The impact of early interventions and pre-school experience on the cognitive development of young children in England

Christine Merrell and Peter Tymms

CEM Centre,
University of Durham,
U.K.

Contact Christine.Merrell@cem.dur.ac.uk
www.cemcentre.org

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Abstract

What benefits do different children derive from early intervention programmes and pre-school settings? In recent years, the UK Government has increased the provision of pre-school education and focused resources on early intervention programmes. The aim of this paper is to analyse the progress made in early language and mathematics by four successive cohorts of children in pre-school settings (nurseries) in England. This will be done in relation to home background, i.e. the level of neighbourhood deprivation, and we will reflect on the findings in relation to recent nationwide initiatives intended to reduce the impact of social deprivation. The paper will be useful to researchers and policy-makers in other countries with an interest in the effectiveness of early interventions.

Introduction

Pre-school has been shown to enrich the lives of young children in many ways, although not invariably (see for example Ramey and Ramey, 1999). This paper will focus on the cognitive development of young children during their time at pre-school. It will report trends over a four-year period, from 2000 to 2004, of the language and mathematics skills of children when they start pre-school. It will also investigate the progress made during a full academic year in pre-school and the extent to which this progress differs between settings, particularly in relation to neighbourhood deprivation.

In recent years, the English Government has increased the provision of pre-school education and focused resources on early intervention programmes. 'Sure Start' is an ongoing, widely implemented initiative supported by the Government that aims to 'achieve better outcomes for children, parents and communities' (Department for Education and Skills 2004, Sure Start 2004). Socio-economic status is related to academic achievement (Bordieu and Passeron, 1977) and so Sure Start is predominantly aimed at deprived neighbourhoods and includes a wide variety of local programmes. 524 local Sure Start programmes have been established, helping almost half a million children living in disadvantaged areas. Many of the Sure Start interventions are aimed at children from birth to 3 years of age. Another UK Government initiative is the establishment of 'Education Action Zones' (EAZs), which 'allow local partnerships to develop new and imaginative approaches to raising educational standards in disadvantaged urban and rural areas' (DfES 2004). EAZs usually run for three years with the possibility of extended funding for a further two years. So far there have been 73 large EAZs and 40 smaller ones. The first EAZs were set up in 1998, with a second set introduced in 1999. The EAZ programmes included interventions for pre-school and school children. If these recent programmes have enhanced the cognitive development of young children, there should be evidence of a reduction in the previously documented gap between children from affluent and deprived neighbourhoods.

Prior to the analysis in this paper, three large-scale studies have explored the relationship between children's cognitive development and their home background in England. Back in 1995, Tymms, Merrell and Henderson produced a report for the Audit Commission that investigated the impact of nursery and playgroup attendance on early reading and mathematics skills at the point of entry to full time school. It included 2678 children from 71 schools. The data were collected at a time before nursery provision was available for all children and 20% of the children did not attend either playgroup of nursery, which gave a control group. The report found that when children were assessed with the PIPS On-Entry Baseline Assessment (PIPS, 2004) at the start of reception, the early mathematics and reading skills of children who attended nursery were more advanced than children who attended playgroup and children who attended neither. The difference between the total baseline score for the children who attended nursery compared with those who did not was

an Effect Size of 0.34. There was a negative relationship between neighbourhood level of deprivation and baseline assessment score, which indicated that the more deprived the neighbourhood of the child, the lower their baseline score. The correlation at the child level was -0.28 and at the school level was -0.54. Multi-level analyses suggested variation in the impact of nursery provision.

Some years later, Merrell and Beevers (2002) found a school-level correlation of -0.34 between the overall language and mathematics scores of children starting nursery aged 3 and above, and the neighbourhood level of deprivation. The study was conducted in the 2001/2002 academic year and included 393 nurseries across England. The sample included children who attended nurseries within Education Action Zones or were included in Sure Start initiatives (Department for Education and Skills 2004, Sure Start 2004). Perhaps these early interventions were reducing the influence of home background. Alternatively, perhaps the difference between the results in this study and the earlier one by Tymms, Merrell and Henderson was due to comparing different assessments administered to different ages of children.

The Effective Provision of Pre-School Education (EPPE) project (Sammons et al. 2002, Sylva et al. 2003) is a large-scale longitudinal study that has investigated the effectiveness of different types of pre-school provision on different groups of children and endeavoured to identify particular pre-school characteristics that have positive long-term effects. Children were assessed on a wide range of cognitive tasks around the time of their third birthday or if they started pre-school provision when they were older they were assessed as soon as they started. They were re-assessed when they started school (reception year), and at the ends of reception, year 1 and year 2. Background information collected from parents by interview included parent education, occupation, employment history and the family structure. Multi-level analyses were used to analyse the EPPE project data and also found that pre-school experience, compared to none, enhanced children's development. The longer a child attended a pre-school setting, (the number of terms/months) the more advantageous it was, however they found no difference between full and part time attendance (despite experimental evidence to the contrary Liao, 1995). Pre-school did not eliminate the effects of social deprivation although disadvantaged children were found to 'benefit significantly from significantly from good quality pre-school experiences' (Sylva et al., 2003).

The data presented in this paper are recent, which gives the chance to reflect on the findings in relation to early interventions that are intended to reduce the impact of social deprivation.

Method

Sample

The pre-school settings in the sample were not selected on the basis of particular characteristics. They had all bought into the Assessment Profile On-Entry For Children And Toddlers (ASPECTS) project developed by the CEM Centre, University of Durham, to monitor the progress of their children (CEM Centre, 2003). ASPECTS includes measures of personal, social and emotional development, language and mathematics, and motor development. After each assessment, the pre-schools send their children's scores to the CEM Centre for further analysis. The CEM Centre provides feedback that shows the development and progress of their children against a large nationally representative sample. At the same time, this data collection system provides opportunities for research.

Approximately 700 pre-schools use ASPECTS each year. The sample analysed in this paper contains 177 English pre-schools that had used the assessment in each of the 2000/2001, 2001/2002, 2002/2003 and 2003/2004 academic years. All children started pre-school at the start of the academic year in September and left at the end of the academic year in July. The pre-school settings in the sample were either nursery classes in primary schools, state nursery schools or independent nurseries. There were no playgroups. The numbers of children and settings are given in Table 1.

Note: In the tables and analyses, each academic year is abbreviated to the end date. For example, the 2000/2001 academic year is abbreviated to 2001.

Table 1 Sample Size (Number of Children)

	Start of Year Assessment	End of Year Assessment
2001	5590	4573
2002	5030	3193
2003	4808	3183
2004	4744	2859

Variables Collected

ASPECTS includes a comprehensive assessment of language and mathematics, administered by pre-school staff when children start nursery and repeated just before they leave. It can be done at whatever time of year children start and leave pre-school, however for this paper, only pupils who completed a full, single academic year were included. It is recommended that the language and mathematics section be administered in the child's mother tongue at both the start and the end of the year. The assessment is administered on an individual basis taking approximately 10 minutes per child. There are two versions of

ASPECTS. The oldest is the Text version, in which an adult reads two stories to the child and asks questions about the story and the illustrations. More recently, a CD-ROM version of the same assessment has been developed. This contains the same items but a voice on the computer presents the questions rather than the teacher although the sound may be switched off and the teacher can use her voice if this is deemed more appropriate. In the analyses these versions are controlled for. The questions assess the following areas: Vocabulary, Concepts about Print, Repeats of Non-Words, Letter and Word Identification, Concepts about Mathematics, Counting, Number Identification, Shape Identification and Number Problems. Additionally, to assess the quality of their writing, children are asked to write their name, from memory (CEM Centre, 2003). The outcome used in the analyses in this paper is the total language and mathematics score, calculated by assigning one mark to each correct answer for all sections except the 'Repeats of Non-Words' in which children were assigned one mark for a partially correct response and two marks for a fully correct response. The test/re-test reliability of total language and mathematics score of the text version of ASPECTS is 0.82.

Other information collected included the pre-school postcode and each child's date of birth, gender, home postcode and whether or not English was an additional language. The pre-school postcode was used to obtain a measure of deprivation (Jarman Index[1]) for each child because the home postcode was missing from many children's records. The Jarman Index was chosen because it correlated most strongly with the ASPECTS language and mathematics score.

Representativeness Of The Sample

To look at whether or not the sample of pre-schools reported in this paper are representative of England as a whole, the mean and standard deviation of the Jarman deprivation data were compared. The Jarman index for all schools in England and the figures for the pre-schools in this paper are reported below:

	Minimum	Maximum	Mean	Standard Deviation
National	-5.41	26.42	0.735	3.81
Sample of pre-schools	-4.66	26.42	3.06	4.21

The higher the Jarman score, the more deprived the area. The mean and standard deviation of the sample of pre-schools analysed in this paper was biased towards the more deprived areas.

[1] Deprivation indexes, of which the Jarman Index is just one, (Jarman 1984) are composite scores of a range of variables that were related to the ward within the 1991 Census data. Some of the indexes weight the variables. The Jarman Index is a composite measure of unemployment, overcrowding, lone pensioners, single parents, residents born in the New Commonwealth, children under 5 years of age, low social class and one-year immigrants.

Results

Language and Mathematics Over Time

The distributions of scores at the start and end of nursery for each academic year are plotted in Figures 1 (Start of Year) and 2 (End of Year). The maximum total language and mathematics score achievable on the ASPECTS assessment was 85 marks.

Figure 1 Language and Mathematics Mean Scores: Start of Year

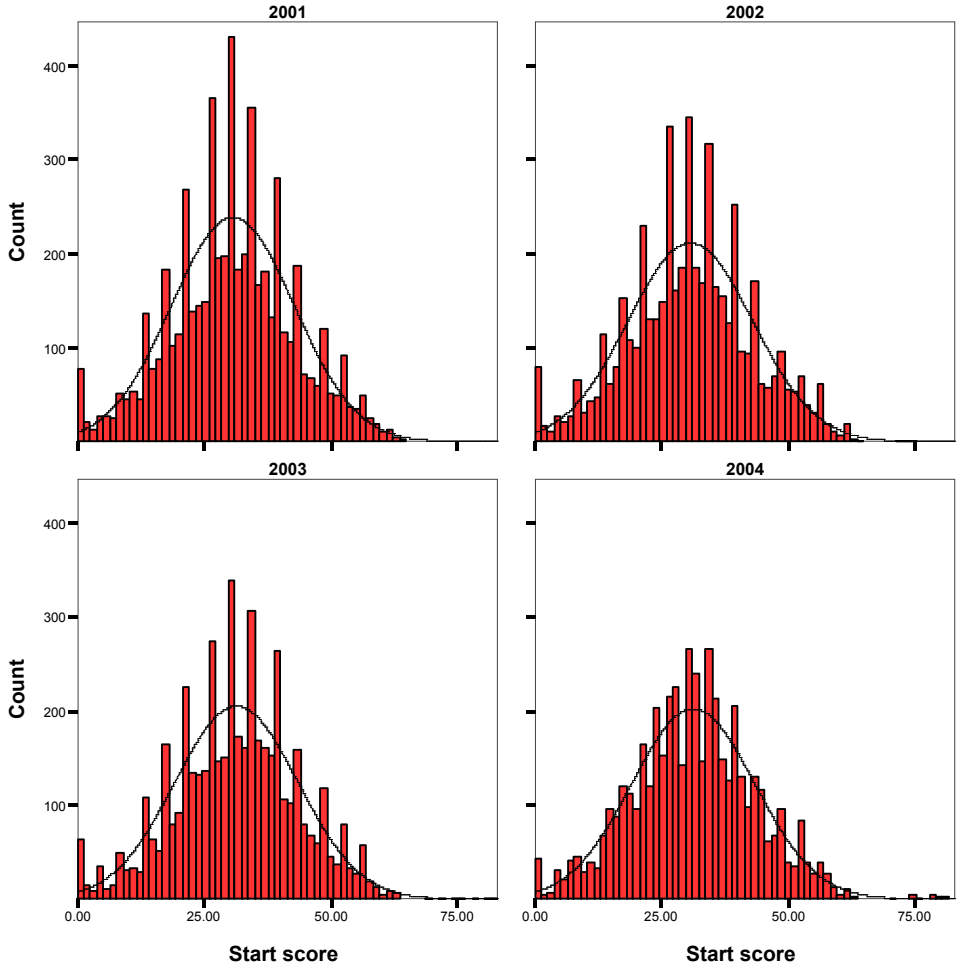
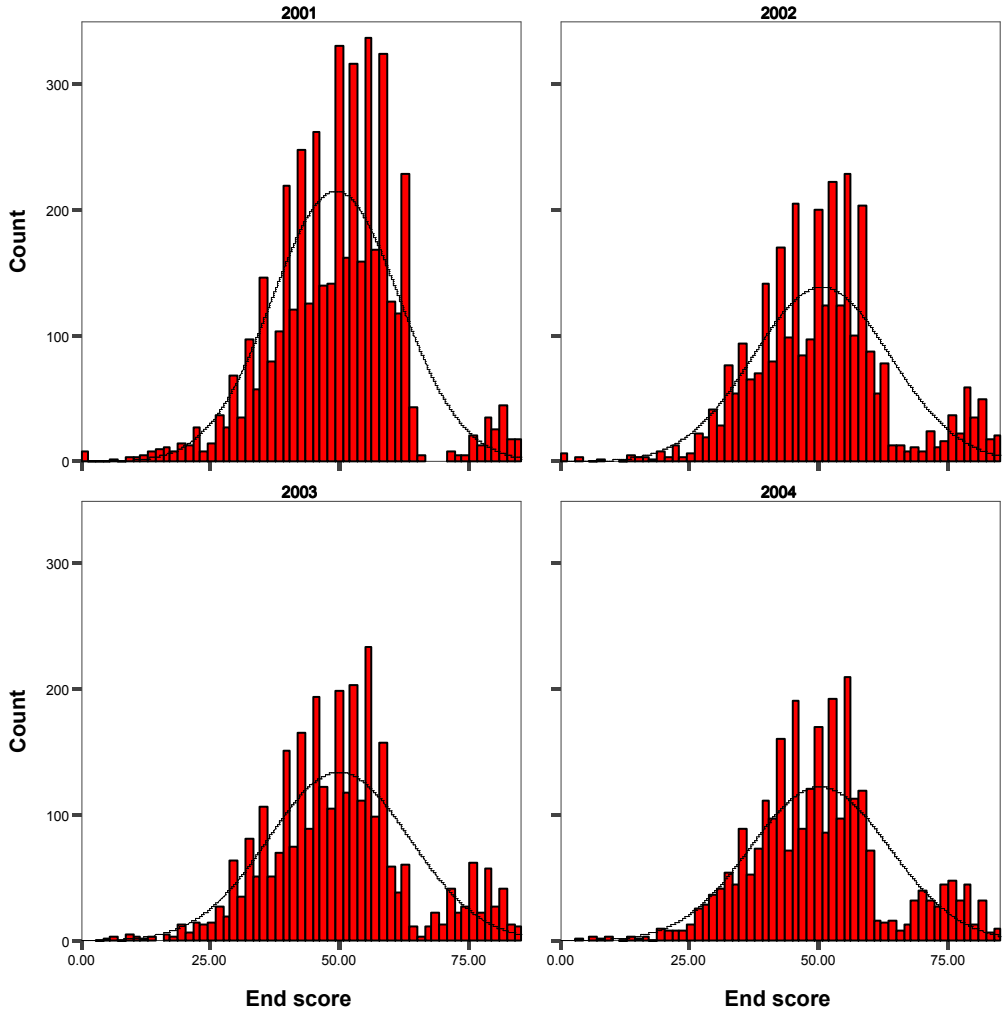


Figure 2 Language and Mathematics Mean Scores: End of Year



The mean language and mathematics scores and standard deviations are reported in Table 2.

Table 2 Language and Mathematics: Mean Scores and Standard Deviations

	Language and Mathematics Start of Year		Language and Mathematics End of Year	
	Mean	SD	Mean	SD
2001	30.659	12.137	49.137	12.203
2002	30.688	12.316	50.405	13.217
2003	31.377	12.138	49.757	13.626
2004	31.251	12.145	50.060	13.392

Although the mean scores look stable over the years, there is a small but statistically significant increase ($p \leq 0.01$) over time with both the start and end of year scores. However, the increase in language and mathematics at the start of the year between 2001 and 2004 is an Effect Size of 0.05, which is extremely small - a mean improvement of 0.59 marks on a scale of 81 marks and an Effect Size of 0.07 at the end of the year.

Language and Mathematics in Relation to Deprivation Level

The correlations between language and mathematics at the start of the year and neighbourhood deprivation level are shown in Table 3. There are two levels: child level and pre-school level.

Table 3 Correlations Between Language and Mathematics at Start of Year and Neighbourhood Deprivation (Jarman Index)

	Child Level Correlation	Pre-school Level Correlation
2001	-0.22**	-0.44**
2002	-0.24**	-0.40**
2003	-0.23**	-0.39**
2004	-0.25**	-0.42**

** Correlation significant at 0.01 level

The 2004 pre-school correlation between language and mathematics, and neighbourhood deprivation was higher than that found in the study by Merrell and Beevers (2002) but lower than the correlation from the report for the Audit Commission (Tymms et al. 1995). There is no suggestion that the relationship between language and mathematics, and level of neighbourhood deprivation is becoming weaker with time. This suggests that government initiatives intended to decrease the disadvantage of children living in deprived areas and more widespread pre-school provision have not eliminated differences in language and mathematics scores.

Table 4 shows the correlations between language and mathematics at the end of the year and neighbourhood deprivation level. Once again there are two levels: child level and pre-school level.

Table 4 Correlations Between Language and Mathematics at Start of Year and Neighbourhood Deprivation (Jarman Index)

	Child Level Correlation	Pre-school Level Correlation
2001	-0.187**	-0.359**
2002	-0.264**	-0.303**
2003	-0.252**	-0.375**
2004	-0.186**	-0.407**

** Correlation significant at 0.01 level

The correlations, although still significant, are slightly lower at the end of the academic year indicating that pre-school experience is beginning to reduce some of the inequality associated with level of neighbourhood deprivation.

Looking at the effect of neighbourhood in more depth, the sample was split into thirds according to pre-school level deprivation level. Language and mathematics was plotted for each group separately at the start and end of the year and the results are displayed in Figures

3 and 4 respectively. Group 1 was the most deprived neighbourhoods and Group 3 the least deprived.

Figure 3 Mean language and mathematics at the start of the year by deprivation group

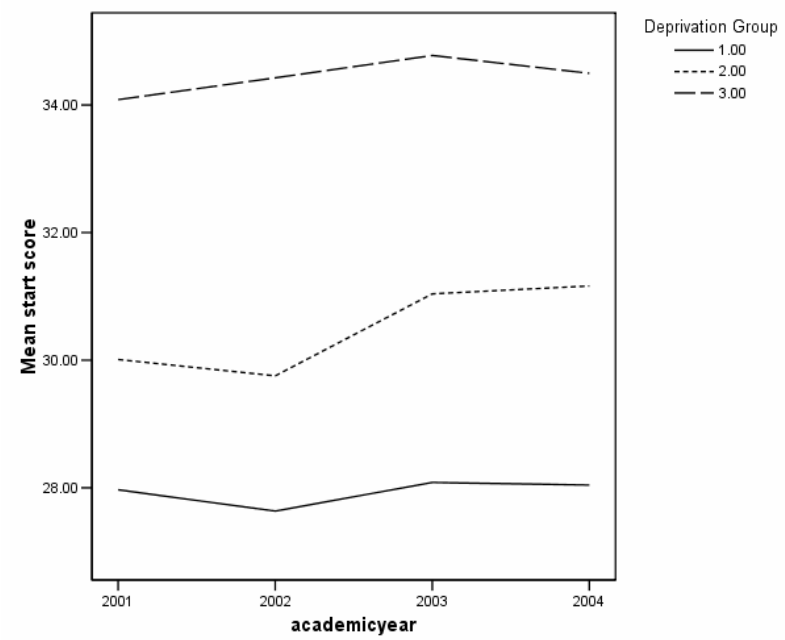
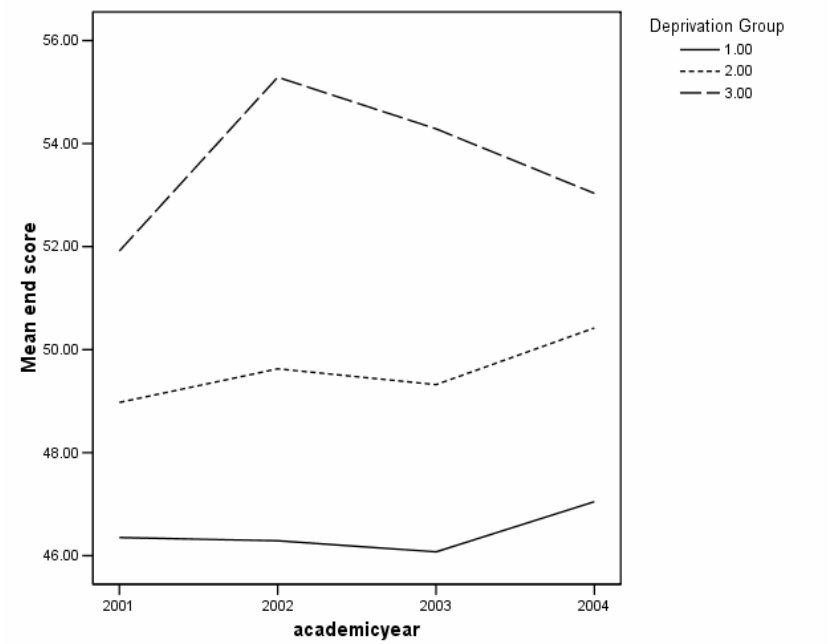


Figure 4 Mean language and mathematics at the end of the year by deprivation group



At the start of the year, there is no significant difference in language and mathematics scores over time for the highest and lowest deprivation groups. The increase in language and mathematics scores seen in the middle deprivation group at the start of the year was statistically significant ($p \leq 0.01$) but small in terms of effect size (0.10).

At the end of the year, the mean language and mathematics scores of deprivation group 2 has risen significantly ($p \leq 0.05$). However, in terms of effect size, again this increase was small (0.12).

It is interesting to see where the gains in language and mathematics are in terms of deprivation level. They are not in the most deprived group, which would have been expected if the government's initiatives aimed at deprived areas were having the desired impact.

Differences Between Pre-school Settings

Earlier studies have found that attendance at pre-school does have a positive impact on the language and mathematics scores of children and the correlations in the previous section suggest that children from more deprived neighbourhoods are benefiting slightly more than children from affluent neighbourhoods although the negative relationship between cognitive development and level of deprivation is still significant at the end of a full academic year. This next part of the results section uses multi-level analysis to explore in more detail the progress made by children in different settings in relation to their prior development and the level of neighbourhood deprivation.

The language and mathematics total score at the end of the year was used as the outcome measure. The controls were for ASPECTS version (CD or Text), language and mathematics at the start of the year, level of deprivation (pre-school postcode, not pupil), sex and age. The Language and mathematics scores and level of deprivation had been normalised. Results from each year are reported in Table 5.

Table 5 Multi-level analysis

	Null Model	Full Model
Fixed		
Cons	0.061(0.046) 0.041(0.051) -0.022(0.054) -0.008(0.054)	*-0.278(0.129)* *-0.043(0.163)* *-0.483(0.145)* *-0.359(0.156)*
Used CD version		0.000(0.000) 0.000(0.000) 0.000(0.000) 0.083(0.080)
Start language and mathematics normalised score		*0.695(0.011)* *0.735(0.015)* *0.761(0.013)* *0.797(0.014)*
Neighbourhood deprivation normalised score (Jarman Index)		-0.048(0.031) -0.059(0.036) -0.046(0.035) -0.050(0.037)
Sex		*0.119(0.018)* *0.088(0.023)* *0.100(0.021)* *0.138(0.022)*
Starting age (Years)		*0.071(0.034)* 0.020(0.044) ***0.136(0.039)*** 0.074(0.041)
Random		
Pre-school	*0.292(0.037)* *0.283(0.041)* *0.302(0.054)* *0.268(0.042)*	*0.151(0.019)* *0.172(0.025)* *0.151(0.022)* *0.142(0.022)*
Child	*0.734(0.016)* *0.754(0.019)* *0.748(0.019)* *0.788(0.021)*	*0.361(0.008)* *0.386(0.010)* *0.327(0.008)* *0.321(0.009)*
Variance Explained		
Pre-school		48% 39% 50% 47%
Child		51% 49% 56% 59%
Variance associated with Pre-school	28% 27% 29% 25%	29% 31% 32% 31%

Key: The table is arranged so that within each cell, the results for the years 2001-2004 are ordered from 2001 at the top to 2004 at the bottom. They are also colour coded – 2001 2002 2003 2004 Figures in *italics* are statistically significant.

The Null model looks at the mean and the variance of the outcome score. These are reported in the row for Cons (constant). The total variance has been partitioned between the pre-

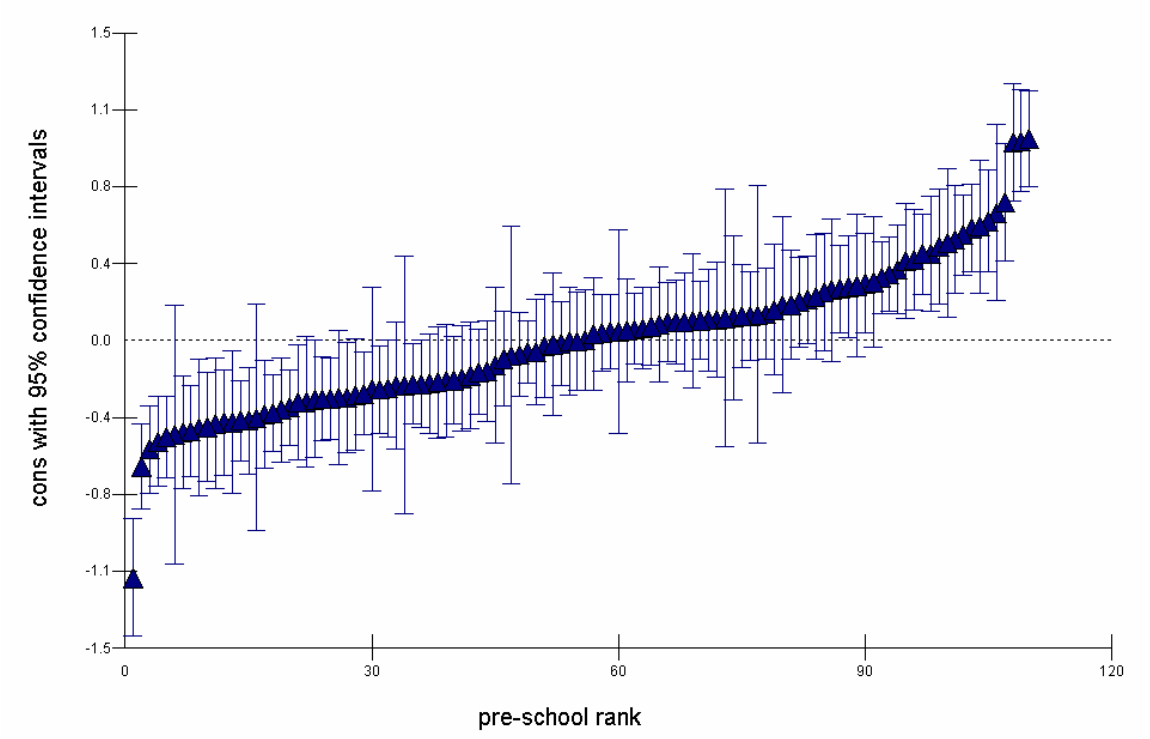
school settings and the individual children. Most of the variance was associated with the children and 25-29% with the pre-school setting. This range of 25-29% is an indication of the extent to which pre-school settings serve children from differing backgrounds and would be expected to be zero if the children had been randomly assigned to their pre-school setting.
For each cohort, the standard error indicated in brackets was small compared to the actual variance, and variation in the scores for the pre-school setting was statistically very significant.

The Full model includes more explanatory variables. The coefficients for these variables indicate their relative importance in model. Clearly language and mathematics at the start of pre-school is a much stronger indicator of language and mathematics at the end of the academic year than are the other variables. The standard errors for sex and in some years starting age indicate that these coefficients are statistically significant at least the 5% level. The coefficients for the neighbourhood deprivation variable were all negative, indicating that children in more deprived areas did not make as much progress in pre-school than children in more affluent areas although the coefficients were not statistically significant. The level of deprivation was calculated from the pre-school postcode and perhaps the children's home postcodes would have made a larger difference, however many of these were missing.

After including the explanatory variables into the Full model, the variance associated with the pre-school setting remained between 29 and 32%. The figure for secondary schools is usually between 9 and 15% and for primary schools rather higher.

There was no evidence that children from deprived backgrounds made significantly less progress than children from more affluent backgrounds. On the other hand the variation in progress from pre-school to pre-school was important and Figure 5 shows the residuals from the Full model for each setting together with 95% confidence intervals.

Figure 5 Residuals from multi-level model



Summary of Main Findings

- The data from this study showed statistically significant, negative correlations between the language and mathematics, and neighbourhood deprivation level of children at both the start and end of four successive academic years of pre-school experience. These results were similar to the findings of previous studies.
- The sample of four successive cohorts of children from a common set of pre-schools was one of the largest analysed to date. The findings make an important addition to those already published from other studies, particularly the recent EPPE project and reflect the impact of government initiatives aimed at improving the outcomes of children from more deprived backgrounds. The data indicated very little change over the years measured in response to government initiatives.
- Although the data suggest a gap between children from affluent and deprived backgrounds, it is nevertheless important to view the findings alongside previous studies that have shown attendance at pre-school to be more beneficial to non-attendance and to be aware that the relationship between language and mathematics, and neighbourhood deprivation, although statistically significant, is quite weak.

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