shown to mediate a small part of parent-offspring IQ associations. These effects were, however, subsumed by the intergenerational influence of parenting behaviours on offspring cognitive development. Nevertheless, improvement in social standing and maintenance of a non-manual social class were important predictors of parenting practices and thus may indirectly effect intergenerational IQ associations through their influence on parenting practices.

This work also identified parenting practices that enabled some children to avoid the poor cognitive outcomes of their parents (cognitive stimulation), and others that were associated with offspring underachievement relative to the parental generation (low quality intellectual environment). There was some evidence to suggest that the provision of a high quality intellectual environment may not be beneficial for offspring IQ if parents lack aspirations for their children to succeed or use coercive discipline techniques.

These findings underscore the importance of cognitive ability, education and socioeconomic background in shaping parenting behaviours. They advance earlier findings by demonstrating that parenting plays a part in cross-generational continuities and discontinuities in cognitive ability.

12.2 Relevance of this thesis

Although this study builds on previous research on parental influences on children, it is unique for several reasons. First, it has examined associations between a range of factors across the life course of three generations and parenting behaviours. Second, and most important, it has identified mediators of the intergenerational association between parent and offspring cognitive ability. In particular, the influences of intergenerational social mobility and a range of parenting practices on cognitive outcomes of offspring were highlighted.

Parenting variables accounted for approximately 12% of the variance in offspring cognition, with effect estimates ranging from 0.2 for intellectual environment to 0.1 for cognitive stimulation, aspirations and coercive discipline. One question requiring consideration is that of how large the association should be between an aspect of parenting and child outcome, in this instance cognitive ability, for such a relationship to be considered meaningful. In the past, correlations of 0.2 to 0.3 between aspects of family function and the outcomes of children were dismissed as being inconsequential (Maccoby, 2000). However, when an effect estimate is translated into the number of children whose cognitive development may be influenced by parenting behaviours, the magnitude of these associations should not be considered trivial.

In assessing the findings, it is also important to place them in the historical and policy contexts in which they arise. Since the 1960s, when the offspring data were collected, a number of important social trends have changed the social and cultural contexts in which children develop. At that time, the constant presence of the mother as the child's primary care-giver fostered the implicit assumption that father-child relationships had little influence on child development. The findings of this, and other studies (Tamis-LeMonde, *et al.*, 2004), suggest otherwise. Furthermore, it is likely that the influence of fathering has become even more important in subsequent decades with increasing employment opportunities for women resulting in greater participation of fathers in domestic and child-rearing activities (Cabrera, *et al.*, 2000).

12.3 Implications of findings

The present findings have implications for cognitive outcomes across the life course of at least two generations. It is clear that education and SEP are important determinants of certain parenting behaviours found to play a role in the transmission of mental ability between generations. This may be because parents with a high socioeconomic status often have more success in preparing their young children for school because they typically have access to a wide range of resources to promote and support their development. They are able to provide their children with high-quality child care, books, and toys with which to encourage them in various learning activities at home. In addition, they may have easy access to information regarding their children's health, as well as social, emotional, and cognitive development. Well-educated parents may also seek out information to help them better prepare their offspring for school. In contrast, parents with low socioeconomic status and educational attainment often lack the financial, social, and educational supports to promote and support the development and school readiness of their children. Such parents are unable to transmit educationally-relevant preschool verbal and non-verbal skills that form the basis of later reading and writing skills, or to model reasoning and thinking skills, frequently using mathematical concepts. In lacking these basic language and numeracy skills, such children begin school and then recapitulate the poor cognitive outcomes of their parents, and the cycle of disadvantage repeats itself.

At least two potential interventions could be used to address the apparent ‘cycle of disadvantage’ that results from poor cognitive ability being transferred across generations. First, the results suggest that policies aimed at ensuring equal access to good quality education could perhaps offer a means of improving employment outcomes and encouraging upward social mobility between generations. This might benefit parenting behaviours, which in turn would possibly translate into cognitive benefits in the next generation. Second, interventions aimed at improving the quality of the intellectual home environment, with particular emphasis on the promotion of early reading habits, could be implemented to improve cognitive outcomes. However, accrued evidence suggests that while there is some indication that such parenting interventions may help the cognitive development of children, these programmes require much financial support and the benefits are short-lived (McKey *et al.*, 1985). It is also interesting to consider these points in light of the changes that have occurred in Britain in the 40 years since the offspring cohort were born. Children in the UK are now three-times more likely to live in one-parent households than in 1972. Furthermore, the number of full-time working mothers has doubled in this period (Office for National Statistics, 2007). A ‘Time Use Survey’ published by the Office for National Statistics (2006) found that parents who work full-time spend on average 24 minutes every day "caring for [their] own children." Thus, the way in which parents interact with their children has changed dramatically. A more far-reaching approach may therefore be to focus on the environment provided by the primary carer, with initiatives aimed at creating more opportunities for parents to work part-time work and high-quality childcare options more affordable to parents who work full-time.

12.4 Strengths and limitations

It is important to consider these findings in light of a number of limitations imposed by the data and study design. One such limitation was the disproportionate dropout rate of survey members with low cognitive ability scores (Wadsworth, *et al.*, 1992). Furthermore, these and previous analyses (Richards & Sacker, 2003) have shown that birth cohort members with missing cognitive outcomes were relatively disadvantaged in terms of paternal occupation, educational attainment and adult occupation and analyses may therefore under-represent those with low SEP. However, the use of maximum likelihood estimation in the path model analyses suggested that these missing data did not affect the results to any considerable extent.

In interpreting these findings it is important to note that the theoretical framework under investigation represented only a small part of a much broader set of influences – such as poverty and neighbourhood effects (Guo & Harris, 2000) – that might be associated with the intergenerational transfer of cognitive ability. The measures of parenting likewise did not represent all child-rearing behaviours that might be related to cognitive development. In particular, the discipline measures only included how parents employed harsh discipline so that the broad picture of parental methods of discipline, including proactive strategies, was not represented.

A further limitation of the theoretical model was that it assigned primary weight to a single transmission source between the G1 parent (i.e. the birth cohort member) and the second-generation offspring. The extent and particular patterns of assortive mating are unknown, but previous studies have reported the tendency of individuals to marry partners with similar educational qualifications and social backgrounds (Blackwell & Lichter, 2000; Schoen & Weinick, 1993), and it is therefore anticipated that the characteristics of the partner of birth cohort parents would not have been sufficiently different to affect results. In similar vein, children might be punished or stimulated by grandparents, siblings, estranged partners and others not included in the theoretical model, and accordingly this might have diminished the accuracy of the estimates.

In addition to the drawbacks of the parenting measures raised in section 9.6.4, one further limitation is that the reliability and validity of these measures have not been established. Although efforts were made to ensure that the data were collected accurately (through, for example, the training of research nurses) the reliability of the questionnaire was not formally assessed. Furthermore, no assessment was made of the validity of the parenting measures – that is, the degree to which they reflected or assessed the specific concept being measured. Thus interventions aimed at ensuring that parents regularly took their children to the public library in order to improve the intellectual environment of the home, might be misplaced until such findings have been replicated using validated measures. A further caveat of the measures used in the analyses is that the indices of SEP, which included education and occupational social class, may not fully reflect all potentially relevant aspects of social background, and residual confounding might therefore be present.

Finally, the study was unable to distinguish between the genetic and environmental effects of parental ability on offspring cognitive development. This was unavoidable, but a broad range of factors across the life course of three generations were nevertheless included in the analyses to show some of the paths through which environmental factors might work to influence intergenerational associations in cognitive ability. The prospective longitudinal design places variables in the appropriate time-ordered sequences, allowing the examination of developmental change, and the ability to draw stronger inferences about causal effects that would otherwise not be possible with a cross-sectional design.

12.5 Future work

As previously noted, similarity between generations is potentially due to both genetic and environmental factors (Plomin & Spinath, 2004), and therefore without genetic information a complete understanding of intergenerational processes is unlikely. A genetically-informed design, such as a longitudinal adoption study, is one possible solution to this problem. Numerous studies have shown that cognitive ability might reflect genetic as well as environmental effects (Neisser, *et al*., 1996; Plomin, 1995). Inclusion of heritable components in future studies would shed light on those genetic factors interacting with environmental influences and would thus assist in delineating the developmental pathways at the interface of interaction between the genotype and the environment.

Since both parents are rarely enrolled in the original sample of an intergenerational study, this may lead to an underestimation of intergenerational continuity because half of the life course information is missing. Solutions to this problem may be found in the future inclusion of spousal and extended family data, as well as the inclusion of all siblings, rather than that of a single child from each family.

One further consideration is that these findings should ideally be replicated in other studies in order to examine their generalisability across diverse samples, populations, contexts and historical periods. This should include validated measures of parenting practices collected from multiple informants as well as observational data of parent-child interactions so as to reduce some of those sources of bias previously discussed. Parenting measures that encompass a range of behaviours – such as high intellectual environment and high coercive disciplines – may advance the preliminary observations in this thesis that the benefits of positive parenting behaviours on offspring IQ may be negated by the presence of negative parenting behaviours.

Identification of the processes associated with parenting that lead to certain children repeating their parents' cognitive achievements, and others avoiding them, is also a matter for continuing investigation. This work identified unique parenting behaviours associated with improvement and deterioration in ability across generations, namely cognitive stimulation and the intellectual environment respectively. A fuller understanding of the mechanisms involved in these discontinuities might help focus any interventions aimed at breaking intergenerational cycles of poor cognitive outcomes.

12.6 Conclusions

In these analyses of intergenerational associations of cognitive ability, parenting practices were shown to represent an important gateway in the transmission cognitive skills from parents to offspring. The ability of parents to provide intellectually-stimulation environment and cognitive stimulation in the home as well as maintain appropriate levels of discipline, played a role in determining their children's ability to acquire cognitive skills. Although approximately 50% of the variation in human intelligence may be attributable to genetic factors, these findings illustrate that environmental factors, which account for the remaining 50% of the variation and are more easily modifiable than genetic factors, play an important part in the intergenerational association of cognitive ability.

13.References

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14. Appendices

Table 14.1 Correlations of a) individual cognitive ability tests scores for G1 parents and G2 offspring, b) mean cognitive ability z-scores for parents at ages 8, 11, 15 and 26, and c) intergenerational correlation between parent and offspring scores at age 8.

a) Correlations between individual ability scores

		Parents				Offspring		
		1.	**2.**	**3.**	**4.**	**1.**	**2.**	**3.**
Age 8	**1.** Reading	1.00				1.00		
	2. Sentence completion	0.86	1.00			0.84	1.00	
	3. Vocabulary	0.67	0.66	1.00		0.60	0.64	1.00
	4. Picture test	0.49	0.53	0.55	1.00	NA		
		1.	**2.**	**3.**	**4.**			
Age 11	**1**. Verbal & non-verbal	1.00						
	2. Arithmetic	0.76	1.00					
	3. Sentence completion	0.69	0.68	1.00				
	4. Vocabulary	0.66	0.63	0.74	1.00			
		1.	**2.**	**3.**				
Age 15	**1.** Verbal & non-verbal	1.00						
	2. Sentence completion	0.34	1.00					
	3. Mathematics	0.37	0.70	1.00				

b) Correlations between mean z-scores across the life course of parents

	1.	**2.**	**3.**	**4.**
1. Age 8	1.00			
2. Age 11	0.76	1.00		
3. Age 15	0.70	0.86	1.00	
4. Age 26	0.64	0.76	0.79	1.00

c) Intergenerational correlation between mean z-scores of parents and offspring at age 8

	Offspring Age 8
Parents Age 8	0.38

All correlations *p*>0.001.

Table 14.2 Mean cognitive ability scores at age 8 for G1 parents and G2 offspring by grandparental (G0) social class, and parental (G1) social class and education (n=1,690).

	G1 parents			G2 offspring		
	Mean cognitive ability *(n)*		*p*-value	Mean cognitive ability *(n)*		*p*-value
G0 Social class						
I & II	-0.39	379		-0.28	324	
IIINM	-0.17	551		-0.09	454	
IIIM	0.27	253	*<0.001*[a]	0.30	220	*<0.001*[a]
IV & V	0.41	348		0.36	316	
Manual	-0.24	930		-0.17	778	
Non-Manual	0.35	601	*<0.001*[b]	0.34	536	*<0.001*[b]
G1 Social class						
I & II	-0.48	238		-0.44	188	
IIINM	-0.33	567		-0.24	498	
IIIM	0.14	217	*<0.001*[a]	0.21	199	*<0.001*[a]
IV & V	0.47	490		0.44	455	
Manual	-0.38	805		-0.29	686	
Non-Manual	0.37	707	*<0.001*[b]	0.37	654	*<0.001*[b]
G1 Education						
No qualification	-0.57	604		-0.37	498	
Vocational	-0.39	60		-0.09	44	
Ordinary	0.20	398	*<0.001*[a]	0.10	359	*<0.001*[a]
Advanced	0.43	348		0.44	323	
Degree level	1.04	96		0.70	87	
Ordinary	-0.27	1,062		-0.17	901	
Advanced	0.56	444	*<0.001*[b]	0.50	410	*<0.001*[b]
Maternal age at childbirth						
≤ 19 years	-0.16	616		-0.21	647	
≥ 20 years	0.16	656	*<0.001*[b]	0.27	700	*<0.001*[b]

p-values are for [a] analysis of variance and [b] t-tests. Analyses exclude missing data.

Table 14.3 Models incorporating structural zeros. Standardised (β) beta coefficients representing the mean differences in G2 offspring cognitive ability z-score per unit increase in G1 parental cognitive ability z-scores. Unadjusted effects shown in model 1 are progressively adjusted for G1 intergenerational social mobility (model 2), G1 educational attainment by age 26 and maternal age at childbirth (model 3).

	Model 1 G2 Cognitive ability		**Model 2 + G1 Social mobility**		**Model 3 + Control variables**	
	β	*p*-value	β	*p*-value	β	*p*-value
OCCUPATIONAL MOBILITY						
***G1 Men* (*n*=269)**						
G1 Cognitive ability (age 8)	0.38	*<0.001*	0.28	*<0.001*	0.26	*<0.001*
G1 Social mobility category [a]						
Stable non-manual			0.15	*0.05*	0.11	*0.01*
Upward			0.18	*0.04*	0.12	*0.01*
Downward			0.07	*0.6*	0.04	*0.09*
G1 Education (age 26) [b]					0.02	*0.9*
Maternal age at childbirth [c]					0.14	*0.01*
LRT: Model 1 vs. Model 2			$\chi2$ =12.37	*0.005*		
***G1 Women* (*n*=350)**						
G1 Cognitive ability (age 8)	0.36	*<0.001*	0.31	*<0.001*	0.26	*<0.001*
G1 Social mobility category [a]						
Stable non-manual			0.13	*0.04*	0.09	*0.06*
Upward			0.03	*0.09*	0.04	*0.6*
Downward			0.05	*0.5*	0.06	*0.5*
G1 Education (age 26) [b]					0.18	*<0.001*
Maternal age at childbirth [c]					0.12	*0.003*
LRT: Model 1 vs. Model 2			$\chi2$ =10.12	*0.06*		
MARITAL MOBILITY (*n*=327)						
G1 Cognitive ability (age 8)	0.38	*<0.001*	0.31	*<0.001*	0.24	*<0.001*
G1 Social mobility category [a]						
Stable non-manual			0.21	*0.006*	0.13	*0.02*
Upward			0.13	*<0.001*	0.16	*0.02*
Downward			0.02	*0.7*	0.00	*0.9*
G1 Education (age 26) [b]					0.15	*0.01*
Maternal age at childbirth [c]					0.12	*0.01*
LRT: Model 1 vs. Model 2			$\chi2$ =31.87	*<0.001*		

[a] Reference category was those G1 parents who remained, or married into, the same manual occupational social class as their G0 fathers (stable manual).
[b] Mean difference in parents with advanced education compared with those with ordinary education.
[c] Mean difference in parents where the maternal age is ≤ 20 years compared with ≥ 19 years.
n's vary from table 8.6 due to exclusion of cells containing structural zeros.

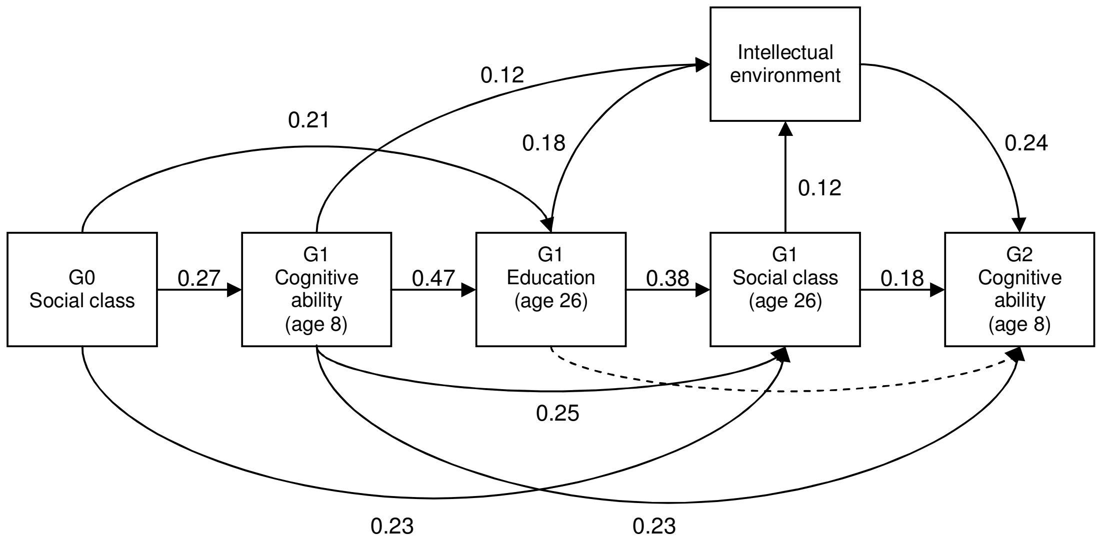

Figure 14.1 Incomplete data model. Path diagram representing intergenerational associations in cognitive ability between G1 parents and G2 offspring mediated by the intellectual environment provided by G1 fathers (*n*=410).

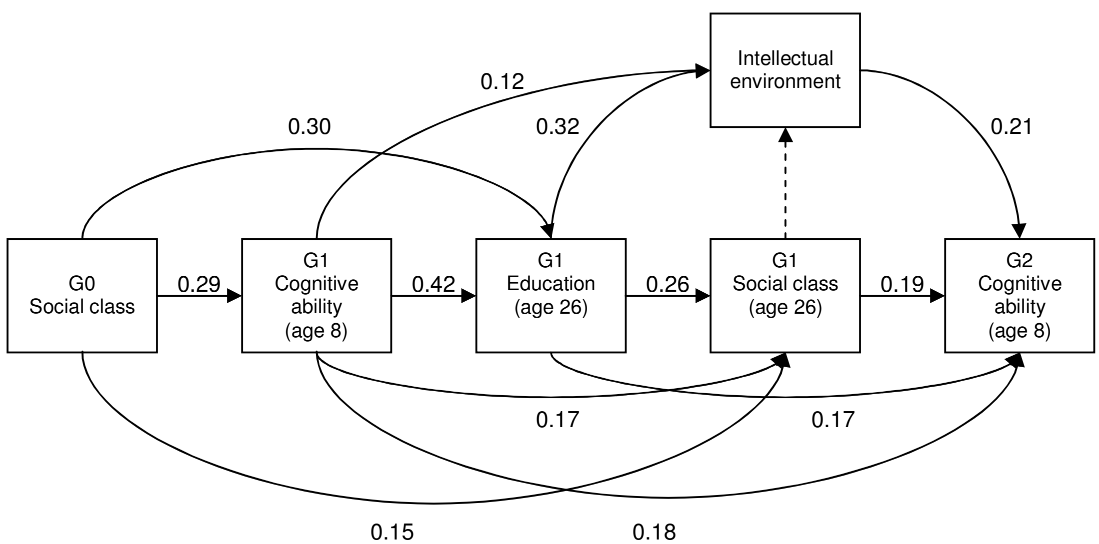

Figure 14.2 Incomplete data model. Path diagram representing intergenerational associations in cognitive ability between G1 parents and G2 offspring mediated by the intellectual environment provided by G1 mothers (*n*=494).

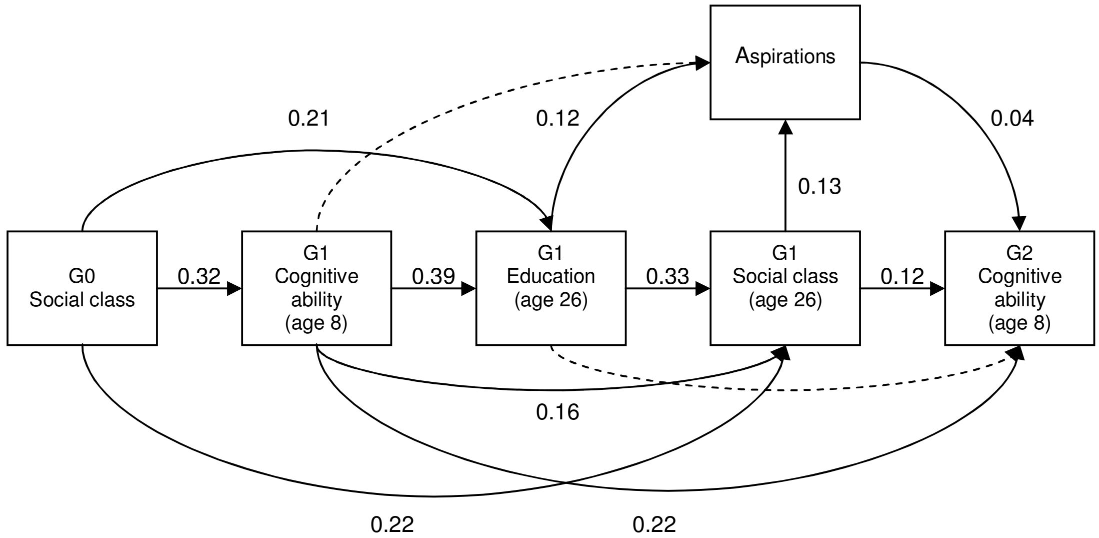

Figure 14.3 Incomplete data model. Path diagram representing intergenerational associations in cognitive ability between G1 parents and G2 offspring mediated by the aspirations of G1 fathers (*n*=410).

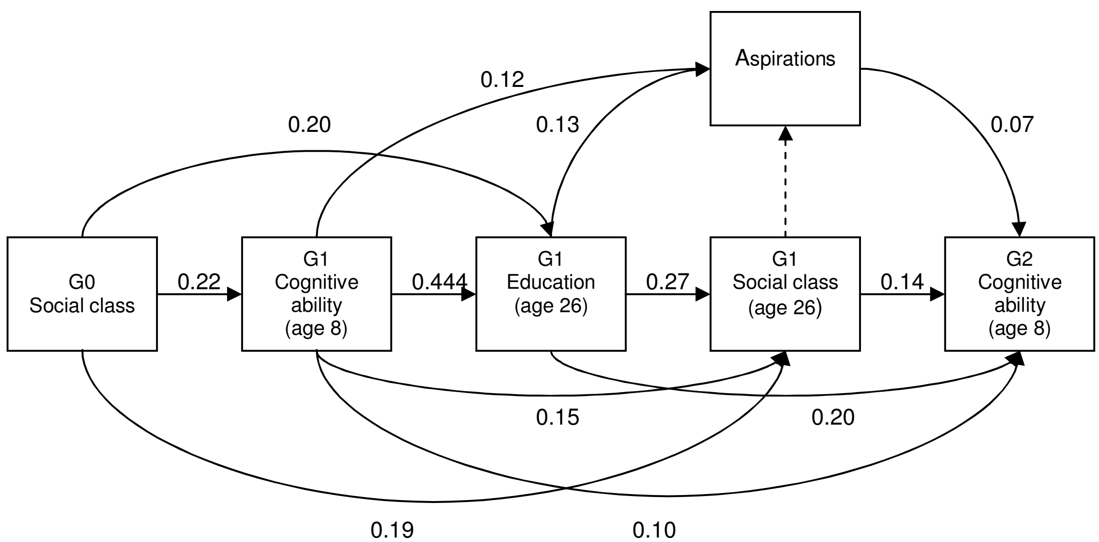

Figure 14.4 Incomplete data model. Path diagram representing intergenerational associations in cognitive ability between G1 parents and G2 offspring mediated by the aspirations of G1 mothers (*n*=494).

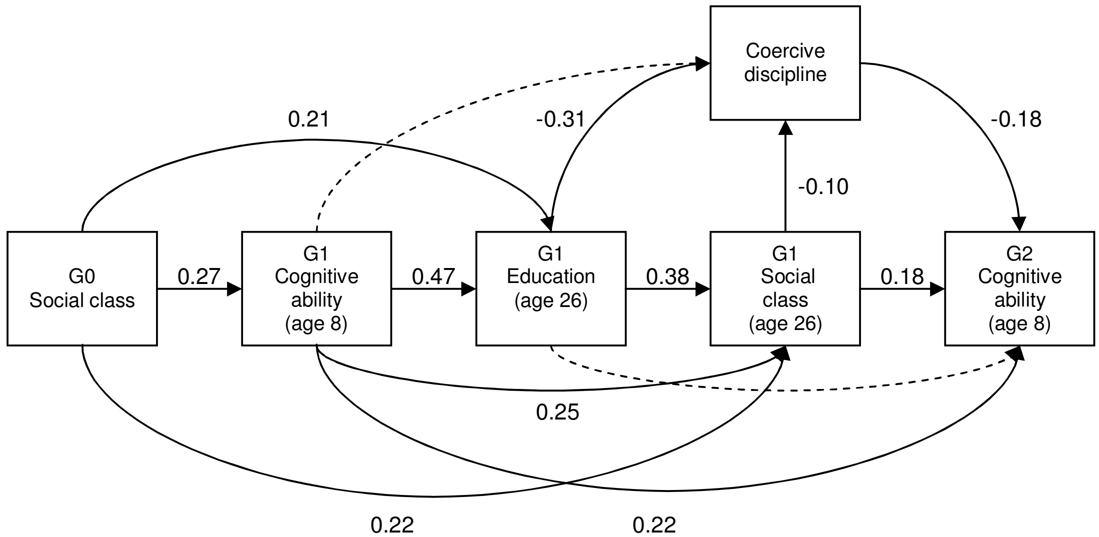

Figure 14.5 Incomplete data model. Path diagram representing intergenerational associations in cognitive ability between G1 parents and G2 offspring mediated by the use of coercive discipline by G1 fathers (*n*=410).

Table 14.4 Proportion of G1 parents in each transition group by social class and education, and mean standardised cognitive ability z-score (*n*=1,052).

		G1 Social class		G1 Education		G1 Cognitive ability		G2 Cognitive ability	
Transition group	***n***	**% Non- manual**	***(n)***	**% Advanced**	***(n)***	**Mean**	***(SE)***	**Mean**	***(SE)***
Low-low	106	17	*(18)*	4	*(4)*	-1.27	*(0.3)*	-1.30	*(0.5)*
Escapers	157	31	*(48)*	17	*(27)*	-1.12	*(0.3)*	0.25	*(0.7)*
High-high	113	86	*(97)*	71	*(80)*	1.39	*(0.5)*	1.42	*(0.4)*
Fallers	150	69	*(104)*	46	*(69)*	1.15	*(0.4)*	-0.12	*(0.6)*
Reference group	526	47	*(247)*	28	*(151)*	0.00	*(0.4)*	0.00	*(0.9)*
Total	1.052	49	*(514)*	31	*(331)*	0.00	*(0.4)*	0.04	*(0.9)*
p-value		0.000		0.000		0.006		0.000	

p-values represent χ^2 tests for SEP and education, and ANOVA for cognitive ability scores.
SE=standard error.