International early learning and child well-being study (IELS): national report for England

Research report

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Contents

List of figures

List of tables

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[1] The role of the National Advisory Committee was to provide independent advice, guidance and constructive feedback to DfE and NFER on the development and implementation of the study.

IELS outputs overview

Below are a list of the main reports produced for IELS.

Reports published by OECD

- [Early learning and child well-being:](#) A study of five year olds in England, Estonia and the United States (OECD, 2020a). This report looks at the findings as a whole and compares and contrasts the findings across the three countries.

- [Early learning and child well-being in England](#) (OECD, 2020b). This report focuses on the findings in England.

- [Early learning and child well-being in Estonia](#) (OECD, 2020c). This report focuses on the findings for IELS in Estonia

- [Early learning and child well-being in the United States](#) (OECD, 2020d). This report focuses on the findings for IELS in the United States.

Report published by Department for Education

- IELS national report for England (this report), which builds on the OECD country report for England by further contextualizing the findings for England by linking the IELS data with the national pupil database (NPD) and reporting on national questions and an additional measure of physical development.

Glossary

Early Years Foundation Stage profile (EYFSP) – summarises and describes children's attainment at the end of Reception Year. Children's level of development is assessed against the early learning goals (ELGs) and practitioners indicate whether children are meeting expected levels of development, exceeding them or not yet reaching expected levels.

Emergent literacy - IELS tablet-based measurement focused on 3 areas of language and literacy: listening comprehension, vocabulary knowledge, and phonological awareness.

Emergent numeracy - IELS tablet-measurement defined as the ability to recognise numbers and to undertake numerical operations and reasoning in mathematics. The measure focused on simple problem-solving and the application of concepts and reasoning in: numbers and counting, working with numbers, shape and space, measurement, and pattern.

Fine motor skills – the use of the smaller muscle of the hands, commonly in activities like using pencils and scissors.

Gross motor skills - the use of the large muscles of the body for walking, running, sitting, jumping and other activities.

Home learning environment - The combination of both the physical characteristics of the home and the quality of the implicit and explicit learning support children receive from parents[2].

IELS - International Early Learning and Child Well-being Study.

Inhibition - An IELS measurement within the self-regulation domain of a child's ability to inhibit an impulsive response in favour of an alternative response.

Low birthweight - IELS identified low birthweight as a being less than 2.5kg.

Mental flexibility - An IELS measurement within the self-regulation domain focused on a child's ability shift between rules according to changing circumstances or to apply different rules in different settings.

National Pupil Database (NPD) - a longitudinal database for all children in maintained schools in England. The NPD is compiled and controlled by the Department for

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[2] Throughout this report, the term 'parents' is used to refer to children's parents and carers.

Education (DfE) and contains data from a number of distinct datasets. The NPD includes data on pupil and school-level characteristics (such as age, gender, ethnicity, attendance, eligibility for free school meals) linked to data on national curriculum tests and public examinations results.

Persistence - The extent to which a child continues his/her planned course of action in spite of difficulty or obstacles.

Self-regulation - Characterised by a child's ability to think before acting, persist at an activity, follow directions, remain calm, and control their impulses. In IELS, the self-regulation domain focused on 3 distinct measurements: Inhibition, Working Memory and Mental Flexibility. These are primarily measures of children's cognitive function (sometimes called 'executive function'), rather than measures of behavioural self-regulation.

Social-emotional domain - A child's ability to begin forming positive relationships with others, to understand and develop behavioural expectations for both themselves and others, and to understand appropriate behaviour in different settings. IELS measured 5 aspects of children's social-emotional development, namely: emotion identification, emotion attribution; prosocial behaviour; trust; and non-disruptive behaviour.

Socio-economic status (SES) – in IELS, a SES index was derived from responses given in the parent questionnaire relating to parents' level of education, income and type of employment (OECD, 2020b).

Working memory - An IELS measurement within the self-regulation domain focused on a child's ability to store information and manipulate it to complete a given task.

Executive summary

Introduction

The International Early Learning and Child Well-being Study (IELS) is a new international study by the Organisation for Economic Co-operation and Development (OECD). It aims to further our understanding of children's abilities at age 5[3] and the influence of individual and family demographic characteristics, the home learning environment and early education experiences on their learning and development. IELS assessed children's emergent literacy, emergent numeracy, self-regulation and social-emotional development (including empathy and trust). In England only, children were also assessed on their physical development.

Children were assessed both directly through the use of tablet-based games and stories, and indirectly through questionnaires completed by parents and teachers. These questionnaires also collected contextual information on children's early learning experiences and individual and familial characteristics. Three OECD countries participated in IELS: England, Estonia and the United States. In England, the IELS fieldwork was conducted from October to December 2018, with a nationally representative sample of 2,577 children from 191 schools.

This report builds on the OECD publication Early learning and child well-being in England (OECD 2020b) by further contextualising the findings for England by linking the IELS data with the national pupil database (NPD). The NPD provides information on individual characteristics of children in IELS, including whether they have an identified special educational need (SEN), their ethnicity, English as an additional language (EAL) status and their eligibility for free school meals (FSM). This report also includes an additional national measure of physical development, created from a suite of 8 questions in the teacher survey covering both gross and fine motor skills. The report also looks at the results for IELS in relation to the home learning environment (HLE), with the inclusion of a question only asked in England on how often parents helped their child to learn to read words or sentences, and the early childhood education and care (ECEC) experiences of those involved. Finally this report includes analysis of the IELS measures in relation to children's persistence (to what extent the child continues his/her planned course of action in spite of difficulty or obstacles).

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[3] Note that although the majority of the children were aged 5, the sample also included some younger children who were aged 4 years 11 months and some older children who were aged 6 years 0 months at the time of assessment.

Where there were statistically significant age-related differences on IELS measures i.e. where children who were older at the time of the study showed greater development, this was used to calculate the average gain in points for each additional month of age. This estimate of months' difference was, in turn, used to calculate the approximate difference between the scores of two groups (for example girls and boys). In this way, the analysis has been used to indicate in relative terms how many months ahead, or behind, one group is compared to another.

Girls showed greater development than boys in emergent literacy, social-emotional measures and physical development

Girls were on average 9 months ahead of boys in physical development, 2 months ahead of boys in emergent literacy, 5 months ahead in emotion identification and 7 months ahead in emotion attribution. However, boys had greater development in inhibition, equating to 1 months' difference. There were no gender differences in emergent numeracy, mental flexibility and working memory. The lack of a gender difference in emergent numeracy was unexpected, given the higher performance of girls in mathematics in the Early Years Foundation Stage Profile (EYFSP) results (DfE, 2018b).

Children with SEN identified in the NPD had lower average scores in all measures, except trust

Overall, 12% of the children in the sample had a SEN identified in the NPD. The majority of these children had difficulties with communication and interaction. They showed markedly lower scores across all measures with the exception of trust, in which they showed higher levels when compared with children with no identified SEN. The greatest differences in outcomes for SEN were in physical development in which those with a SEN identified in the NPD were over 12 months behind their peers; emergent literacy in which they were approximately 12 months behind; mental flexibility in which they were approximately 11 months behind; and emotion identification in which they were 11 months behind.

Figure 1 Months' differerence across a range of IELS measures between children without an identified SEN and those with
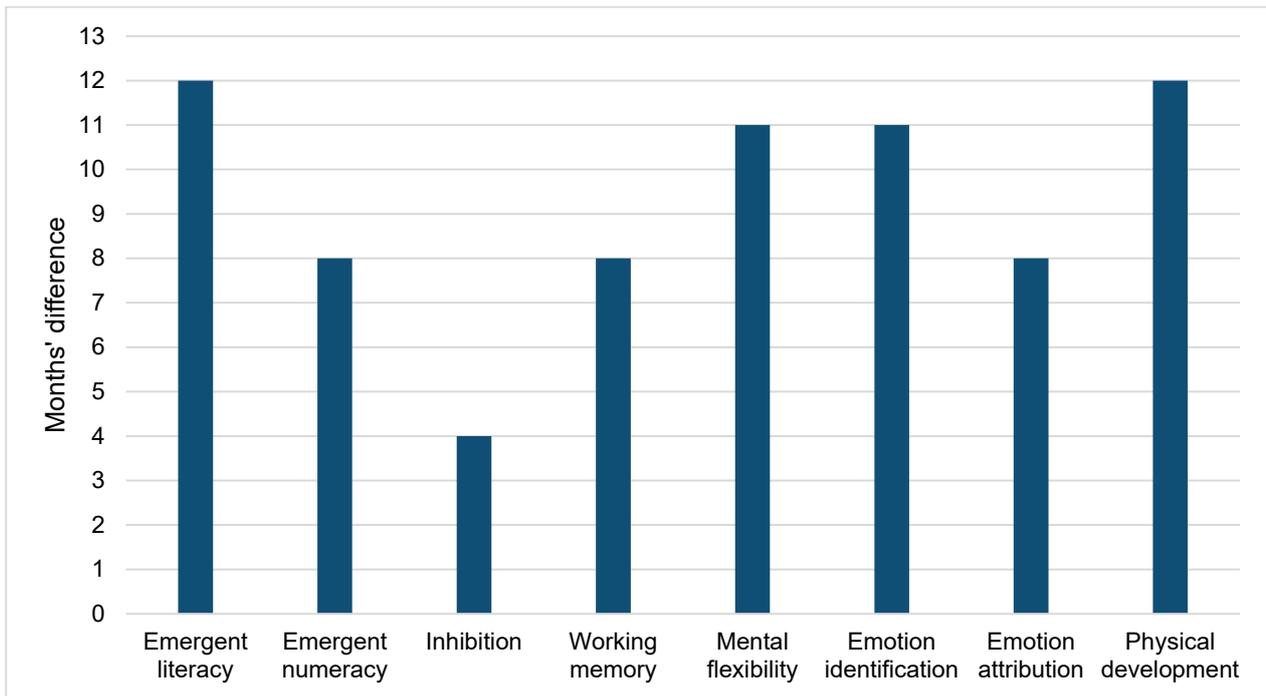
Source: IELS assessment of 2463 children (2192 for physical development) age 5, England, matched to the NPD

Children eligible for free school meals showed lower development than their peers in almost all measures

Overall 17% of children in the sample were eligible for FSM and there was a clear relationship between eligibility for FSM and lower development across measures covered by IELS. Inhibition was the only measure in which there was no statistically significant difference between children eligible for FSM and those who were not.

Figure 2 Months' difference on a range of IELS measures between those who are not eligible for FSM and those who are
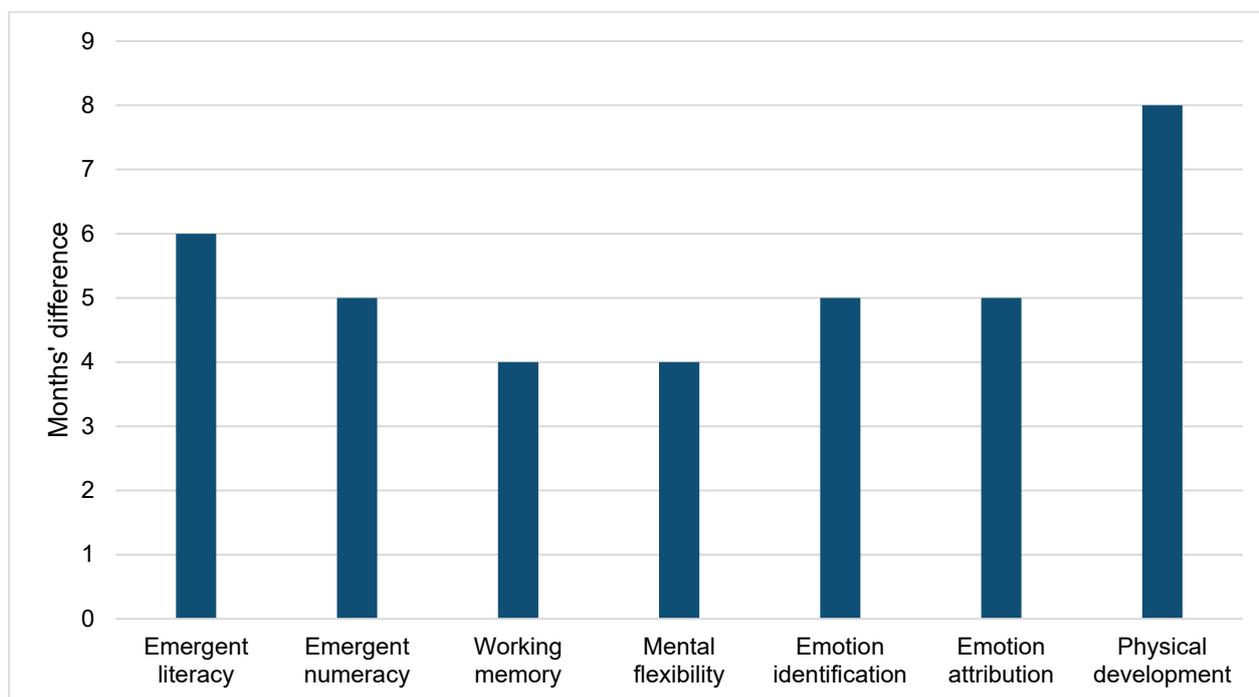
Source: IELS assessment of 2462 children (2191 for physical development) age 5, England, matched to the NPD

The differences in development by FSM were equivalent to approximately 8 months for physical development; 6 months for emergent literacy; 5 months for emergent numeracy, emotional identification and emotional attribution; and 4 months for both working memory and mental flexibility.

Children with English as an additional language were behind their peers in the cognitive measures but less so in other measures

Children with English as an additional language (EAL) made up 17% of the sample and showed lower development than their peers in cognitive, self-regulation and social-emotional development but not in physical development. The differences in cognitive development were equivalent to approximately 8 months for emergent literacy and approximately 3 months for emergent numeracy.

Within self-regulation, children with EAL showed lower development in mental flexibility and working memory (by the equivalent of approximately 3 months' difference on both

measures), however there was no difference in inhibition when compared to their peers. Children with EAL also showed lower development in 3 of the social-emotional measures (emotion attribution, prosocial behaviour and trust). The difference was equivalent to approximately 3 months in emotion attribution. There were no significant differences related to EAL status in non-disruptive behavior, emotion identification or physical development.

Low birthweight was associated with lower physical and cognitive development, but not social-emotional development

One of the interesting features of IELS was the ability to investigate the influence of low birthweight on children's development, as this information is not routinely collected by ECEC settings or schools. Children whose parents had reported them as having low birthweight (11% of the sample for whom information was available) had statistically significantly lower levels of emergent literacy, emergent numeracy, working memory and physical development compared to their peers. The largest development gap associated with low birthweight was found in physical development (equivalent to approximately 9 months). The other gaps were around 3 months (emergent literacy) and 4 months (emergent numeracy and working memory). Low birthweight was not significantly related to development in any of the social-emotional measures in IELS.

Older children showed greater development in cognitive, self-regulation and physical development

As would be expected, the oldest children (aged 6 years 0 months) showed greater development than the youngest children (aged 4 years 11 months) in emergent literacy and numeracy, all 3 self-regulation measures and in the measure of physical development. The picture was more complicated within the social-emotional measures. The oldest children in the sample had significantly greater development than the youngest in the direct measures of emotion identification and emotion attribution but there was no significant difference by age in the teacher-rated measures of trust, prosocial behaviour and non-disruptive behaviour.

Children's development in emergent literacy and emergent numeracy varied by ethnic group but other areas of development did not

There were statistically significant differences between children of different ethnic backgrounds in emergent literacy and emergent numeracy, though not in the other domains measured by IELS. Children from a White ethnic background showed greater

development in emergent literacy than children from Asian and Black ethnic backgrounds (approximately 7 and 5 months' difference, respectively), and greater development in emergent numeracy compared to children from Black ethnic backgrounds (equating to approximately 3 months' difference).

Children's development did not appear to vary by region

IELS investigated the relationship between outcome measures and region (North, Midlands, Greater London and South). There were no significant differences between regions for any of the outcome measures, with the exception of inhibition. For inhibition, children in Greater London showed statistically significantly greater development than children in the South of England, equivalent to approximately 3 months' difference.

At age 5, parents/carers reading to children, helping them read words and sentences, and having back-and-forth conversations is associated with greater development in a range of domains

IELS gathered information on children's home learning environment (HLE) through a set of questions in the parent questionnaire. The key findings, after controlling for socioeconomic status (SES), are summarised below.

Reading to children at least 5 days a week (accounting for 59% of those who responded) was associated with greater development in emergent literacy and all measures within the self-regulation and social-emotional domains, when compared to those who did this less than once a week (3% of those who responded). Furthermore, children whose parents helped them to read words and sentences[4] on 3 or more days a week (73% of the sample) had greater development in both emergent literacy, emergent numeracy, and the self-regulation measures than children whose parents did so less than once a week or never (6% of those who responded).

Having a larger number of children's books in the home, including library books, was related to greater levels of emergent literacy, emergent numeracy, social-emotional development, working memory, mental flexibility and physical development. In particular, when compared to the 9% of children with fewer than 10 books in the home, those with over 10 books (91% of the sample) had higher levels of development in emergent literacy, those with over 25 books in the home (79% of the sample) had higher levels of

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[4] This was a national question for England only and has not been adjusted for SES.

development in emergent numeracy, and those with other 100 books in the home (29% of the sample) had higher levels of physical development and mental flexibility.

Children whose parents had a back-and-forth conversation with them about their feelings most often (at least 5 days a week, 53% of the sample) had greater development in emergent literacy than children whose parents did so less than once a week (3% of the sample). Additionally those who had these conversations at least 3 days a week (81% of the sample) had greater development in emotion identification than children who did so less than once a week (3%).

Parental engagement with schooling was associated with greater development, particularly in social-emotional measures

Children whose teachers rated their parents as more engaged in their schooling (e.g. by attending parents' evenings and activities at the school, accounting for 69% of the sample) showed greater development in emergent literacy, emergent numeracy and all social-emotional measures than those whose parents were rated as slightly or not involved in their child's schooling (31%). This difference remained significant after controlling for SES.

Attending special or paid-for activities every week was associated with greater development across social-emotional and cognitive measures

Attending special or paid-for activities (such as sports clubs, dance, swimming or language lessons) regularly was associated with greater development in a number of measures, although it was not necessarily the case that those attending these activities most often showed greater development across the IELS measures. For example, a positive difference was seen for emotion identification, emotion attribution and prosocial behaviour when children attended such activities 1-2 times a week (accounting for 47%) compared to those who went less than once a week or never (35%), whereas for emergent literacy and emergent numeracy, the difference was seen when children attended such special activities 3 to 4 times a week (16%) compared to those who did this less than once a week or never. For physical development, children who attended special or paid-for activities between 1 and 4 times a week showed greater development than those who attended less than once a week or never. It is important to note that these differences were present even after controlling for SES.

The use of digital devices was associated with greater development in some areas

The study collected information on the frequency of use of digital devices by asking parents how often their child uses a desktop or laptop computer, tablet device or smartphone with the response options of 'never or hardly ever', 'at least once a month, but not every week', 'at least once a week, but not every day' and 'every day'. After accounting for SES, greater development in working memory was seen in those children using electronic devices most often (weekly, accounting for 46% of children or daily, 39%) compared to those who used such devices 1 to 3 times a month (9%) or never (6%). However, low use of digital devices (1 to 3 times a month, accounting for 9%) was associated with greater development in emergent literacy, compared to those who never used them (6%) or used them 1 to 6 times a week (accounting for 46%), both of which were associated with significantly lower development in emergent literacy. Using digital devices more than once a month but less than every week was also associated with the highest levels of trust, compared to those who used them at least once a week (46%) or every day (39%).

There were no significant differences in physical development between children who did educational activities on a computer, tablet or smartphone regularly and those who did not.

Greater physical development was not related to more frequent physical activities outside the house but was related to more frequent drawing and painting

Children who drew pictures or painted on 3 or 4 days a week (37% of the sample) showed significantly greater physical development than children who drew pictures or painted less than once a week or never (7% of the sample). The difference between these groups was equivalent to approximately 5 months. However, IELS found no significant differences in physical development between children who regularly did physical activities outside and those who did not. The reason for this is unclear and would warrant further investigation.

After accounting for socio-economic status, there were very few differences by ECEC type, intensity or age of attendance

The parent questionnaire collected extensive information on early childhood education and care (ECEC), including age of attendance, type of setting and intensity of attendance. The IELS study (OECD, 2020b) found few statistically significant differences by ECEC factors after adjusting for SES, which may reflect that the majority of children in

England attended ECEC (98% of children in the sample attended some form of ECEC with 71% of these children first attending before the age of 3 and 29% attending at age 3 or 4). This is also partly consistent with the Study of Early Education and Development (SEED, Melhuish and Gardiner, 2020), which found no association (across the whole study sample) between ECEC take up and EYFSP outcomes for literacy, numeracy and physical development. However, the SEED study found that for the 40% most disadvantaged children, starting to use a minimum of ten hours per week of formal ECEC no later than age two, combined with a mean use of over twenty hours per week of formal ECEC between age two and the start of school, increases the chances of achieving expected EYFSP levels in school reception year and improves children's verbal ability in school year one.

The few statistically significant findings for ECEC found in IELS are summarised below:

- Children who started ECEC earlier (those attending for more than 20 hours before the age of 1) showed greater development in emergent literacy and working memory and higher levels of trust than those who attended for less than 20 hours or did not attend at age 1. The association with higher levels of trust was statistically significant for girls but not for boys. This is partly consistent with findings from the SEED study (Melhuish and Gardiner, 2020) which found small effects on overall EYFSP scores and verbal ability in year one of school for the most disadvantaged 40% of children starting to use a minimum of ten hours per week of formal ECEC no later than age two, combined with a mean use of over twenty hours per week of formal ECEC. SEED also found a significant positive association between more hours per week of informal individual childcare between ages 2 and 5 and the verbal ability of 5-year-old children in England.

- On the other hand, attending ECEC later (children who first attended at age 3 or more) was associated with greater levels of non-disruptive behaviour compared with children who started ECEC before the age of 3. This finding is consistent with the SEED study (Melhuish and Gardiner, 2020) which found that using more formal childcare between age 2 and start of school was associated with social-emotional problems at age 5.

It should be noted that in the United States where a much larger proportion of children did not attend ECEC (20% of children) compared to England, IELS found these children had lower emergent literacy and emergent numeracy scores than those who had attended, even after controlling for SES (OECD, 2020d).

At the age of 5, children's development in one area of learning is related to their development in other areas of learning

IELS measures are, to differing extents, correlated with each other. The strongest relationships are highlighted below.

- Children's development in emergent literacy at age 5 was most strongly related to their development in emergent numeracy. Both emergent literacy and emergent numeracy were strongly correlated with the outcome measures of mental flexibility, working memory and emotion identification.

- Mental flexibility and working memory were strongly related.

- Emotion identification and emotion attribution were strongly correlated with each other; and prosocial behaviour was strongly correlated with trust and non-disruptive behaviour.

- Physical development was strongly correlated with prosocial behaviour and trust.

Persistence is associated with early development

Children's persistence was measured through a question on the teacher questionnaire. Teachers were asked to rate the child's ability to 'continue on his or her planned course or action in spite of difficulty or obstacles'. Just over one third (34%) of children were rated as having high levels of persistence ('often' or 'always' continuing their planned course of action), while 48% were rated as having medium levels ('sometimes') and 18% were rated as having low persistence ('rarely' or 'never' continuing their planned course of action).

Persistence was statistically significantly related to all of the 11 IELS outcome measures. It was correlated most strongly with prosocial development, trust and physical development, although the strength of these correlations were moderate. It was also moderately correlated with all other measures, with the exception of inhibition, emotion identification and emotion attribution, which had relatively weak correlations with persistence.

When comparing the differences between those rated as having high levels of persistence and those rated as having low levels of persistence, it was found that children's persistence was associated with statistically significantly greater development across all IELS measures. The differences were particularly pronounced for physical development, emergent literacy and mental flexibility. Where possible these differences have been converted into differences in months, which are summarised below:

- Children whose teachers rated them as 'often or always' persistent were over 12 months ahead of their peers rated as 'rarely or never' persistent in physical development.

- Children whose teachers rated them as 'often or always' persistent were approximately 11 months ahead of their peers rated as 'rarely or never' persistent in emergent literacy and 8 months ahead in emergent numeracy.

- Children whose teachers rated them as 'often or always' persistent were approximately 10 months ahead of those rated as 'rarely or never' persistent in mental flexibility, 7 months ahead in working memory and 3 months ahead in inhibition.

- Children whose teachers rated them as 'often or always' persistent were approximately 8 months ahead of their peers rated as 'rarely or never' persistent in emotion identification and approximately 6 months ahead in emotion attribution.

Children in England showed greater development in emergent numeracy than the other two counties but lower development in inhibition

The IELS international report (OECD, 2020a) found that children in England showed greater development in emergent numeracy than their counterparts in Estonia and the United States. Children in England showed similar development in emergent literacy to children in Estonia and greater development than children in the United States.

In 2 of the 3 areas of self-regulation measured in IELS (working memory and mental flexibility), children in England showed similar development to children in Estonia and greater development than children in the United States. However, for the third measure in self-regulation (inhibition), children in England showed significantly lower development than children in both the United States and Estonia.

Overall, children in England showed similar social-emotional development to children in the other 2 countries, although results differed across the 5 measures included in IELS (namely emotion identification, emotion attribution, pro-social behaviour, non-disruptive behaviour and trust).

Conclusion

The IELS study was successfully implemented in England for the first time in 2018 and provides findings for a nationally representative sample of 5-year-olds in England. Comparisons with the other participating countries suggest that, broadly speaking, children in England had similar development to children in Estonia and greater development than those in the United States. There were 2 statistically significant differences between results in England and both the other 2 countries: children in England showed greater development in emergent numeracy and lower development in inhibition.

The findings have identified a set of risk factors for lower development in children's family and individual characteristics which could potentially benefit from additional support, including deprivation, SEN, EAL and low birthweight.

IELS also adds to the existing evidence on the importance of the home learning environment, suggesting that there are many simple activities that parents can do (such as reading to their children every day, making sure they have access to children's books, having regular conversations with children about their feelings and being involved in their child's school) which are positively associated with children's early development. The findings related to children's ECEC participation are consistent with the importance of continuing to provide a spectrum of high quality ECEC experiences for all children.

IELS is an innovative study which successfully engaged children, their parents and teachers, achieving high response rates from participants (please see section 1.4 for details). The findings provide a robust and vivid picture of the development of 5-year-olds in England.

1   Introduction

1.1   What did the IELS study set out to achieve?

The International Early Learning and Child Well-being Study (IELS) is a new study by the Organisation for Economic Co-operation and Development (OECD) to understand children's abilities at age 5 and the influence of early education experiences, home environment and individual characteristics on their learning and development. The study focused both on learning and well-being as these are interrelated and mutually reinforcing. If children feel safe and happy, and are supported to learn about themselves and their environment, they thrive (OECD, 2020b).

Three countries participated: England, Estonia and the United States. This first round of IELS was an opportunity to develop and test the methodology of the study in a small number of countries. The Department for Education (DfE) commissioned the National Foundation for Educational Research (NFER) to conduct IELS in England.

The main aims of IELS were to:

- provide robust empirical data on children's early learning through a broad scope of domains that comprise cognitive and social-emotional development.
- identify factors that foster and hinder children's early learning, both at home and in early childhood education programmes.
- provide findings that will allow parents and caregivers to learn about interactions and learning activities that are most conducive to child development.
- inform early childhood education settings and schools about children's abilities at this age as well as contextual factors related to them that they could use to make more informed decisions about curriculums and pedagogical methods.
- provide researchers and educators in the field of early education with valid and comparable information on children's early learning, as well as contextual information about the influence of children's characteristics and contextual factors.

1.2   What did IELS measure?

IELS measured children's learning in 4 domains identified as key to later outcomes (Shuey and Kankaras, 2018): emergent literacy, emergent numeracy, self-regulation and social-emotional development. Emergent literacy and emergent numeracy were both single measures, while self-regulation and social-emotional development contained multiple measures. Within self-regulation there were 3 measures: inhibition, mental flexibility and working memory. Within social-emotional development there were 5 measures. These were emotion identification and emotion attribution (both measures of

aspects of empathy), prosocial behaviour, non-disruptive behaviour and trust. The IELS team in England also developed a measure of children's physical development, which was administered in England only. A description of these measures and their definitions are given within the corresponding domain chapters.

The study gathered contextual data on children's early learning experiences, including on children's family background (such as their parents'/carers' occupations and family income), their home learning environment (HLE) and participation in early childhood education and care (ECEC).

1.3 What methods did IELS use?

The data collection methodology used tablet-based activities for children and questionnaires for school staff and parents. The domains of emergent literacy, emergent numeracy, self-regulation and two of the measures within the social and emotional domain (emotion attribution and emotion identification) were measured directly through story- and game-based activities on tablets. Children completed these activities one-to-one with the support of a trained and experienced study administrator.

The school staff questionnaire was used to indirectly measure three of the social-emotional outcomes (prosocial behaviour, non-disruptive behaviour and trust) and physical development. Further information was also collected on all domains measured in IELS. The parent questionnaire collected further information on all domains measured in IELS. In addition it collected contextual information on the child's family background, ECEC use and the home learning environment. Figure 3 summarises the different measurements of IELS.

Figure 3 The different measurements of IELS

Direct assessment of children

Direct measures of emergent numeracy, emergent literacy, self-regulation, emotion identification and emotion attribution

Staff questionnaire

Indirect measures of trust, prosocial behaviour, non-disruptive behaviour and physical development.

Contextual information on the child and member of staff

Parent questionnaire:

Indirect measures of trust, prosocial behaviour, non-disruptive behaviour and physical development.

Contextual information on the child and family

Study administrators visited schools from October to early December 2018. They invited children to take part in the tablet-based activities which took place in 2 sessions split over 2 days. Each domain lasted around 20 minutes with a break between domains.

The study was designed to be appropriate for 5-year-old children. Tasks were based on stories and short activities. None of the tasks required children to read or write – instructions were given orally (delivered by a voice recording on the tablet) and children used a tablet to indicate their preferred response, which was automatically recorded by the IELS software programme.

1.4   Who took part?

The IELS sample was designed to be nationally representative of 5-year-olds in schools in England. The sample was stratified by school type (local authority maintained, academy or independent), deprivation (percentage of children in the school eligible for

free school meals) and geographical region (North, Midlands, Greater London and South).

The initial sample for England comprised 202 schools. The study in England achieved a high response rate, with a total of 191 of 202 schools taking part (95% participation rate). From these 191 schools, 2,577 children participated (92% participation rate), 613 staff completed questionnaires on 2,318 children (83% of all sampled staff and 90% of staff of children who participated) and 1,734 parents (62% of all sampled parents and 67% of parents of children who participated) completed questionnaires on their child. Table 1 shows the key participation rates for England.

Table 1 Participation rates

Participant	Total number sampled	Achieved sample	Participation rate (%)
Schools	202	191	95
Children	2,803*	2,577	92
Staff questionnaire on child	2,803	2,318	83
Parents	2,803	1,734	62

*Sample size of 2,803 was based on 191 participating schools.

Source: IELS main study

Further information on the sampling and participation rates can be found in Appendix 1.

The sample of children who took part was nationally representative of 5-year-olds in England. However, due to the lower response rate of parents, analysis of the parent sample revealed statistically significant differences between the parent sample and the main IELS children's sample in a number of areas. Most notable of these was eligibility for free school meals (FSM) whereby a smaller proportion of parents whose children were eligible for FSM responded compared with the sample as a whole. Therefore any results based on parent data that have not been adjusted for socioeconomic status (SES) may not be representative of the overall population because they are likely to under-represent children from low SES backgrounds. Further details of this bias analysis can be found in Appendix 2.

1.5   What is the focus of this report?

This report builds on the report produced by the OECD (2020b) by further contextualising the findings for England and including unique analysis of nationally specific questions. In order to do this the IELS data for England was linked to the national pupil database

(NPD). This provides a more comprehensive set of data on a wide range of pupil characteristics including ethnicity and special educational needs and disabilities (SEND) than was available through the IELS dataset alone. The NPD also provided contextual information about the children in the sample that were important within the England policy context, such as eligibility for FSM.

Additionally, this report also includes national questions (those only asked to participants in England) that were omitted from the reports produced by the OECD. These included a set of questions relating to physical development, a question on the child's persistence and a question for parents focusing on how often they helped their child to learn to read words or sentences.

Throughout this report, any differences reported between different groups of children have been tested for statistical significance, and therefore any differences reported are statistically significant at the $p < 0.05$ level (unless explicitly reported otherwise). To add further context to the findings in this report, where possible, differences between groups have been translated into differences in months of development. On IELS measures where there were significant differences by age of child, the difference was converted into a monthly difference value, which provides the number of points gained with each additional month of age. This was then used to calculate the approximate difference in months between the scores of two groups (for example girls and boys), to quantify, in relative terms, how far ahead or behind one group was of the other. More detail on this calculation can be found in Appendix 2. Please note the findings have not been age-standardised.

The report looks at each domain in turn, including the relationships between children's development and their individual/family characteristics. Chapter 2 looks at the cognitive domain (emergent literacy and emergent numeracy), before moving on the self-regulation in chapter 3, social-emotional development in chapter 4, and physical development in chapter 5. Chapter 6 focuses on the relationships across the different domains and persistence and finally chapter 7 provides a discussion and conclusion of the findings. Two appendices provide further information about the study administration, sample characteristics, outcome measures and analyses.

2 Emergent literacy and emergent numeracy

2.1 Chapter summary

- IELS measured children's emergent literacy (listening comprehension, vocabulary knowledge, and phonological awareness) and emergent numeracy (number recognition, numerical operations and mathematical reasoning) directly, using activities on tablets.

International findings

- Children in England showed greater development[5] in emergent literacy than children in the United States, and similar development to children in Estonia. Children in England showed greater development in emergent numeracy than their counterparts in both Estonia and the United States.

The relationship with individual characteristics

- Children with an identified Special Educational Need (SEN) were approximately 12 months behind their peers without SEN in emergent literacy and 8 months behind in emergent numeracy.

- Children whose parents identified them as having low birthweight had lower development in emergent literacy (approximately 3 months' difference) and emergent numeracy (approximately 4 months' difference) compared with children whose birthweight was above 2.5kg.

- Girls showed greater emergent literacy development than boys (equivalent to approximately 2 months' difference) but there was no significant gender difference for emergent numeracy, although on might have been expected, based on Early Years Foundation Stage Profile (EYFSP) results.

- The oldest children in the sample showed greater development than the youngest in both measures.

The relationship with family characteristics

- Children with English as an additional language (EAL) showed lower development in both measures compared to their peers without EAL by approximately 8 months for emergent literacy and 3 months for emergent numeracy.

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[5] By 'greater development' or 'lower development' the report is referring to statistically significant differences ($p = < 0.05$) in the mean scores on any given measure.

- Children who were eligible for free school meals (FSM) showed lower development in emergent literacy (by approximately 6 months) and emergent numeracy (by approximately 5 months) than children who were not eligible for FSM.

The relationship with the home learning environment

- Children whose parents helped them to read words or sentences on 3 or more days per week were ahead of those children whose parents did so less than once a week or never by approximately 8 months in emergent literacy and 7 months in emergent numeracy (though note that this analysis is not adjusted for SES).

- A number of other home learning environment factors were associated with greater development in both emergent literacy and emergent numeracy, after controlling for socioeconomic status (SES, OECD, 2020b). In particular, having more than 25 children's books at home, attending special or paid-for activities (such as sports clubs, dance, swimming or language lessons) 3 to 4 days a week and having parents who were more engaged with their children's schooling were associated with greater development in both measures. In addition, reading to children and having a back-and-forth conversation with them about the child's feelings 5 to 7 days per week were associated with greater development in emergent literacy, as was using an electronic device monthly (rather than more or less frequently). Engaging in numeracy activities with parents 5 to 7 days a week was associated with greater development in emergent numeracy.

2.2   What literacy and numeracy development would we expect of 5-year-olds?

IELS used tablet-delivered activities to measure children's emergent literacy and emergent numeracy. IELS assessed 3 areas of emergent literacy: listening comprehension, vocabulary knowledge, and phonological awareness (OECD, 2020b). The assessment of listening comprehension involved 2 main components: story-level oral comprehension and sentence-level oral comprehension. For story-level comprehension, children listened to a story and responded to a series of audio-recorded questions about the story. For sentence-level comprehension, children listened to a series of sentences and responded to a single question about their meaning. Each vocabulary question required children to identify from a range of very common everyday word options (Tier 1 words[6]) the synonym of a more complex (Tier 2) word. Phonological awareness was

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[6] Tier 1 words are common words used in everyday speech (such as 'table' or 'blue'), Tier 2 words are high-frequency words that occur across contexts and are more common in written than spoken language

assessed by asking children to identify the first, middle and final phonemes (sounds) of short words. Print knowledge was not assessed in IELS because some countries do not expect children to develop these abilities until they are older (typically around the age of 6 or 7). The IELS emergent literacy assessment focused on pre-reading literacy and language skills that are known to be predictive of later reading success (Shuey and Kankaras, 2018). This differs from the expectation of the early years foundation stage (EYFS) curriculum in England, which focuses on reading and writing as well as language development.

Emergent numeracy was defined in IELS as the ability to recognise numbers and to undertake numerical operations and reasoning in mathematics (see OECD, 2020b). The measure focused on simple problem-solving and the application of concepts and reasoning in: numbers and counting, working with numbers, shape and space, measurement, and pattern. As with literacy, the emergent numeracy assessment was delivered on a tablet and involved children engaging in game-like activities. The emergent numeracy assessment used a mixture of drag-and-drop technology, which asked children to move items around the screen, and hot-spot technology, which asked children to tap objects to indicate their preferred option when answering a question. The content of the IELS measure for emergent numeracy was consistent with areas covered in the EYFS curriculum in England.

The Early Years Foundation Stage profile (EYFSP) provides information on children's development at the end of the Reception year, when children are aged 4 to 5 years (DfE, 2018a), via teacher observation and assessment of children's abilities in relation to 17 early learning goals (ELGs), organised into 7 areas of learning. The literacy and numeracy domains included in IELS relate most strongly to the following areas of learning within the EYFSP: communication and language development (comprising 3 ELGs of listening and attention; understanding; and speaking) and mathematics (comprising 2 ELGs of numbers; and shape, space and measures). Communication and language development is one of 3 prime areas of learning[7] whereas mathematics is one of 4 specific areas of learning[8]. The EYFSP also contains an ELG for literacy (designed to capture children's development in reading and writing) but these specific areas were not included in IELS.

(such as 'compare' or 'coincidence'). Tier 3 words are low-frequency words used in domain-specific contexts (such as 'thesis' or 'ecosystem').

[7] The 3 prime areas of learning are: communication and language development; physical development; and personal, social-emotional development.

[8] The 4 specific areas of learning are: literacy; mathematics; understanding the world; and expressive arts, designing and making.

The 2018[9] EYFSP results (DfE, 2018b) show that nationally, 86% of children achieved at least the expected level in each of the 3 individual ELGs within the 'communication and language' area of learning. In mathematics, 80% of children achieved at least the expected level in numbers and 82% achieved at least the expected level in shape, space and measures. This suggests that children might be expected to perform slightly better in emergent literacy than emergent numeracy, as measured by IELS.

Children's early development in both literacy and numeracy is important for their later development. Strong development in literacy and numeracy before the age of 6 is associated with higher levels of academic attainment and better lifestyle and wellbeing outcomes in adulthood (Shuey and Kankaras, 2018).

Early literacy development at age 5 is a predictor of reading competence at age 10, which in turn is a predictor of the socio-economic status of an individual in adulthood (Shuey and Kankaras, 2018). In relation to the specific areas included in the IELS measure of emergent literacy, children's vocabulary by the age of 5 predicts their later phonological awareness, sentence complexity, story comprehension, early reading proficiency and fewer problem behaviours at school; and children's phonological awareness predicts their alphabet knowledge, ability to segment words, spelling and early reading proficiency (Graf and others, 2016).

Children's early numerical understanding is strongly associated with their later mathematical achievement as well as their adult income and socio-economic status (Asmussen and others, 2018). In relation to the specific areas included in the IELS measure of emergent numeracy, children's understanding of ordinality (counting, one-to-one correspondence and number identification) is associated with later proficiency in mathematics (including mathematical operations and problem-solving), proficiency in science and early reading skills (Graf and others, 2016).

There is also evidence that strong early development in literacy and numeracy is associated with better adult health outcomes (Schoon and others, 2015; Shuey and Kankaras, 2018). For example, a longitudinal study in England found that low literacy development at age 5 is associated with poor self-reported health outcomes and more unhealthy behaviours such as smoking in adulthood (Sabates and Parsons, 2012; Schoon and others, 2015).

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[9] We have reported the 2018 EYFSP results, as these results directly relate to those children in the IELS sample who were in the first term of Year 1 at the time of the study.

2.3   What does IELS tell us about young children's development in literacy and numeracy?

In IELS, international comparisons for emergent literacy found that England's 5-year-olds, on average, showed statistically significantly greater development than their peers in the United States and similar development to children in Estonia.

IELS found that England's 5-year-olds showed statistically significantly greater development in emergent numeracy than their counterparts in both Estonia and the United States.

Table 2 shows the means and standard deviations for the emergent literacy and emergent numeracy development of 5-year-olds in England. The metric for all learning outcome scales in IELS is the same. There is theoretically no minimum or maximum score in IELS. The results are scaled to have approximately normal distributions, with means around 500 and standard deviations around 100. The overall mean score of 500 points represents the standardised mean of all 3 participating countries[10]. Each participating country has contributed equally to the computation of the mean.

Table 2 Development in emergent literacy and emergent numeracy

Measure	Mean	Standard Deviation
Emergent literacy	515.44	97.50
Emergent numeracy	528.71	99.88

Source: IELS assessment of 2,577 children age 5, England

As shown in Table 2, England's mean scores for both emergent numeracy and emergent literacy were above the international standardised mean of 500.

2.4   How does children's early literacy and numeracy relate to their individual and family characteristics?

This section explores how the IELS findings related to children's individual and family characteristics, and how this is supported, or not, by previous research.

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[10] A one-point difference on the IELS scale corresponds to an effect size of 1% and a 10-point difference to an effect size of 10%.

The relationship between early literacy and numeracy and gender

By the age of 5, girls out-perform boys on measures of early literacy and numeracy. The 2018 EYFSP results (DfE, 2018b) show a clear gender gap in communication and language development of around 10 percentage points across the 3 early learning goals: for example in listening and attention, 82% of boys and 91% of girls achieved at least the expected level. The gender gap in mathematics was around 7 percentage points: for example in numbers, 76% of boys and 83% of girls achieved at least the expected level.

The IELS sample was almost equally divided by gender, with the sample comprising 49% girls and 51% boys. Table 3 shows the emergent literacy and emergent numeracy development of girls and boys participating in IELS.

Table 3 Relationship between emergent literacy and emergent numeracy and gender

Measure	Girls Mean (a)	Boys Mean (b)	Points difference (a-b)	Standard Error of difference	Equivalence of difference in months
Emergent literacy	523.77	507.48	16.29*	4.17	2.24
Emergency numeracy	532.52	525.05	7.47	4.00	N/A

* This is statistically significant (p < 0.05)

Source: IELS assessment of 2,577 children age 5, England

Girls had greater development in emergent literacy compared with boys. This difference in development was equivalent to girls being approximately 2 months ahead of boys. Further details on months' difference and how to calculate the confidence intervals can be found in Appendix 2.

There was no statistically significant gender difference in emergent numeracy.

As mentioned above, the 2018 EYFSP results (DfE, 2018b) found that teachers assess more young girls than boys as achieving the expected level in *both* literacy and numeracy. The lack of a gender difference in the direct assessment of emergent numeracy was therefore unexpected, although teachers reported girls as being more highly developed in numeracy than boys in IELS, which is more reflective of the EYFSP results, and like the EYFSP, is based on teacher assessment. No gender difference for the direct assessment of emergent numeracy was seen in any of the 3 participating countries (OECD, 2020a). It is interesting to find that the direct measures show a gender

difference for emergent literacy but not numeracy. One possible explanation for the difference in the teacher-assessed numeracy measure could be that girls are better at articulating and communicating their understanding of numeracy than boys, for example using appropriate maths 'language' (such as bigger, longer, half, double). Therefore it may be this articulation that teachers are picking up on when providing teacher-reported measures of numeracy, rather than the actual operational numeracy ability of the child, as identified by the direct measures.

The relationship between emergent literacy and numeracy and socioeconomic status

In England, children's development in both early literacy and numeracy shows evidence of a clear gap in development associated with the socioeconomic status (SES). The 2018 EYFSP results show that the difference between the proportion of children eligible for free school meals and all other children achieving the expected level of development in communication and language was 10 percentage points. The equivalent gap for mathematics was 17 percentage points.

The IELS SES measure reported by the OECD used 3 parent-reported variables, namely household income, parent occupation and parent educational attainment to create an index of SES. While 67% of parents of children participating in the England IELS study completed the parent questionnaire, 33% of parents did not which means this SES measure is missing for one third of children in IELS. However, the NPD includes alternative measures of deprivation, including eligibility for Free School Meals (FSM). This information was available for 96% of the children in IELS (2,462 children), and as such provided more comprehensive coverage of data than was available through the IELS measure of SES.

Table 4 shows the means for children's emergent literacy and emergent numeracy development and the differences in these measures between 429 children who were eligible for FSM (17% of the sample for whom data was available) and 2,033 children (83%) who were not eligible for FSM.

Table 4 Relationship between emergent literacy and emergent numeracy and eligibility for FSM

Measure	Non FSM mean (a)	FSM mean (b)	Points difference (a-b)	Standard Error of difference	Equivalence of difference in months
Emergent literacy	520.05	476.30	43.75*	7.07	6.00
Emergent numeracy	534.54	486.01	48.52*	7.05	4.95

* This is statistically significant ($p < 0.05$)

Source: IELS assessment of 2,462 children, age 5, England matched to NPD data

As shown in Table 4, children who were eligible for FSM showed statistically significantly lower development in both emergent literacy and emergent numeracy than children who were not eligible for FSM. The differences in development for emergent literacy and emergent numeracy by FSM were equivalent to approximately 6 and approximately 5 months, respectively.

Of the 3 countries that participated in IELS, England and Estonia were similar in terms of income inequality, whereas the United States had a higher level of income inequality (OECD, 2020a). Echoing the findings above, IELS found that higher SES was associated with greater development in both emergent literacy and emergent numeracy in all 3 countries. There was a stronger association between SES and children's development in both emergent literacy and emergent numeracy in England, compared with Estonia. The association between SES and children's emergent literacy development in the United States was of similar strength to the association in England. However, the association between SES and emergent numeracy development was stronger in the United States than in England.

The relationship between emergent literacy and numeracy and ethnicity

Previous findings have identified some differences in the EYFSP results for children from different ethnic backgrounds (DfE, 2018b). Children from White and Mixed ethnic backgrounds performed similarly to each other in communication and language development and mathematics, and slightly better than all children (by about one percentage point). Children from Asian and Black backgrounds scored similarly to each

other. Compared to all children, the proportion of children from both Asian[11] and Black backgrounds who achieved at least the expected level was 3 percentage points lower in both communication and language development and in mathematics.

The NFER team analysed the emergent literacy and emergent numeracy development of children in relation to their ethnic group. Although some information on ethnicity was available from the IELS parent questionnaire, this was missing for a third of the sample, so the national team used information from the NPD which was available for 2,436 (94.5%) of the 2,577 children in the sample. The figure of 2,436 included 48 children from Any Other Ethnic Group who were subsequently removed from analysis, due to low numbers in this group, leaving 4 major ethnic backgrounds: White, Asian (including Chinese), Black (including Black African and Black Caribbean) and Mixed. In total, the sample of 2,388 comprised 1,852 children from White ethnic backgrounds (78% of the sample for whom data was available), 249 children from an Asian ethnic background (10%), 121 children from a Black ethnic background (5%) and 166 children from a Mixed ethnic background (7%). The analysis compared the largest ethnic group (White) with each of the other 3 major ethnic groups[12]. Table 5 shows this comparison for emergent literacy.

Table 5 Relationship between emergent literacy and ethnic group

Ethnic group	Mean	Standard Deviation	Points difference (comparator: White Ethnic Group)	Standard Error of Difference (comparator: White Ethnic Group)	Equivalence of difference in months (comparator: White Ethnic Group)
White	522.02	94.30	-	-	-
Asian	473.97	92.69	-48.05*	7.64	6.59
Black	486.45	86.87	-35.57*	10.81	4.88
Mixed	504.50	100.66	-17.52	8.97	N/A

* These findings are statistically significant ($p < 0.017$) [13]

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[11] Not including children with a Chinese background who scored statistically significantly higher in listening and attention and mathematics.

[12] The analysis was based on the 'major groups' because the numbers of children in the ethnic 'sub-groups' were too small to allow for a more fine-grained analysis of the relationship with ethnicity.

[13] To control the false discovery rate (FDR) associated with multiple testing, we have applied a Bonferroni adjustment for this analysis with an adjusted p-value. Please see Appendix 2 for further details.

Children from White ethnic backgrounds had statistically significantly greater development in emergent literacy than children from Asian and Black ethnic backgrounds. These differences were equivalent to approximately 7 and 5 months, respectively. However, there is likely to be a relationship between ethnicity and other characteristics, so it may be the case that some of this difference is related to children's SES and their understanding of English (the language used for the direct assessments).

Table 6 shows the comparison between the largest ethnic group (White) with each of the other 3 ethnic groups for emergent numeracy.

Table 6 Relationship between emergent numeracy and ethnic group

Ethnic group	Mean	Standard Deviation	Point difference (comparator: White Ethnic Group)	Standard Error of Difference (comparator: White Ethnic Group)	Equivalence of difference in months (comparator: White Ethnic Group)
White	532.05	98.10	-	-	-
Asian	513.99	100.11	-18.06	8.12	N/A
Black	500.20	82.60	-31.85*	10.95	3.25
Mixed	516.09	104.94	-15.96	9.14	N/A

* This is statistically significant ($p < 0.017$)[14]

Source: IELS assessment of 2,388 children, age 5, England matched to NPD data

Children from White ethnic backgrounds (78% of the sample) had statistically significantly greater development in emergent numeracy than children from Black ethnic backgrounds (5% of the sample), equating to approximately 3 months' difference (but note that this relationship could also be influenced by SES and EAL). There were no other statistically significant differences related to children's ethnic background.

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[14] To control the false discovery rate (FDR) associated with multiple testing, we have applied a Bonferroni adjustment for this analysis with an adjusted p-value. Please see Appendix 2 for further details.

The relationship between emergent literacy and numeracy and English as an additional language

Previous research has found that having English as an additional language (EAL) is associated with lower levels of literacy and numeracy in the early years, but this effect reduces markedly with age and is largely eliminated by age 16 (Strand, 2016).

In the 2018 EYFSP results (DfE, 2018b), children identified as having EAL scored lower in both communication and language development and mathematics compared with children whose first language was English. The gaps for the 'communication and language' area of learning were 7 percentage points for achieving the expected level of development in listening and attention; 10 percentage points for understanding; and 11 percentage points for speaking. In mathematics, the gap was 6 percentage points for numbers and 9 percentage points for shape, space and measures.

For the IELS national analysis, the NFER team obtained information on children's EAL status by matching the IELS data with the NPD (whereas the OECD gathered this information from the parent questionnaire).

A total of 2,459 (95%) of the children in the IELS sample had information on their EAL status in the NPD. Table 7 shows the relationship between EAL and emergent literacy and emergent numeracy development for 426 children identified as having EAL (17% of the sample for whom data was available) and 2,033 children whose first language was English (83%).

Table 7 Relationship between emergent literacy and emergent numeracy and EAL

Measure	English as first language mean (a)	EAL mean (b)	Points difference (a-b)	Standard Error of difference	Equivalence of difference in months
Emergent literacy	522.03	466.09	55.95*	6.59	7.68
Emergent numeracy	531.63	499.02	32.60*	7.74	3.33

* This is statistically significant ($p < 0.05$)

Source: IELS assessment of 2,459 children, age 5, England matched to NPD data

Children with EAL (accounting for 17% of the sample) had statistically significantly lower development in both emergent literacy and emergent numeracy compared to children whose first language was English.

The differences in development was equivalent to approximately 8 months for emergent literacy and approximately 3 months for emergent numeracy. These findings are in line with the 2018 EYFSP results (DfE, 2018b), but note that they have not been adjusted for SES.

The relationship between emergent literacy and numeracy and special educational needs status

Previous evidence from the 2018 EYFSP results (DfE, 2018b) has found an association between having an identified special educational need (SEN) and much lower scores for both communication and language development and mathematics. The gap between the percentage of children with and without SEN who achieved at least the expected level was 49 percentage points for communication and language[15] and 45 percentage points for mathematics[16].

The IELS school sample included only mainstream schools, and as such the SEN category in IELS is representative of those children with an identified SEN who are enrolled in a mainstream school. Children with more severe SEN would not be represented in this sample as they would likely be enrolled in special schools, and additionally any child with a SEN/disability that was severe enough to prevent them from engaging with the assessments were not asked to participate.

Using NPD data to establish whether children in the IELS sample had an identified SEN, the relationship between SEN and emergent literacy and emergent numeracy was investigated. While IELS collected information on SEN, the NPD provided more comprehensive data, with 96% of the sample (2,463 children) having this information available, and as such this was used when investigating differences between those with a SEN identified in the NPD and those without.

SEN category in IELS is representative of SEN children who are enrolled in mainstream schools, therefore we expect that children with more severe SEN are not represented in the sample because special schools were not sampled, and in addition because any children with an SEN/disability severe enough to prevent them from engaging with the assessments were not asked to participate.

In total 299 (12%) of children in IELS had a SEN identified in the NPD. The majority of these children (181, or 61% of those who had an identified SEN) had difficulties with communication and interaction (including speech, language and communication

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[15] Comprising a difference of 47 percentage points for 'Listening and attention', 48 for 'Understanding' and 51 for 'Speaking'.
[16] Comprising a difference of 44 percentage points for 'Numbers' and 46 for 'Shape, space and measures'.

difficulties and autistic spectrum disorder). In addition, 43 (14%) had difficulties with cognition and learning (moderate learning difficulties and specific learning difficulties); 40 (13%) had social, mental and emotional health issues; 12 (4%) had sensory and/or physical needs (hearing impairment, visual impairment and physical disability); and 23 (8% of those with an identified SEN) had other difficulties or no specialist assessment of the type of need[17]. Table 8 shows the relationship between SEN and children's development in emergent literacy and emergent numeracy.

Table 8 Relationship between emergent literacy and emergent numeracy and SEN

Measure	No SEN identified mean (a)	SEN mean (b)	Points difference (a-b)	Standard Error of difference	Equivalence of difference in months
Emergent literacy	523.17	435.93	87.24*	7.08	11.97
Emergent numeracy	536.22	453.82	82.40*	7.17	8.41

* This is statistically significant ($p < 0.05$)

Source: IELS assessment of 2,463 children, age 5, England matched to NPD data

Children with a SEN identified in the NPD had statistically significantly lower scores in both emergent literacy and emergent numeracy. The IELS findings were consistent with the 2018 EYFSP results in this respect (DfE, 2018b). Children with a SEN identified in the NPD were on average approximately 12 months behind their peers without SEN in emergent literacy and 8 months behind in emergent numeracy.

The relationship between emergent literacy and numeracy and low birthweight

Existing evidence suggests that low birthweight (2.5kg[18] or less) is associated with poorer academic outcomes in terms of cognitive, reading and mathematics achievement, and these negative effects are particularly prevalent among children with a very low birthweight of less than 1.5Kg (equivalent to 3 pounds and 4.9 ounces) (Breslau and others, 2001; Goisis and others, 2017; Chatterji and others, 2014; Klein and others, 1989).

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[17] The number of children in each category was too small to allow for analysis by type of SEND.
[18] Equivalent to 5 pounds 8 ounces

Premature birth is also associated with poorer academic outcomes. For example, a meta-analysis by Twilhaar and others, (2017) found that pre-term children scored significantly lower than their full-term peers on arithmetic, reading and spelling at age 5 or older and were 3 times more likely to receive assistance for SEN. Similar findings were reported by Quigley and others, (2012) who used data from the Millennium Cohort Study to examine children's development in the 2006 EYFSP cohort. They concluded that birth before full term has a smaller effect than socio-demographic factors, but it is one more element that affects the child's risk profile for poorer performance at age 5.

There is also research suggesting an additional impact of premature birth on children born in the summer[19], as they suffer an added disadvantage from starting school a year 'early' and being among the youngest in their school year group (Pettinger and others, 2019).

IELS asked parents whether their child was born prematurely and/or had low birthweight[20] and 1,707 (66%) parents of children in the sample provided information for both of these characteristics. There was a strong relationship between premature birth and low birthweight (see appendix 2 for details), therefore the report focuses on the larger category of children with low birthweight.

Table 9 shows the mean emergent literacy and numeracy development for 188 children whose parents identified them as having a low birthweight of less than 2.5kg (11% of the sample who completed the parent questionnaire), compared with 1,537 children whose parents confirmed that they did not have low birthweight (89% of the sample who completed the parent questionnaire).

[19] Further evidence on the effect of a child's age within their year group is included in the following section.
[20] IELS identified low birthweight as a being less than 2.5kg.

Table 9 Relationship between emergent literacy and emergent numeracy and low birthweight

Measure	Not low birthweight mean (a)	Low birthweight mean (b)	Points difference (a-b)	Standard Error of difference	Equivalence of difference in months
Emergent literacy	525.19	503.14	22.05*	9.41	3.03
Emergent numeracy	539.97	505.29	34.69*	8.36	3.54

* This is statistically significant ($p < 0.05$)

Source: IELS assessment of 1,725 children, age 5, England

IELS found that children whose parents had reported them as having low birthweight (11% of the sample) had statistically significantly lower emergent literacy and emergent numeracy development than their counterparts who did not have low birthweight. While IELS found no relationship between the IELS measure of SES and low birthweight in England (OECD, 2020b), it is important to note that previous research has found that low birthweight is likely to be associated with socioeconomic deprivation, for example, see Martinson and Reichman, 2016.

The general findings concerning lower early literacy and numeracy development are consistent with the evidence base on the effects of low birthweight (and premature birth). The differences in emergent literacy and emergent numeracy were equivalent to approximately 3 months and approximately 4 months, respectively.

The relationship between emergent literacy and emergent numeracy, age and year group

Previous research has shown that children born at different times of year perform differently on a range of measures (Crawford and others, 2010; Campbell, 2013; DfE, 2010). There is a clear age-related gradient within a school year group, with children who are the oldest in the year group tending to perform best and children who are youngest tending to perform least well. Age-related differences are largest in the early years and tend to reduce, though not to disappear, as children progress through primary and secondary school. Crawford and others, (2010) found that children born in August (at the end of the academic year in England) scored approximately half a standard deviation lower, and were 25 percentage points (over one third) less likely to reach the government's expected level of performance at age 7 than children born in September (the start of the academic year).

The most likely reason for these age-related differences is that there is an advantage to being older at the point of assessment (Crawford and others, 2010). The early use of ability grouping (i.e. by the age of 7) also appears to contribute to age-related differences (Campbell, 2013). This is because teachers' decisions about assignment to ability groups are influenced by a child's relative age and being allocated to a top set gives children an academic advantage over those who are allocated to a bottom set.

The 2018 EYFSP results (DfE, 2018b) show that a higher proportion of children who were older in their year group achieved the expected level in both communication and language development and mathematics. The performance gap between children born in the autumn and summer months[21] who achieved at least the expected level was 10 percentage points in all three of the communication and language ELGs. The gap for mathematics was 16 percentage points for numbers and 14 percentage points for shape, space and measures. It would therefore be expected that older children in the group would show greater development in emergent literacy and emergent numeracy.

IELS collected data on children's age in years and months and their year group when they took part in the study. Children in the IELS sample in England ranged from 4 years 11 months[22] to 6 years and 0 months. The sample was also split across 2 year groups: Reception and Year 1, with the majority of children in the sample in Year 1 (84%).

The children's development was compared by age and year group. The IELS team for England developed an age calculation for each of the IELS measures (see Appendix 2 for further details).

IELS found that the difference between the oldest (6 years 0 months, accounting for 3% of the sample) and youngest (4 years 11 months, accounting for 2% of the sample) age group was statistically significant for both emergent literacy and emergent numeracy. The difference in development was equivalent to over 12 months for both emergent literacy and emergent numeracy, which is consistent with the evidence base. Children in Year 1 (accounting for 84% of the sample) showed statistically significantly greater development than children in Reception (16% of the sample) on both measures. This is to be expected, because children in Year 1 are older and have a year's greater experience of school.

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[21] The EYFSP results are grouped into three age-related categories: autumn born with birthdays in September to December; spring born with birthdays in January to April and summer born, with birthdays in May to August.
[22] Note that this report includes children aged 4 years 11 months but the OECD omitted this age group from their analysis because there were too few children of this age in the other 2 countries to allow for international comparisons.

Figures 4 and 5 show the emergent literacy and emergent numeracy outcomes for the IELS sample broken down by age in months and year group[23].

Figure 4 The relationship between age, year group and emergent literacy
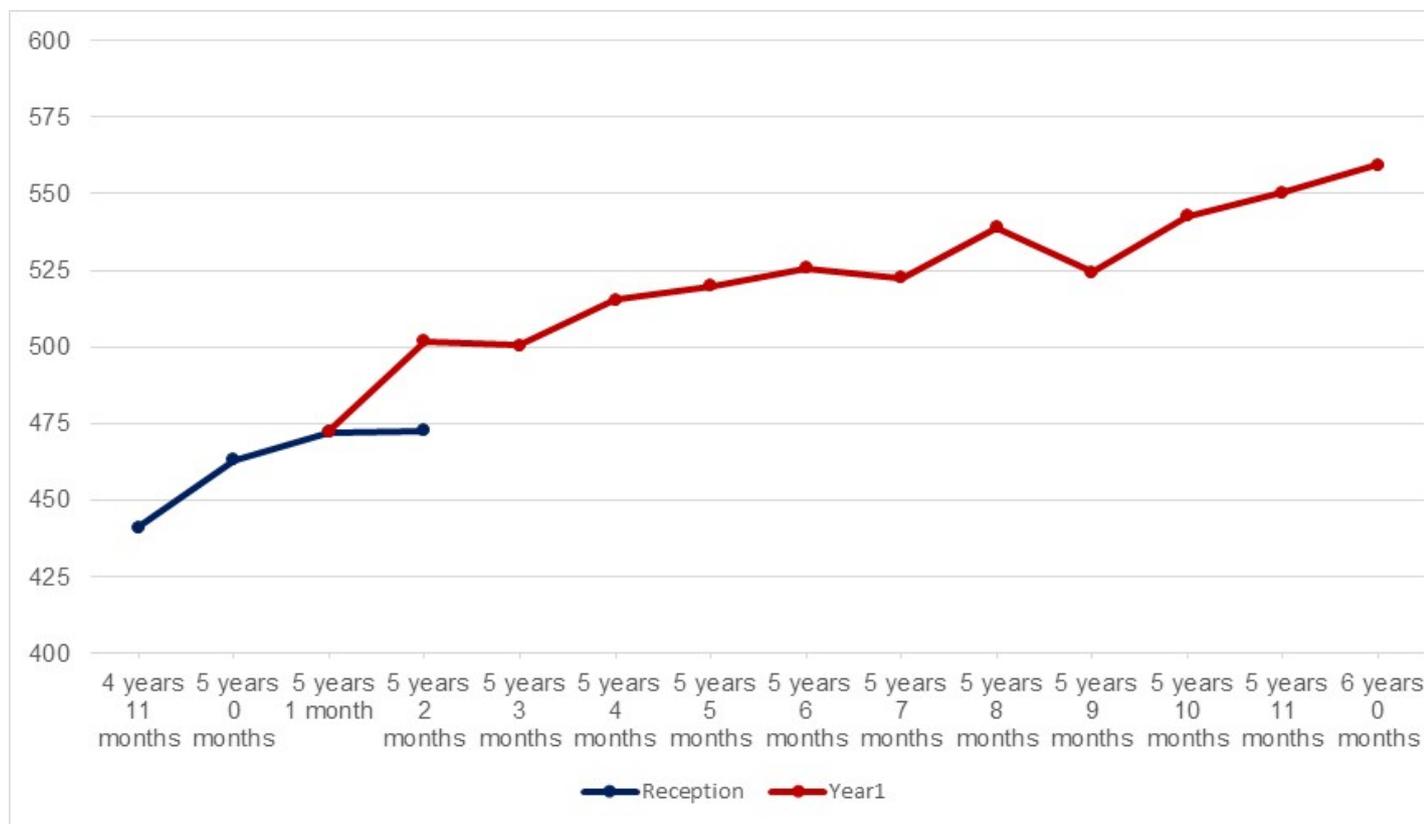
Source: IELS assessment of 2,577 children, age 5, England

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[23] The number of children represented by each point on the graph ranges from 40 (5 years 1 month in Year 1) and 41 (4 years 11 in Reception) to 242 (5 years 4 months in Year 1). Note that the number of children in the following groups is comparatively small which means that they have comparatively high associated standard errors: Reception – 4 years 11 months, Reception – 5 years 2 months, Year 1 – 5 years 1 month, and Year 1 – 6 years 0 months.

Figure 5 The relationship between age, year group and emergent numeracy
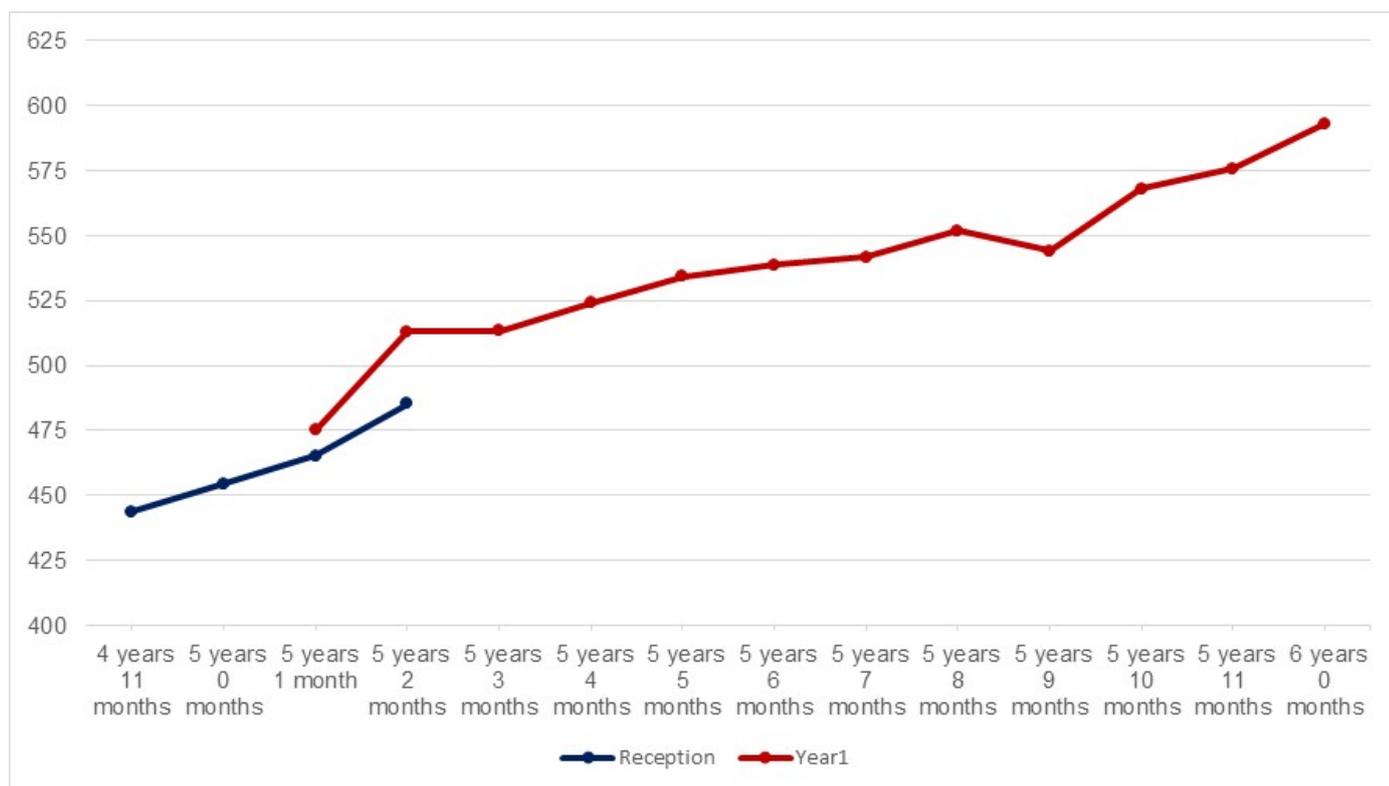
Source: IELS assessment of 2,577 children, age 5, England

The figures show clear evidence of a general age-related trend, whereby older children showed greater development in emergent literacy and emergent numeracy.

It is interesting to compare children of the same age in Reception and Year 1, to consider the additionality of the extra year of schooling. As can be seen from the figures, there was very little difference in the mean emergent literacy or emergent numeracy development between children aged 5 years and 1 month in Reception and Year 1, whereas the children aged 5 years and 2 months in Year 1 appear to have greater development than children aged 5 years and 2 months in Reception, but this difference was not statistically significant[24].

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[24] To control the false discovery rate (FDR) associated with multiple testing, we have applied a Bonferroni adjustment for this analysis. Please see Appendix 2 for further details.

2.5 How does children's early literacy and numeracy development relate to their home learning environment?

Children's early development is influenced by the child's home learning environment (HLE), which includes both the physical characteristics of the home and the quality of the implicit and explicit learning support they receive from parents and carers. Previous research has shown that parenting and children's activities in the early years have a powerful influence on children's cognitive development (Melhuish, 2010). It has also been shown that parents who engage in learning activities when their child is young are more likely to continue to be involved in their learning as they move through primary and secondary school (Toth and others, 2020).

The HLE is an important factor in the development of early speech, language and communication (Sylva and others, 2004; DfE and the National Literacy Trust, 2018d). The availability of books in the home, book-sharing activities, and high-quality linguistic interactions, between child and caregiver are associated with improved language outcomes such as vocabulary and early literacy development (Asmussen and others, 2018). Romeo and others, (2018) found that conversational turns between child and carer was related to verbal abilities in 4 to 6 year olds. Their research suggested that the child's conversation experiences impacted neural language processing more so than SES or the quantity of words children heard. Phonological literacy activities such as singing songs and nursery rhymes are also beneficial for development in this domain (Sylva and others, 2004). Enjoyable reading experiences in the HLE are also thought to contribute to an increased participation in reading (Asmussen and others, 2018).

Previous research suggests that children's early numeracy and number development is consistently associated with the quality of the HLE (Sylva and others, 2004; Asmussen and others, 2018). Informal numeric activities, counting and sorting exercises, and child-caregiver conversations about numbers have been positively associated with the development of key early numeracy concepts (Sylva and others, 2004; Asmussen and others, 2018). There is also evidence to suggest that early literacy activities are beneficial for the development of numeracy skills (LeFevre and others, 2010; Anders and others, 2012).

A higher quality HLE is more prevalent in families with higher socio-economic status (Law and others, 2017; Sim and others, 2018). Disadvantaged children are less likely to experience a HLE that supports their early cognitive development, particularly in early literacy and language (DfE, 2017). Toth and others, (2020) found an association between SES and children's access to enrichment activities at different time points throughout childhood, with children from lower SES backgrounds making fewer visits to libraries and museums during lower primary school and secondary school. However, a high-quality HLE also operates independently from social class, which means that children from deprived backgrounds with a high quality HLE have better outcomes than children from

deprived backgrounds with a lower quality HLE (Melhuish, 2010; Sylva and others, 2007). Siraj-Blatchford (2004) argued that parental involvement in education is extremely important, outlining activities that parents undertake with their child, such as reading to them, that the research evidence has shown as being likely to improve the child's cognitive development.

These findings have prompted the British government to promote a strong HLE, for example through the 3-year Hungry Little Minds campaign introduced in 2019[25]. This campaign was designed to encourage parents to engage in activities that support their children's early learning and help set them up for school and beyond. Practices such as reading with and counting with children, using complex language, responsiveness and emotionally warm interactions, are all associated with better developmental outcomes for children (Sylva and others, 2007; Melhuish, 2010; Hunt and others, 2011; Kelly and others, 2011; Law and others, 2017; Asmussen and others, 2018). The Study of Early Education and Development (SEED, Melhuish and Gardiner, 2018) found several statistically significant associations between the HLE[26] and children's outcomes at age 4, after controlling for demographic factors. Children from families with a more stimulating HLE had better cognitive outcomes (in terms of both their verbal and non-verbal ability). These positive findings continued to be apparent at age 5, when a higher quality HLE was associated with better EYFSP outcomes for both communication and language and numeracy and higher verbal ability during Year 1 (Melhuish and Gardiner, 2020).

What does IELS tell us about children's development and the home learning environment?

IELS measured the HLE through asking a series of questions in the parent questionnaire about the frequency with which parents carried out activities with their children, at home, such as drawing pictures, imaginative play, having a back-and-forth conversation, visiting a library and helping their child learn letters of the alphabet. The IELS team in England added a national question to the list of activities which asked parents how often they 'do activities with your child that help them to learn to read words or sentences'. This was in addition to the international question on doing activities to help them to learn letters of the alphabet. The rationale for adding this item was that at the time of the study, the majority of 5-year-olds in England had already been in school for over a year and as such were likely to be learning to read words and sentences.

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[25] Please see Hungry Little Minds campaign introduced in 2019
[26] The HLE index used in the SEED study measured the frequency of home activities that allow learning opportunities for the child such as the frequency of the child being read to, taken to library, painting/drawing, play with letters/numbers and songs/rhymes.

In England, 56% of parents who responded to the questionnaire stated that they did activities with their children to help them to learn letters of the alphabet at least 3 days of the week and 13% of parents did this less than once a week or never. When comparing school year groups, it can be seen that proportions are similar, with 60% of those in Reception class and 55% of those in Year 1 doing this at least 3 times a week, and 9% of Reception children and 14% of Year 1 children doing this activity less than once a week or never.

A higher proportion of parents regularly undertook activities to help their children to read words or sentences, 73% of parents reported doing this at least 3 times a week (64% of children in Reception and 75% of children in Year 1) with just 6% of parents doing this less than once or week or never (9% of children in Reception and 6% of those in Year 1).

Further to this, there was no relationship found between how often parents did activities to help their child learn letters of the alphabet and scores in emergent literacy (OECD, 2020b), yet there was a relationship between how often parents undertook activities to help their children to read words and sentences and scores in emergent literacy (note this latter analysis has not controlled for the influence of SES, but the relationship was found in both Reception and Year 1). Indeed, children whose parents helped them to read words or sentences at least 3 days a week showed greater development in emergent literacy than children whose parents did so less than once a week or never. The difference in development was equivalent to approximately 6 months for children whose parents engaged in this activity 3 or 4 times a week and approximately 8 months for children whose parents did so between 5 and 7 times a week compared to those who did so less than once a week or never. When this is broken down and analysed separately by year group, children in both Reception and Year 1 whose parents helped them to read words or sentences once a week or more showed greater development in emergent literacy than children in their year group whose parents did so less than once a week or never. Aditionally, children in Year 1 whose parents helped them to read words or sentences 3 times a week or more showed greater development in emergent literacy than children in Year 1 whose parents did so on 1 or 2 days a week.

In addition, children whose parents helped them to read words or sentences at least 3 days a week (73% of the sample) showed greater development in emergent numeracy than children whose parents did so less than once a week or never (6% of the sample). The difference in development was equivalent to approximately 5 months for children whose parents helped them to read 3 or 4 times a week and approximately 7 months for children whose parents did so between 5 and 7 times a week compared to those whose parents did so less than once a week or never.

Overall this suggests that helping children to read more frequently was associated with greater emergent literacy, and emergent numeracy development, which is consistent with the evidence base. Furthermore, this would suggest that at age 5, helping children to

read words and sentences is more effective than helping them to learn letters of the alphabet.

The OECD (2020b) identified a number of other aspects of the HLE which were statistically significantly associated with children's development in emergent literacy and emergent numeracy after controlling for SES. These are summarised below.

- Nine per cent of the children whose parents responded had 10 or fewer children's books in the home. These children showed statistically significantly lower emergent literacy development than children who had more than 10 children's books at home (91% of those who responded) and significantly lower emergent numeracy development compared to those with more than 25 children's books in the home (79% of those who responded).

- Six per cent of children whose parents responded never or rarely used electronic devices (such as a computer, tablet or smartphone). These children showed lower emergent literacy development than those who used them monthly (9% of those who responded). However there was no significant difference between those who used electronic devices never or rarely and those who used them at least once a week but not every day (46% of those who responded) or everyday (39% of those who responded). There was no association between use of electronic devices and emergent numeracy development.

- Children whose parents had back-and-forth conversations with them about the child's feelings at least 5 days per week (53% of those who responded) showed greater emergent literacy development than those whose parents did so less than once per week (accounting for 3% of those who responded).

- Children whose parents read to them at least 5 days a week (accounting for 59% of those who responded) showed greater emergent literacy development than those whose parents did so less than once a week (accounting for 3% of those who responded).

- Just over one fifth (22%) of children whose parents responded hardly ever or never played with numbers, counters, measuring or shapes with their parents and 8% of children hardly ever or never did activities to learn numbers with their parents. In contrast, 21% of children had parents who played with numbers, counters, measuring or shapes with their child at least five times week and 13% did activities to learn numbers with their parents at least 5 days a week. When these two activities are taken together, children whose parents engaged in numeracy activities with them at least 5 days a week had higher emergent numeracy development than children whose parents did so less than once a week or never.

- One fifth of children whose parents responded never attended special or paid for activities outside of the home (e.g. sports clubs, dance, swimming lessons, language lessons) with a further 15% doing so less than once a week. Nearly half (47%) attended these types of activities 1 or 2 times a week, 16% did so 3 or 4 times a week and 2% did so on 5 or more days a week. Children who attended these types of activities showed greater emergent literacy and emergent numeracy development than those who never did so. Children showed the greatest level of development in both measures when these activities took place 3 or 4 days a week, rather than more or less often.

- There was no statistically significant relationship between children's emergent literacy development and the frequency of phonological literacy activities such as telling, rather than reading stories; singing songs and nursery rhymes. This is somewhat surprising, since the IELS measures relied on children listening to stimuli, which might be expected to be related to their involvement in oral language activities at home. It is important to note that these findings relate to children aged 5, whereas previous research has shown singing songs and nursery rhymes to be beneficial for pre-school children's literacy development (for example, Sylva and others, 2004).

- Children whose parents were moderately or strongly engaged with their children's schooling (69%), as reported by teachers[27], had greater emergent literacy and emergent numeracy development compared to those whose parents were slightly or not involved in their schooling (31%).

2.6 How does children's early literacy and numeracy development relate to their early childhood education and care experience?

In England, some 2-year-olds, and all 3-, and 4-year olds, are entitled to free part-time early childhood education and care (ECEC). At the age of 2, children from disadvantaged backgrounds are eligible for 15 hours of free ECEC per week[28]. At the age of 3, all children are eligible for 15 hours of free ECEC per week. Beyond this, 3- and 4-year olds

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[27] The teacher questionnaire asked teachers to rate how involved each child's parents/carers were in activities (such as school fetes, concerts and parents' evenings) taking place at the school on a 4-point scale ('strongly involved, moderately involved', 'slightly involved' or 'not involved at all')
[28] This applies for 38 weeks per year.

may then be eligible for extended ECEC provision, which amounts to 30 hours of provision per week[29].

Existing research suggests that ECEC provision can play an important role in supporting children's early cognitive development (Sylva and others, 2008; Bonetti and Brown, 2018; Melhuish and Gardiner, 2020). Irrespective of demographic and home environment factors, children who had attended ECEC in some form scored more highly in cognitive outcomes at age 5 and age 7 when compared with those who had not (Melhuish and Gardiner, 2020; Sylva and others, 2004; 2008). Research suggests that disadvantaged children have the most to gain from ECEC. While disadvantaged children are less likely to be in ECEC, particularly centre-based care, they were found to benefit significantly from good quality ECEC experiences, particular when they are able to mix with children from a range of different social backgrounds (Sylva and others, 2004; 2008; Roberts and others, 2010, Albakri and others, 2018). There is also some evidence that high quality ECEC provision can be particularly beneficial to boys' overall development (Sylva and others, 2008).

It is important to note, however, that take-up of free early education entitlement is related to child and family characteristics. Albakri and others, (2018) found that at local authority level, high levels of disadvantage, EAL, SEN, and population mobility are associated with lower rates of uptake of the free entitlement. They also found that uptake in London was lower than in other large, diverse urban areas. Uptake among eligible 2-year-olds was lower than among 3- and 4-year-olds.

The quality of ECEC is important. The Effective Pre-School, Primary and Secondary education Project (EPPSE) found children's ECEC experience is associated with their cognitive outcomes at the end of Key Stage 4. Children who attended a high quality ECEC setting were more likely to have higher total GCSE scores, obtain more GCSEs and achieve higher grades in both English and Maths at age 16 (Sammons and others, 2014; 2015; Silva and others, 2014).

What is the relationship between children's development in literacy and numeracy and the age their participation in ECEC began?

Previous research suggests that starting ECEC between 2 and 3 years old is linked with better cognitive outcomes for children (Sylva and others, 2004; 2008). More recently, the SEED longitudinal study found that starting ECEC between 2 and 3 years old was associated with higher cognitive outcomes for children at age 4 (Melhuish and Gardiner,

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[29] This applies to the children of parents working the equivalent of 16 hours a week at the national minimum or living wage and earning under £100,000 per year.

2018). However, there were fewer positive relationships between ECEC attendance and cognitive outcomes at age 5, although a larger amount of informal individual ECEC (with friends and relatives) between age 2 and the start of school was associated with higher verbal ability at age 5 (measured during Year 1, Melhuish and Gardiner, 2020).

Analysis of 2015 PISA results (Balladares and Kankaraš, 2020) found a relationship across participating countries between pupils who had attended ECEC and higher academic scores at the age of 15. For example, in the UK, 15-year-olds who had attended ECEC a year before the typical age of starting ECEC (in England the typical age of starting ECEC was deemed to be 3 years of age) achieved higher scores in the 2015 assessment of reading. However, across all countries these differences reduced to almost nil when socio-economic status (SES) was taken into account, which the authors consider is likely to be due to differential access to high quality ECEC by children from different SES backgrounds.

The IELS study (OECD, 2020b) found that, after adjusting for SES, children who attended ECEC for more than 20 hours per week at the age of 1 (accounting for 20% of those whose parents responded to the questionnaire) had statistically significantly greater development in emergent literacy than children who either attended for fewer hours per week (19% of those who responded) or not at all at the age of 1 (62% of those who responded). Aside from this, no statistically significant differences were found for either of the IELS cognitive measures in relation to children who had first participated in ECEC before the age of 3 and those who had first participated after this age.

It is important to note that in England, 98% of children for whom information was available had attended ECEC settings before the age of 5, making it more difficult to identify the impact of ECEC on children's development. However, in the United States where there is a more substantial minority of children (20%) who had not attended ECEC before the age of 5, IELS found that these children who had not attended had lower emergent literacy and emergent numeracy development than those who had attended, even after controlled for SES (OECD, 2020d).

3 Self-regulation

3.1 Chapter summary

- Self-regulation is important for both academic attainment and wellbeing in later life (Schoon and others, 2015). IELS measured 3 aspects of cognitive self-regulation: inhibition; mental flexibility; and working memory. Direct measurement of children's cognitive self-regulation is an innovative feature of IELS.

International findings

- Children in England showed similar development to children in Estonia and greater development than children in the United States for working memory and mental flexibility. For inhibition, children in England showed significantly lower development than children in the United States and Estonia.

Relationship between self-regulation and individual characteristics

- Children with an identified special educational need (SEN) showed significantly lower scores than their peers in all 3 measures. The differences in development were equivalent to approximately 4 months for inhibition, 8 months for working memory and 11 months for mental flexibility.

- Children who had experienced low birthweight showed significantly lower development than their peers in working memory, equivalent to approximately 4 months' difference.

- There was a small but significant difference between boys and girls on inhibition with boys being approximately one month ahead of girls. There were no significant differences between boys and girls for mental flexibility or working memory.

- Older children showed significantly greater development than younger children in all 3 measures, as did children in Year 1 compared with children in Reception.

Relationship between self-regulation and family characteristics

- For mental flexibility and working memory, children eligible for free school meals (FSM) showed significantly lower development than their peers, equating to approximately 4 months' difference for both measures.

- Children with English as an additional language (EAL) showed significantly lower development than their peers in mental flexibility and working memory, equating to approximately 3 months' difference on both measures (though note that this finding has not been adjusted for socioeconomic status).

Relationship between self-regulation and the home learning environment

- Children whose parents helped them to read words and sentences on at least 5 days a week showed greater development than those whose parents helped them to read less than once a week or never in all 3 measures (not adjusted for socioeconomic status). This was equivalent to approximately 9 months' difference in mental flexibility, 6 months' difference in working memory and 4 months' difference in inhibition.

- Several other aspects of the home learning environment (HLE) were associated with greater development in self-regulation, after adjusting for socioeconomic status. Children whose parents helped them read at least 5 days a week showed significantly greater development in all 3 measures than children whose parents did so less than once a week or never. Positive development in working memory and mental flexibility was associated with: having more than 100 children's books in the home; and attending a special or paid-for activity outside of the home (e.g. sports clubs, dance, swimming lessons, language lessons) between 1 and 4 days in a week.

- Children who used a digital device at least once a week had statistically significantly higher working memory development than children who used a digital device hardly ever or never.

3.2 What is self-regulation and why is it important?

Self-regulation is characterised by a child's ability to think before acting, persist at an activity, follow directions, remain calm, and control their impulses (Feinstein 2015; McClelland and Tominey, 2015; Melhuish and Gardiner, 2018). It is an important area of development which comprises a broad and complex blend of attributes including inhibitory control, being able to shift attention, restraint in emotional expression, and working memory (Blair and others, 2005; Melhuish and Gardiner, 2018; Shuey and Kankaras, 2018). Young children's ability to regulate their thoughts, emotions and behaviour develops as part of their physical maturation and as a result of having opportunities to practice (Shuey and Kankaras, 2018).

Specifically within IELS, self-regulation refers to executive functions; a set of mental processes including inhibition, working memory and mental flexibility (Diamond, 2013; Hackman and others, 2015). It is argued that self-regulation skills are essential for success in transition to school (Blair and Raver, 2015) and for cognitive, social, and psychological development (Diamond, 2013). These skills are important for both academic attainment and wellbeing in later life, independent of cognitive ability. Schoon and others, (2015) found that, after controlling for early literacy and maths scores, children with more developed self-regulation at age 5 tended to obtain more GCSEs at

age 16 and were more likely to have completed a degree by the age of 30. They also found evidence to suggest that the link between self-regulation and later attainment may be particularly pronounced for boys. Similarly, children who increased their self-regulation throughout childhood were more likely to have higher incomes, higher socioeconomic status in their 30s, and better physical and mental health outcomes, including avoiding substance dependence (Schoon and others, 2015; Shuey and Kankaras, 2018).

3.3   What does IELS tell us about children's development in self-regulation?

IELS measured 3 distinct self-regulation domains through direct assessment on a tablet: inhibition, working memory and mental flexibility. These are primarily measures of children's cognitive function (sometimes called 'executive function'), rather than measures of behavioural self-regulation. Table 10 summarises the tasks for each measure.

Table 10 Definitions of the IELS self-regulation domain

Content component	Description	Tablet task and example
Inhibition	Ability to inhibit learnt responses based on new information	Stop/go task: Children were shown an image and asked to touch a button on screen whenever the image appeared, and shown another (similar) image and asked to touch a different button whenever this new image appeared. The child was then presented with one of the images much more frequently than the other. Inhibition was measured as the children's ability to touch the different button whenever the less frequently presented image appeared.
Mental flexibility	Ability to shift between rules according to changing circumstances or to apply different rules in different settings	Switching task: The task introduced children to two distinct animals and asked them to touch a different shape on the screen depending on which animal appeared. The assessment then introduced a new rule, which asked the child to touch the opposite shape when each animal appeared. Mental flexibility was measured as the children's ability to adapt to the new inverse rule.
Working memory	Ability to store information and manipulate it to complete a given task	Odd-one-out task: Children were introduced to a visually distinct main character (a zebra) which appeared in 1 of 3 slots within a visual image (a bus). The other slots were occupied by elephant characters. The child was asked to remember which of the 3 slots the zebra occupied and touch the corresponding slot in a following image. This assessment was divided into several sections of increasing levels of difficulty involving more slots to remember. If the child did not complete the higher difficulty tasks, the assessment automatically moved on to the next section.

In IELS, international comparisons showed that on, average, children in England had greater development in their mental flexibility and working memory than children in the United States and similar to those in Estonia. Conversely, children in England had significantly lower outcomes than children in both the United States and Estonia in inhibition. On average, children in England's inhibition development was 40 points below

the international mean. As previously mentioned, the scores are scaled so that the mean for each measure is 500 and the standard deviation is 100. Each participating country has contributed equally to the computation of the international mean. The study also found that for mental flexibility, the distribution of outcomes for English children was similar to Estonia and greater than the United States. For working memory, the inverse was found – the spread of outcomes in England was narrower than in the other two countries. The distribution of outcomes for inhibition was similar across all 3 countries.

Table 11 Children's development in self-regulation measures

Measure	Mean	Standard Deviation
Inhibition	459.76	94.68
Mental flexibility	512.87	107.27
Working memory	515.99	84.73

Source: IELS assessment of 2,577 children, age 5, England

Table 11 shows that, in England, children's development across the 3 measures was uneven. Children showed higher development in mental flexibility and working memory than in inhibition, which suggests that children in England were more able to successfully switch between rules and recall short visual sequences than they were able to inhibit their automatic responses when presented with a new set of information. The gap between children's outcomes in inhibition and the other measures of self-regulation is currently unexplained. However, as is shown in Chapter 6, inhibition is not strongly correlated with any of the other emergent skills (other self-regulation measures, cognitive skills, social-emotional skills or physical development) and as such their relatively lower development in this area does not appear to be holding back their development in other areas.

The different components of self-regulation were positively related to one another. There was a strong correlation[30] between mental flexibility and working memory. Children's scores in inhibition were moderately correlated with both mental flexibility and working memory. This suggests that that children's' development of the different components of self-regulation are mutually supportive of one another. (Chapter 6 provides further information on the correlations within and between outcome measures.)

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[30] A correlation lower than 0.20 is considered relatively weak, between 0.20 and 0.50 is moderately strong, and over 0.50 is strong.

3.4 How does children's self-regulation relate to their individual and family characteristics?

The relationship between self-regulation and gender

Previous international research (McClelland and others, 2015) suggests that young girls out-perform boys in cognitive self-regulation both in direct assessments and teacher reports, though there is evidence of some variation in this trend internationally.

Table 12 shows the relationship between gender and inhibition found in IELS.

Table 12 Relationship between self-regulation and gender

Measure	Girls Mean (a)	Boys Mean (b)	Points difference (a-b)	Standard Error of difference	Equivalence of difference in months
Inhibition	455.76	463.59	-7.83*	3.67	1.13
Mental flexibility	516.46	509.43	7.03	5.03	N/A
Working memory	516.61	515.39	1.23	3.97	N/A

* This is statistically significant (p < 0.05)

Source: IELS assessment of 2,577 children, age 5, England

The inhibition measure was the only aspect of self-regulation where a statistically significant gender difference was found. Here, boys showed statistically significantly greater development than girls, equivalent to approximately one month of development[31]. For mental flexibility and working memory, the gender differences were not statistically significant (there was no evidence of a consistent or significant gender pattern in the findings across all 3 countries participating in IELS).

The relationship between self-regulation and socioeconomic status

Previous research suggests that children from households with a lower socioeconomic status (SES) show lower development in executive function and cognitive self-regulation

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[31] Note that the estimate of the difference by age in months reported here may differ from that reported by the OECD (2020) because this calculation includes children aged 4 years and 11 months, which were excluded from the OECD's analysis.

(McClelland and others, 2015; Hackman and others, 2015; Ackerman and Friedman-Krauss, 2017).

The IELS team in England used free school meals (FSM) eligibility as the measure of deprivation as identified in the national pupil database (NPD). Table 13 shows the results of this analysis for FSM.

Table 13 Relationship between self-regulation and FSM eligibility

Measure	Non FSM Mean (a)	FSM Mean (b)	Points difference (a-b)	Standard Error of difference	Equivalence of difference in months
Inhibition	459.95	451.72	8.23	5.33	N/A
Mental flexibility	515.63	491.28	24.35*	7.88	3.88
Working memory	519.07	487.91	31.17*	5.55	4.10

* This is statistically significant ($p < 0.05$)

Source: IELS assessment of 2,462 children matched to NPD data, age 5, England

Children who were eligible for FSM (accounting for 17% of the sample) showed statistically significantly lower development than their peers (79% of the sample) in mental flexibility and working memory. For both measures, this was equivalent to approximately 4 months' difference. There was no significant difference in inhibition.

The OECD (2020b) found that children from higher SES backgrounds had higher outcomes in mental flexibility and working memory. The relationship between inhibition and SES was less clear. The relationship between SES and self-regulation in England was similar to the United States and stronger than in Estonia.

The relationship between self-regulation and ethnicity

There is little prior evidence on the relationship between ethnicity and children's cognitive self-regulation. The IELS national team in England found no significant differences between children related to their ethnic group[32].

The relationship between self-regulation and English as an additional language

There is little prior evidence on the relationship between English as an additional language (EAL) and children's cognitive self-regulation.

Table 14 Relationship between self-regulation and EAL

Measure	Non EAL Mean (a)	EAL Mean (b)	Points difference (a-b)	Standard Error of difference	Equivalence of difference In months
Inhibition	458.42	458.62	-0.21	5.75	N/A
Mental flexibility	514.06	497.93	16.13*	7.03	2.57
Working memory	517.36	496.05	21.31*	5.55	2.81

* This is statistically significant ($p < 0.05$)

Source: IELS assessment of 2,459 children, age 5, England, matched to NPD

As shown in Table 14, children with EAL (accounting for 17% of the sample) showed significantly lower development for mental flexibility and working memory than their peers. For both measures, this was equivalent to approximately 3 months' difference. No significant differences were found for inhibition. However, it is important to note that assessments were in English and therefore scores in self-regulation may have been influenced by potential language issues.

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[32] The analysis was based on the 'major groups' of Asian, Black, Mixed, and White (and any other ethnic groups). Numbers in each category were too small to allow for a more fine-grained analysis of the relationship with ethnicity. There were no significant differences between White ethnic group and the other major ethnic groups, whether analysed separately or as a combined group.

The relationship between self-regulation and special educational needs status

There is little prior evidence on the relationship between special education needs (SEN) and children's cognitive self-regulation.

Table 15 shows the relationship between SEN status and self-regulation

Table 15 Relationship between self-regulation and SEN

Measure	No identified SEN Mean (a)	SEN Mean (b)	Points difference (a-b)	Standard Error of difference	Equivalence of difference in months
Inhibition	461.65	436.23	25.42*	6.32	3.65
Mental flexibility	520.15	448.87	71.28*	8.80	11.34
Working memory	521.12	460.66	60.46*	6.61	7.96

* This is statistically significant (p < 0.05)

Source: IELS assessment of 2,463 children, age 5, England, matched to NPD

The analysis found that children with a SEN identified in the NPD (12% of the sample, see section 2.4 for further information on this) had statistically significantly lower scores than their peers across all 3 measures of self-regulation. For inhibition, children with a SEN identified in the NPD were on average 4 months behind their peers, for working memory they were on average 8 months behind their peers and for mental flexibility they were on average 11 months behind their peers.

The relationship between self-regulation and low birthweight

There is some evidence to suggest that children who experience low birthweight exhibit lower cognitive self-regulation, particularly in relation to working memory and inhibition (Ackerman and Friedman-Krauss, 2017).

IELS asked parents whether their child had experienced a low birthweight (defined as below 2.5 kg). The results of a comparison between the 188 (11%) children with low birthweight and the 1,537 without are shown in Table 16.

Table 16 Relationship between self-regulation and low birthweight

Measure	Not low birthweight mean (a)	Low birthweight mean (b)	Points difference (a-b)	Standard Error of difference	Equivalence of difference in months
Inhibition	460.17	450.40	9.78	7.50	N/A
Mental flexibility	519.37	507.33	12.04	9.16	N/A
Working memory	523.56	491.84	31.71*	7.28	4.18

* This is statistically significant (p < 0.05)

Source: IELS assessment of 1,725 children, age 5, England

The analysis shows that while there was a trend for children who experienced a low birthweight to demonstrate lower development in self-regulation than their peers in all 3 measures, this difference was only statistically significant for working memory. This was equivalent to approximately 4 months' difference in working memory.

The relationship between self-regulation and age in months

There was a clear age-related trend whereby older children exhibited greater development than younger children. For all 3 measures, the difference between the youngest children (aged 4 years and 11 months at the time of the study, accounting for 2% of the sample) and oldest (6 years 0 months, accounting for 3% of the sample) was statistically significant. The gap for inhibition is equivalent to approximately 10 months , whereas the gap for both mental flexibility and working memory is equivalent to over 12 months. As expected, given that they were a year older and had experienced an extra year of school, children in Year 1 (84% of the sample) showed statistically significantly greater development in all 3 measures compared to those in Reception (16% of the sample). For inhibition and working memory the difference between the year groups equates to approximately 7 months, whereas for mental flexibility the difference is larger and equivalent to 10 months.

The following figures show the relationship between age in months and year group with children's development in the 3 self-regulation measures[33].

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[33] Note that the number of children in the following groups is comparatively small and so the means for these groups have higher standard errors: Reception - 4 years 11 months, Reception - 5 years 2 months, Year 1- 5 years 1 month, and Year 1- 6 years 0 months. Further information on the age-related calculations is provided in Appendix 2.

Figure 6 The relationship between age, year group and inhibition
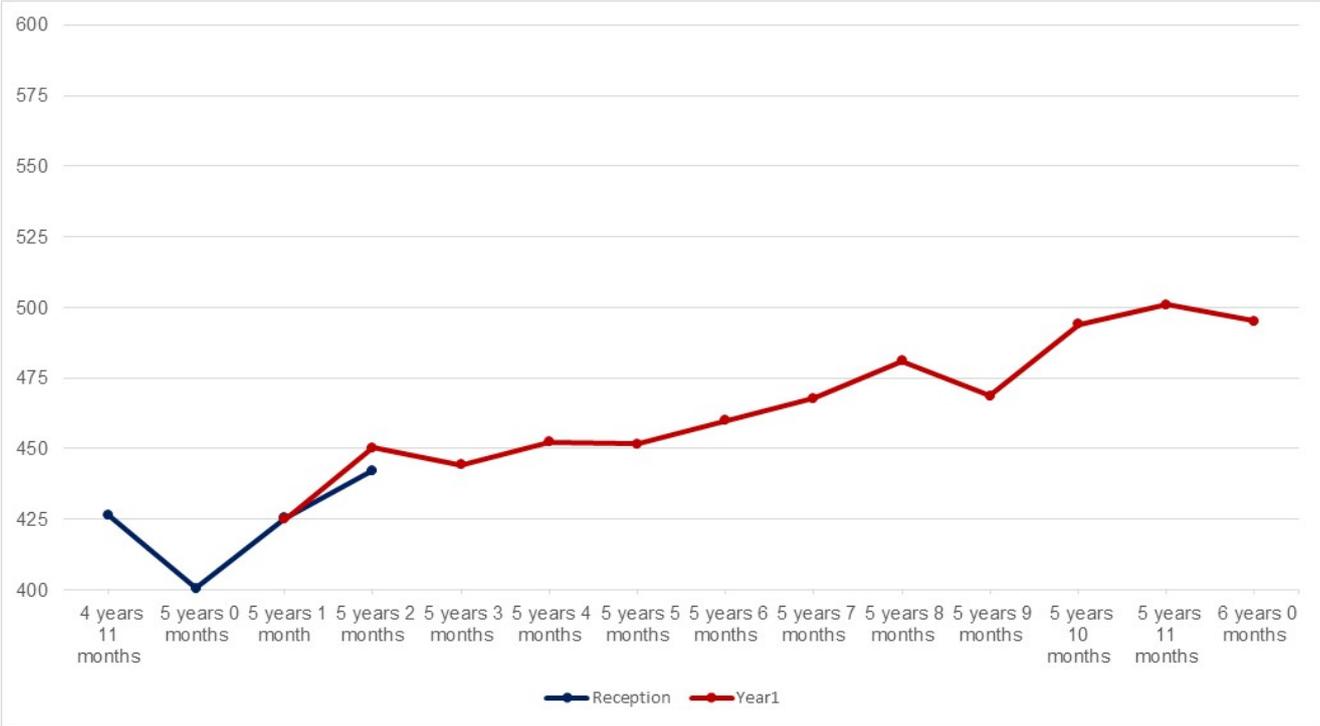
Source: IELS assessment of 2,577 children, age 5, England

Figure 7 The relationship between age, year group and mental flexibility
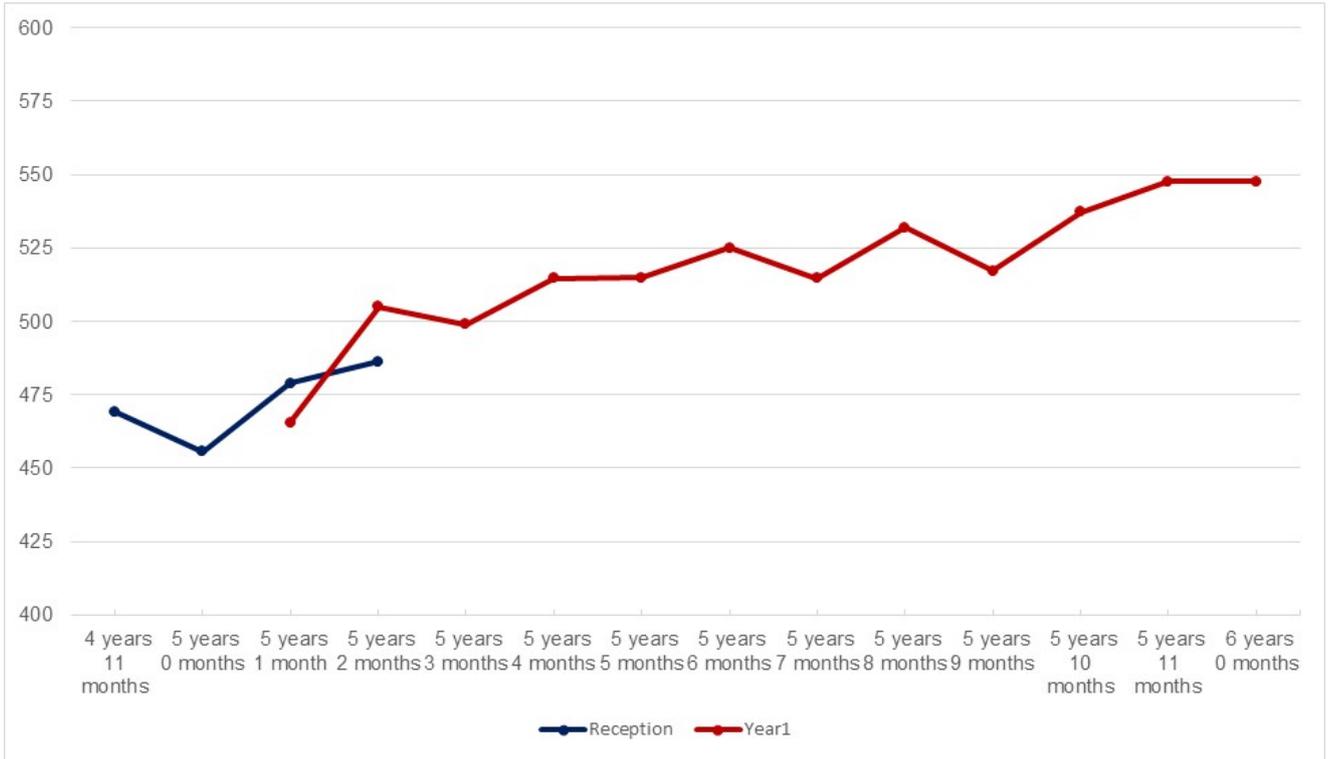
Source: IELS assessment of 2.577 children, age 5, England

Figure 8 The relationship between age, year group and working memory
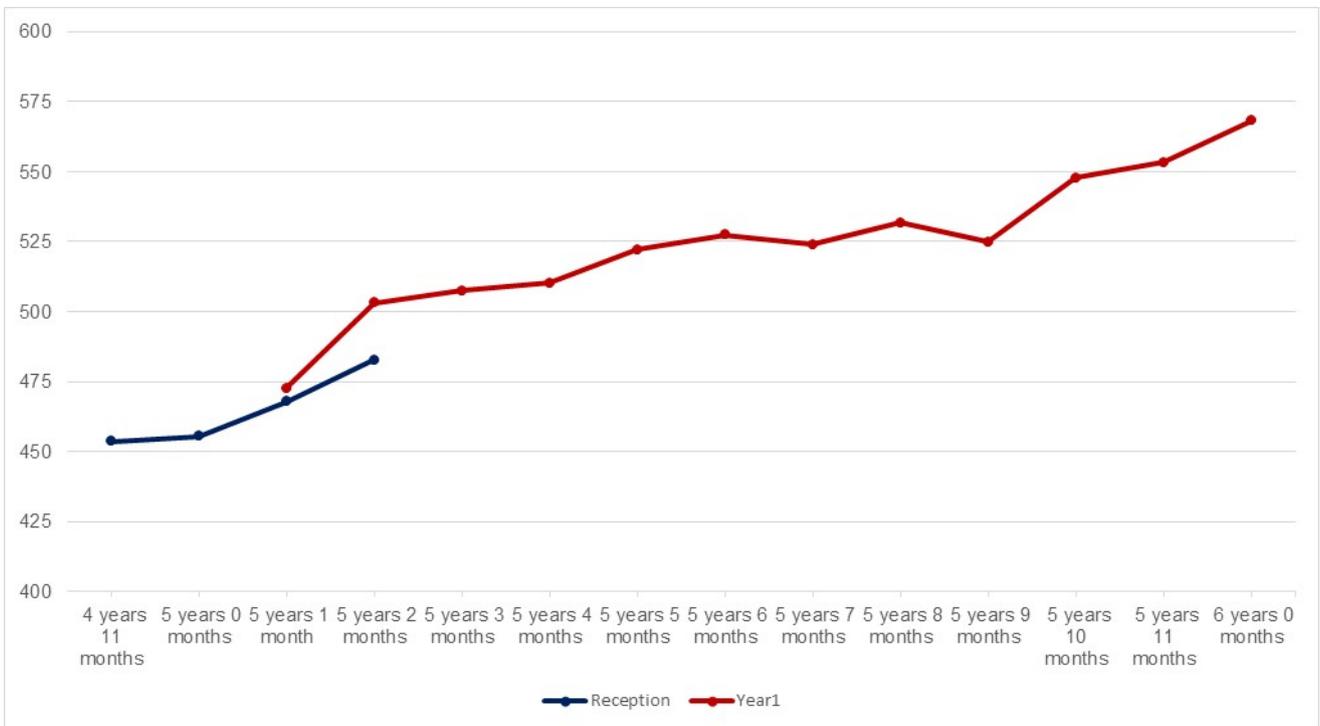
Source: IELS assessment of 2,577 children, age 5, England

3.5 How does children's self-regulation relate to their home learning environment?

Children's self-regulation might be expected to relate to the quality of the home learning environment (HLE). Although not referring specifically to cognitive self-regulation, the Study of Early Education and Development (SEED, Melhuish and Gardiner, 2018) found that high HLE scores[34] were associated with higher behavioural self-regulation at age 4, although not at the age of 5 (Melhuish and Gardiner, 2020). Unexpectedly, the study also found that a higher HLE score was associated with lower children's emotional self-regulation at age 4. Neither of these findings were replicated for these children at age 5 (Melhuish and Gardiner, 2020).

The IELS study (OECD, 2020b) found statistically significant associations between self-regulation and the following aspects of children's HLE in England: the number of children's books in the home, the frequency with which a child used a digital device[35], and the frequency with which they are taken to an activity outside of the home. These findings were statistically significant after adjusting for parental SES and are summarised below.

- Children who used a digital device at least once a week (46% of those who responded) or every day (39% of those who responded) had statistically significantly higher working memory development than children who never used a digital device (6% of those who responded). Digital device usage at home was not significantly related to children's development in inhibition or mental flexibility.

- The number of children's books in the home was statistically significantly related to children's development in working memory. As the number of books increased, so did working memory outcomes. For mental flexibility, children with more than 100 children's books in the home (29% of those who responded) had statistically significantly greater development than children with less than 10 books (9% of those who responded to the parent survey). No statistically significant relationship was found between the number of children's books in the home and inhibition.

- There was a statistically significant positive association between children attending a special or paid-for activity outside of the home (e.g. sports clubs, dance, swimming lessons, language lessons) and working memory. As the frequency with which they attended these activities increased, so too did their working memory outcomes. For mental flexibility, children who attended a special or paid for activity

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[34] The HLE index used in the SEED study measured the frequency of home activities that allow learning opportunities for the child such as the frequency of the child being read to, taken to the library, painting or drawing, playing with letters/numbers and songs/rhymes.
[35] A desktop or laptop computer, a tablet device or smartphone.

outside of the home between 1 and 4 days a week (accounting for 63% of those who responded to the parent survey) had statistically significantly greater outcomes that children who attended less than once a week (15% of those who responded) or never (20% of those who responded). There was no significant difference between children who attended at least 5 days a week and those who attended less than once a week or never.

In England an additional question was added to the parent questionnaire concerning the frequency of parents doing activities with their children to help them to read words or sentences (see section 2.5 for details). This had the following relationships with the self-regulation measures (but note that this analysis has not been adjusted for SES).

Children whose parents reported helping them to read words or sentences at least 5 days a week (36% of the sample) showed significantly greater self-regulation development than children whose parents did this less than once a week or never (6% of the sample) for all 3 measures. The development gap between those whose parents helped them to read words and sentences at least 5 times a week and those whose parents did this less than once a week or never was equivalent to approximately 4 months for inhibition, 6 months for working memory and 9 months for mental flexibility.

Figure 9 Average months' differences for those whose parents helped them to read words or sentences at least 5 days a week, compared to those whose parents did this less than once a week or never.
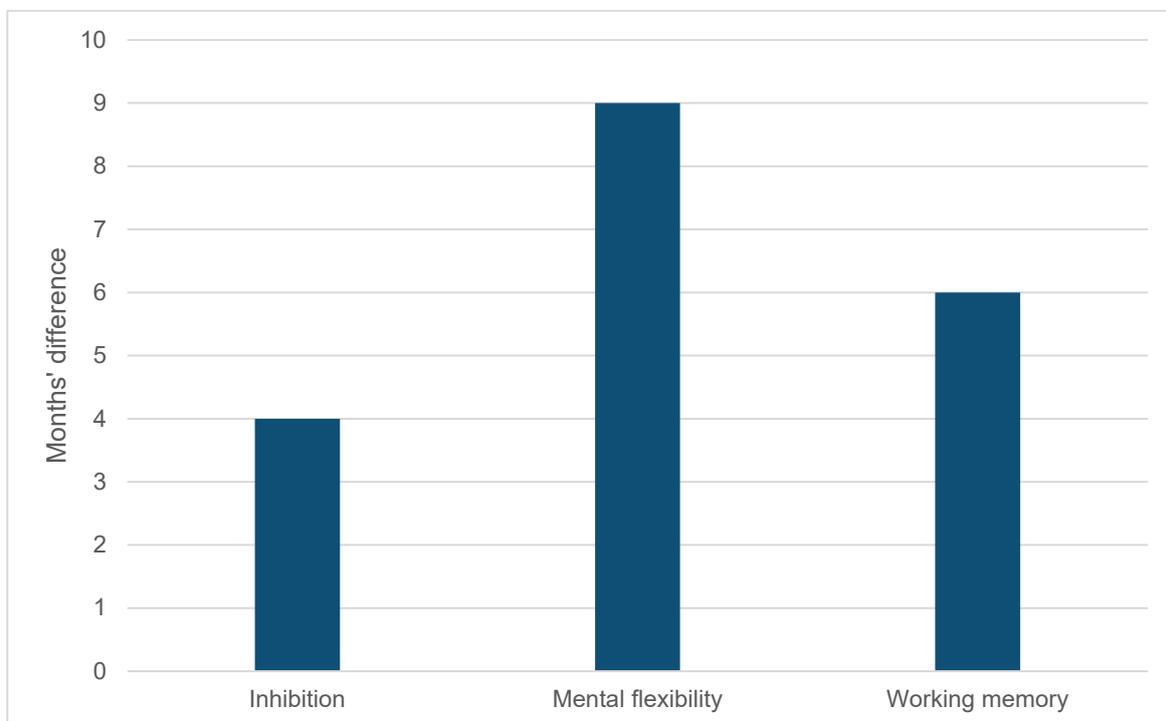
Source: IELS assessment of 1,715 children, age 5, England

Children whose parents reported helping them to read words or sentences 3 or 4 days a week (37% of those who responded) also showed statistically significantly greater development than children whose parents did this less than once a week or never (6%), for mental flexibility and working memory. For mental flexibility, the gap is equivalent to approximately 7 months, whereas for working memory the difference was notably smaller at 4 months. There was no statistically significant difference related to the frequency of parents helping children to read and children's development in inhibition.

3.6 How does children's self-regulation relate to their early childhood education and care (ECEC) experience?

IELS gathered information from the parent questionnaire about children's prior attendance at early childhood education and care (ECEC) in terms of when and the type of ECEC they attended. This analysis was conducted by OECD and all results were adjusted for SES. International comparisons (OECD, 2020b) identified one statistically significant finding in relation to children's attendance at ECEC and their self-regulation development.

- Children who started attending ECEC at age 1 (39%) showed significantly greater development in working memory than children who did not attend an ECEC setting at age 1 (62%).

3.7 How does children's self-regulation relate to their school characteristics?

Analysis of the relationship between region (North, Midlands, Greater London and South[36]) and children's outcomes[37] found there were no statistically significant differences between regions for working memory or mental flexibility. For inhibition, children in Greater London showed statistically significantly greater development than children in the South, equivalent to approximately 3 months' difference. There were no other statistically significant differences in inhibition between children living in different regions.

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[36] Due to small numbers within some of the Government Office Regions, regions were combined into 4 larger regions for analysis purposes.
[37] To control the false discovery rate (FDR) associated with multiple testing, we have applied a Bonferroni adjustment for this analysis. Please see Appendix 2 for further details.

4 Social-emotional development

4.1 Chapter summary

- Social-emotional development in early childhood is an important foundation for later life. IELS measured children's social-emotional development using 2 direct assessments of empathy (emotion identification and emotion attribution) and 3 indirect teacher assessments of prosocial behavior, trust and non-disruptive behavior.

International findings

- Overall, children in England had similar social-emotional development to children in Estonia and the United States, although results differed across the 5 measures.

Persistence and the relationship with other social-emotional measures

- Children whose teachers rated them as 'often' or 'always' demonstrating persistence (34% of the sample) had significantly greater social-emotional development in all 5 measures than those whose teachers rated them as 'rarely' or 'never' demonstrating persistence (18% of the sample). These differences were equivalent to approximately 8 months in emotion identification and 6 months in emotion attribution. It is not possible to estimate months' difference for the other 3 measures because children's development on these measures was not significantly related to age.

The relationship between social-emotional measures and individual characteristics

- Children with an identified special educational need (SEN) had significantly lower scores than their peers in 4 social-emotional measures, but showed significantly greater levels of trust. Those with an identified SEN were approximately 11 months behind their peers in emotion identification and 8 months behind in emotion attribution.

- Girls showed significantly greater development than boys in all 5 measures. Differences were equivalent to approximately 5 months in emotion identification and approximately 7 months in emotion attribution.

- The oldest children in the sample had significantly greater development than the youngest in emotion identification and emotion attribution, but not the 3 other measures. Children in Year 1 had significantly greater development than children

in Reception in emotion identification and emotion attribution, but children in Reception had significantly greater levels of trust.

The relationship between social-emotional measures and family characteristics

- Children eligible for free school meals (FSM) had significantly lower development than their peers in all 5 measures. The difference was equivalent to approximately 5 months in both emotion identification and emotion attribution.

- Children with English as an additional language (EAL) showed significantly lower levels of emotion attribution, prosocial behaviour and trust when compared to their peers. The difference was equivalent to approximately 3 months in emotion attribution. There were no significant differences related to ethnic background.

The relationship between social-emotional measures and the home learning environment

- Children whose parents helped them to read 5-7 days per week had greater development in emotion identification than children whose parents helped them to read less than once a week or never, equivalent to approximately 6 months' difference.

- Several aspects of the home learning environment (HLE) were associated with greater social-emotional development, after accounting for socioeconomic status (SES). Positive social-emotional development was particularly related to parents reporting: having more than 100 children's books at home; having back-and-forth conversations with children about how children feel at least 5 days per week; reading to children at least 5 days per week; attending a special or paid activity outside the home on 1 or 2 days per week; and teachers reporting parents as moderately or strongly involved in their child's school.

- Children's whose parents reported that they used digital devices once a month had greater levels of trust than those who used them once a week. Children whose parents reported doing educational activities on a digital device with their child on 1 or 2 days a week had greater development in emotion identification.

The relationship between social-emotional measures and early childhood education and care

- There were few differences related to early childhood education and care (ECEC) attendance after adjusting for SES. Girls who first attended when they were under 12 months old had significantly greater levels of trust than those who started ECEC at age 3. Children who first attended ECEC aged 3 or more had statistically

significantly higher levels of non-disruptive behaviour than children who first attended at an earlier age.

4.2 What do we know about children's social-emotional development?

Social-emotional development can be understood as a child's ability to begin forming positive relationships with others, to understand and develop behavioural expectations for both themselves and others, and to understand appropriate behavior in different settings (DfE, 2018a; Lally, 2009; Rogoff, 2003). This includes their ability to manage their own emotions and actions as well as to empathise with the feelings of others and respond with appropriate behaviours (DfE, 2018a; Hinnant and O'Brien, 2007; Montroy and others, 2016). The positive relationship between wellbeing and cognitive outcomes has been found to be similar for children regardless of gender, special educational needs (SEN) status, and parents' educational level (Gutman and Vorhaus, 2012).

IELS measured 5 aspects of children's social-emotional development, namely: empathy (comprising emotion identification and emotion attribution); prosocial behaviour; trust; and non-disruptive behaviour. Empathy was measured directly through tablet-based activities, whereas the other measures were collected indirectly via the teacher questionnaire.

For emotion identification and emotion attribution, IELS asked children to respond to story-based scenarios about a set of characters, represented by cartoons. This asked children to identify an emotion using emoticons representing happy, sad, afraid, angry and surprised. Questions were designed to elicit whether children were able to empathise with the characters by correctly identifying the characters' emotional state (emotion identification) and whether they were able to correctly attribute the reasons for the characters' emotional states (emotion attribution).

IELS' measures of prosocial and disruptive behaviour were based on the Adaptive Social Behaviour Inventory[38] (Hogan and others, 1992). The prosocial behaviour measure aimed to capture expression of positive social behaviour (e.g. 'understands others' feelings, such as when they are happy, sad or angry') and conformity with others' expectations (e.g. 'considers other people's feelings'). IELS defines trust as a child's expectation that others will be protective and benevolent. A trusting 5-year-old expects classmates to be reasonable and cooperative and teachers to be protective, responsive and kind. For these reasons, trust is as a positive attribute in young children, although it

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[38] This is an inventory 30 items designed for mothers to assess young children's social competence in relation to children's expression, compliance and disruption.

is important to acknowledge that parents and teachers would not wish children to be indiscriminately trusting of others who could pose a potential risk to them. Teachers taking part in IELS rated whether each child displayed more or less trust (e.g. 'trusts others, asks for help' or 'approaches familiar adults for comfort when upset') than average for children in the same age-range. IELS measured disruptive behaviour using several questions in the teacher questionnaire such as 'Fights with other children', and 'Prevents other children from doing their own activities'. This scale has been reversed so that a positive score represents non-disruptive behaviour.

Social-emotional development in early childhood is known to be an important foundation for later life. Social skills and emotional wellbeing are key facilitators of cognitive development throughout childhood (Gutman and Vorhaus, 2012; Graf and others, 2016; Shuey and Kankaras, 2018). Children's prosocial behaviour before they start school is a predictor of a child's later academic success (Asmussen and others, 2018; Graf and others, 2016). Better emotional development in children at the end of key stage (KS) 1 is a significant predictor of higher attainment at the end of key stage (KS) 2 (Gutman and Vorhaus, 2012). Children's emotional health is also a strong predictor of adult life satisfaction (Flèche and others, 2019). Early development in this area is important for allowing children to develop more complex social-emotional abilities as they mature (Shuey and Kankaras, 2018).

Personal, social, and emotional development (PSED) is one of the key areas of learning assessed in the early years foundation stage profile (EYFSP), consisting of three early learning goals (ELGs): self-confidence and self-awareness; managing feelings and behavior; and making relationships (DfE, 2018a). The 2018 EYFSP results showed that the proportion of children achieving at least the expected level of development in self-confidence and self-awareness was 89%, 88% of children in managing feelings and behaviour, and 90% of children in making relationships (DfE, 2018b).

4.3   What does IELS tell us about children's social-emotional development?

Overall, the international comparisons (OECD, 2020b) showed that 5-year-old children in England had similar social-emotional development to the other two countries participating in IELS, although results differed across the 5 measures, as described below.

The mean development of 5-year-olds in England in emotion identification (i.e. children's ability to correctly identify the feelings of characters in a story) was similar to the United States but statistically significantly lower than Estonia. For emotion attribution (i.e. children's ability to identify the reasons for the emotions experienced by characters in a story), children in England had similar development to children in the other two countries.

72

According to the indirect assessment of their teachers, children in England had similar development in prosocial behaviour to children in the United States, but their development in prosocial behaviour was rated by teachers as statistically significantly lower than children in Estonia. Children in England were rated by their teachers as statistically significantly less disruptive (i.e. they had higher levels of non-disruptive behaviour) than children in Estonia and similar to children in the United States. Children in all 3 countries had similar levels of trust, as assessed by their teachers.

Table 17 shows the means for children's development in England for each of the 5 social-emotional outcomes. As with the other outcome measures, the scores are scaled so that the mean in each measure is 500 and the standard deviation is 100. Each country contributed equally to the computation of the international mean. As shown in Table 17, children in England scored relatively highly on non-disruptive behavior and lower than the international mean on prosocial behavior and emotion identification.

Table 17 Children's development in the social-emotional measures

Measure	Mean	Standard Deviation
Emotion identification	496.58	96.63
Emotion attribution	499.78	96.56
Prosocial behaviour	495.14	97.93
Trust	504.13	103.49
Non-disruptive behaviour	514.69	96.78

Source: IELS assessment of 2,577 children, age 5, England

The study also showed evidence of positive correlations between different aspects of social-emotional development (see Chapter 6). This suggests that children's development in one area of social-emotional development is related to their development in other social-emotional areas.

Although IELS collected data on the 3 indirect measures of social-emotional development (prosocial behaviour, trust and non-disruptive behaviour) from both parents and teachers, the OECD report prioritised findings based on teachers' assessments, so the same approach has been adopted here.

4.3.1 Children's persistence

In England only, both parents and teachers were asked to rate children's persistence on a 5-point scale[39]. Persistence was defined as the extent to which the child 'Continues his/her planned course of action in spite of difficulty or obstacles'. This provided data on a total of 1,551 children for whom there was both a teacher rating and parent rating. Figure 10 shows the distribution across each of the 5 ratings.

Figure 10 Children's persistence as assessed by teachers and parents

To what extent child continues his/her planned course of action in spite of difficulty or obstacles
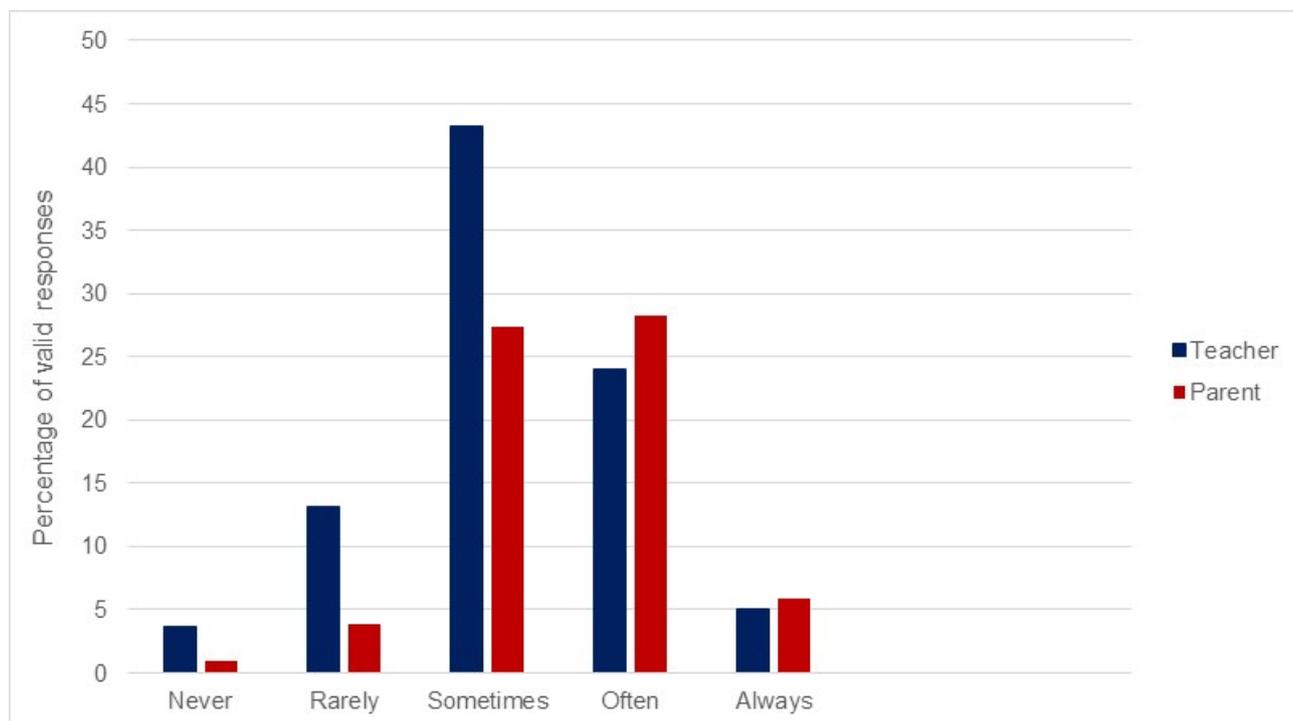
Source: IELS teacher and parent questionnaires completed by 1, 551 teachers parents

Figure 10 shows that both parents and teachers considered most children to be demonstrating persistent behaviour for at least some of the time (a rating of 3 represents that they continued their planned course of action in spite of difficulty or obstacles 'sometimes' and a rating of 4 represents that they did so 'often'). Parents rated children as demonstrating persistence more often ('often' or 'always') than did teachers. There

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[39] The questionnaires asked teachers and parents to rate the child's persistence on a 5-point scale (never, rarely, sometimes, often, always).

was little agreement between parents and teachers in their ratings of each child's persistence, as indicated by the low correlation between the two (r=0.08).

There could be a number of reasons for the differences between parents' and teachers' assessments. Children can behave differently at home and at school, which could account for some of the observed differences between parents' and teachers' judgements.

The relationship between the IELS measures and children's persistence was investigated further using the teacher measure, as this was available for the majority (2,294 children) and because teachers had experience with a large group of children to draw on in making their assessments.

Responses were grouped into high (children rated as 'often' or 'always' persistent) representing 34% of the sample, medium ('sometimes') representing 48% of the sample and low ('rarely' or 'never') representing 18%.

Children's persistence was associated with greater development in all of the 5 IELS outcome measures for social-emotion development.

- Children whose teachers rated them as 'often or always' persistent had statistically significantly greater development in emotion identification than children whose teachers rated them as 'rarely or never' persistent. This was equivalent to approximately 8 months' difference in emotion identification.

- Children who were rated as 'often or always' persistent had statistically significantly greater development in emotion attribution than children who were 'rarely or never' persistent. This was equivalent to approximately 6 months' difference in emotion attribution.

- Children who were rated as 'often or always' persistent had statistically significantly higher levels of non-disruptive behaviour than children who were 'rarely or never' persistent[40].

- Children who were rated as 'often or always' persistent had statistically significantly greater development in prosocial behaviour than children who were 'rarely or never' persistent.

- Children who were rated as 'often/always' persistent had statistically significantly greater levels of trust than children who were 'rarely or never' persistent.

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[40] Note that it is not possible to give an equivalence in months for the size of differences for the 3 indirect measures because these measures did not have a statistically significant relationship with children's age.

4.4 How does children's social-emotional development relate to their individual and family characteristics?

The relationship between social-emotional development and gender

Previous research has found that young boys typically display more disruptive behaviour and emotional problems than do young girls (Sylva and others, 2004). The 2018 EYFSP results (DfE, 2018b) show evidence of a gender gap in children's social-emotional development at age 4, with girls out-performing boys in all 3 PSED ELGs. The gap was 7 percentage points for self-confidence and self-awareness, 10 percentage points for managing feelings and behaviour, and 8 percentage points for making relationships. This sets an expectation for the IELS findings to show that girls out-performed boys in these aspects of social-emotional development.

The gender gap in relation to social-emotional development in England is shown in Table 18.

Table 18 The relationship between gender and social-emotional development

Measure	Girls Mean (a)	Boys Mean (b)	Points difference (a-b)	Standard Error of difference	Equivalence of difference in months
Emotion identification	513.34	480.56	32.77*	5.27	5.00
Emotion attribution	516.54	483.75	32.79*	4.40	6.94
Prosocial behaviour	515.47	475.69	39.78*	4.04	N/A
Trust	514.21	494.49	19.72*	4.03	N/A
Non-disruptive behaviour	530.71	499.38	31.33*	4.07	N/A

* This is statistically significant (p = <0.05)

Source: IELS assessment of 2,577 children, age 5, England

Girls showed statistically significantly greater development in social-emotional development than boys in both the directly-assessed measures (emotion identification and emotion attribution) and the indirect measures (prosocial behaviour, trust and non-disruptive behaviour), which were assessed by teachers. The largest difference by gender was in prosocial behaviour and the smallest difference was in trust.

The gender differences were equivalent to approximately 5 months in emotion identification and approximately 7 months in emotion attribution[41] (see Chapter 2 and Appendix 2 for an explanation of months' difference).

IELS found evidence of a statistically significant gender gap in all 3 countries, with girls having greater development in all 5 measures. The gender gap in England was similar to that in Estonia and greater than in the United States (OECD, 2020b).

The relationship between social-emotional development and socioeconomic status

Previous research has found that young children from higher-income households tend to exhibit more advanced social-emotional development, while their peers from lower-income homes tend to exhibit more disruptive behaviour and poorer emotional health (Feinstein, 2015; Chowdry and McBride, 2017). These differences are evident by the age of 3 (Feinstein, 2015). One study calculated that, at age 5, the gap between the highest and lowest socio-economic class groups in terms of disruptive behavior and emotional health was 0.6 standard deviations (Chowdry and McBride, 2017).

The 2018 EYFSP data (DfE, 2018b) showed that children who were eligible for free school meals (FSM) achieved lower ratings in the three PSED ELGs than their non-FSM eligible peers. There was a gap of 9 percentage points for both self-confidence and self-awareness and making relationships; and a gap of 10 percentage points for managing feelings and behavior between children who were eligible for FSM and their peers.

Information from the national pupil database (NPD) was used to establish children's FSM status. This provided data on 2,462 children (96%), 492 of whom (17%) were eligible for FSM. The relationships between FSM eligibility and the 5 IELS measures of social-emotional development are shown in Table 19.

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[41] It is not possible to give an estimate of the equivalent difference in months of age for the indirect measures because development in these measures was not statistically significantly related to differences in children's age.

Table 19 The relationship between social-emotional development and FSM

Measure	Non FSM Mean (a)	FSM Mean (b)	Points difference (a-b)	Standard Error of difference	Equivalence of difference in months
Emotion identification	501.29	471.22	30.07*	6.45	4.59
Emotion attribution	501.86	478.82	23.04*	6.13	4.88
Prosocial behaviour	498.90	470.16	28.74*	6.31	N/A
Trust	506.63	487.45	19.18*	7.09	N/A
Non-disruptive behaviour	516.32	498.49	17.83*	5.25	N/A

* This is statistically significant (p = <0.05)

Source: IELS assessment of 2,462 children, age 5, England matched to NPD data

The analysis showed that children who were eligible for FSM had considerably lower development than children who were not eligible for FSM in all 5 social-emotional measures. The FSM-related differences were equivalent to approximately 5 months in both emotion identification and emotion attribution.

An analysis of the IELS measure of socioeconomic status (SES), based on their parents' level of education, income and type of employment (OECD, 2020b), showed that children from the most advantaged socioeconomic backgrounds in England had statistically significantly higher social-emotional development than children from the most disadvantaged group. The differences between the most and least advantaged (i.e. comparing those in the top and bottom quarter of the distribution) were statistically significant for all 5 social-emotional outcome measures. The differences in England were similar to those of children in the United States, whereas the SES-related differences in Estonia were narrower than in the other two countries.

These findings are consistent with previous research (Feinstein, 2015; Chowdry and McBride, 2017; DfE 2018b) but IELS is able to add further insights into the range of young children's social-emotional capabilities that are affected and the extent of the deprivation gap.

The relationship between social-emotional development and ethnicity

The 2018 EYFSP results showed some differences for children from different ethnic backgrounds in social-emotional development (DfE, 2018b). Children from White ethnic backgrounds achieved slightly higher scores than all children (by about one percentage point) in all 3 PSED ELGs, while children from Mixed ethnic backgrounds performed similarly to all children. Children from Asian and Black backgrounds scored similarly to each other, but compared to all children, the proportion of children from these backgrounds achieving the expected standard in these ELGs was around 3 percentage points lower.

The IELS team in England analysed children's social-emotional development in relation to their ethnic group. This information was available for 2,436 (95%) of the 2,577 children in the IELS sample after matching to the NPD. A total of 1,852 children (76% of the sample) were in the White ethnic group.

The findings showed no significant differences in social-emotional development when comparing children from different ethnic groups[42].

The relationship between social-emotional development and English as an additional language

In the 2018 EYFSP results (DfE, 2018b), the proportion of children with English as an additional language (EAL) achieving the expected standard in the PSED ELGs was 5 percentage points lower than the proportion of children with English as their first language achieving the expected standard in this area.

For the IELS national analysis, information on children's EAL status was obtained by matching the IELS data with the NPD. The information on EAL status was available for 2,459 children (95% of the sample), 426 of whom (17%) were identified as having EAL.

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[42] The analysis was based on the 'major groups' of Asian, Black, Mixed and White (and any other ethnic groups). Numbers in each category were too small to allow for a more fine-grained analysis of the relationship with ethnicity. There were no significant differences between the White group and the other major ethnic groups, whether analysed separately or as a combined ethnic minority group.

Table 20 The relationship between social-emotional development and EAL

Measure	English as first language mean (a)	EAL Mean (a)	Points difference (a-b)	Standard Error of difference	Equivalence of difference in months
Emotion identification	498.21	485.74	12.48	8.02	N/A
Emotion attribution	500.46	485.86	14.60*	7.31	3.09
Prosocial behaviour	497.66	476.13	21.53*	8.36	N/A
Trust	506.28	489.38	16.89*	8.02	N/A
Non-disruptive behaviour	512.07	519.09	-7.01	7.11	N/A

* This is statistically significant (p = <0.05)

Source: IELS assessment of 2,459 children, age 5, England matched to NPD data

The results showed that children with EAL had statistically significantly lower development for 3 social-emotional outcome measures: emotion attribution (which was directly assessed); prosocial behavior and trust (both of which were assessed by teachers). Children with EAL were approximately 3 months behind their peers for emotion attribution[43]. One possible reason for the difference in emotion attribution is that the direct assessment was based on scenarios presented in the form of short stories, which may have been slightly more difficult for children with EAL. Note that this analysis did not take account of family SES.

The relationship between social-emotional development and special educational needs status

Previous research has shown large differences in the social-emotional development of children with and without an identified special educational need (SEN) (DfE, 2018b). Typically 50% or fewer of 4-year-olds with an identified SEN achieved the expected standard in the PSED ELGs. The gap between children with SEN and their peers for self-

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[43] It is not possible to give an estimate of the difference in months of age for the other 2 outcome measures because the analysis of development on these measures did not find a statistically significant difference between the oldest and youngest children.

confidence and self-awareness, managing feelings and behaviour, and making relationships was 43, 48, and 44 percentage points respectively.

The IELS data was linked to the NPD on SEN. The results of the analysis of social-emotional development for children with SEN are shown in Table 21.

Table 21 The relationship between social-emotional development and SEN

Measure	No identified SEN Mean (a)	SEN Mean (b)	Points difference (a-b)	Standard Error of difference	Equivalence of difference in months
Emotion identification	504.94	432.41	72.53*	7.24	11.07
Emotion attribution	502.69	463.23	39.47*	8.02	8.35
Prosocial behaviour	503.34	426.57	76.77*	7.60	N/A
Trust	510.31	453.52	-56.79*	6.91	N/A
Non-disruptive behaviour	518.23	477.51	40.73*	7.47	N/A

* This is statistically significant (p = <0.05)

Source: IELS assessment of 2,463 children, age 5, England matched to NPD data

The 12% of children in the IELS sample with a SEN identified in the NPD had statistically significantly lower scores in 4 of the 5 social-emotional measures (2 of which were directly assessed and 2 were teacher assessed). When converted to months' difference, it can be seen that children with a SEN identified in the NPD were on average 11 months behind their peers in emotion identification and 8 months behind their peers in emotion attribution. Teachers also considered children with SEN to be statistically significantly more trusting. This is an interesting finding, worthy of further investigation.

The relationships between SEN and social-emotional scores are broadly consistent with the findings from the EYFSP (DfE, 2018b), reported above. They add to our understanding of the needs of young children with SEN and highlight the extent of the relationship between SEN and difficulties in empathy, prosocial behaviour and non-disruptive behaviour. They also show that teachers consider children with SEN to be more trusting.

The relationship between social-emotional development and low birthweight

There is little prior evidence on the relationship between low birthweight and children's social-emotional development.

IELS found no statistically significant differences between children in England with low birthweight (less than 2.5kg) and children with a normal birthweight for any of the 5 measures of social-emotional development used in IELS.

The relationship between social-emotional development, age and year group

Previous research has shown that children who are younger in the year group (summer-born children) have less advanced social-emotional development at the point of entry into primary school compared with children who are older in the year group (Campbell, 2013).

The 2018 EYFSP results (DfE, 2018b), showed a clear age-related gradient in the proportion of children achieving the expected level of development in the PSED ELGs. The performance gap between the percentage of children born in the autumn and summer months who achieved at least the expected level was around 7 percentage points in all 3 of the ELGs (i.e. self-confidence and self-awareness; managing feelings and behaviour; and making relationships). This sets an expectation that children who are older in the year group will achieve higher scores in the social-emotional domain of IELS. It would also be expected that children in Year 1 would show greater development than children in Reception because they are older and have had longer to establish positive social relationships and behavior patterns at school.

Analysis of the IELS results by month of birth[44] confirmed that the 3% of children who were in the oldest age group (i.e. those who were aged 6 years 0 months at the time of the study) had statistically significantly more advanced development in emotion identification and emotion attribution than the 2% in the youngest age group (4 years 11 months). In line with this, children who were in Year 1 (who made up 84% of the sample) had greater development in emotion identification and emotion attribution than those in Reception (who made up the remaining 16%). However in a reversal of this relationship, children in Reception were rated by their teachers as showing statistically significantly greater levels of trust. This relationship is unexpected, and may be influenced by the different expectations and frames of reference being used by teachers in Reception and Year 1. There was no significant relationship between year group and development for prosocial behaviour or levels of non-disruptive behaviour. Figures 11-12 show the

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[44] This analysis was carried out by the IELS national team in England.

relationship between age in months and year group with children's development in the 5 social-emotional measures.

Figure 11 The relationship between age, year group and emotion identification
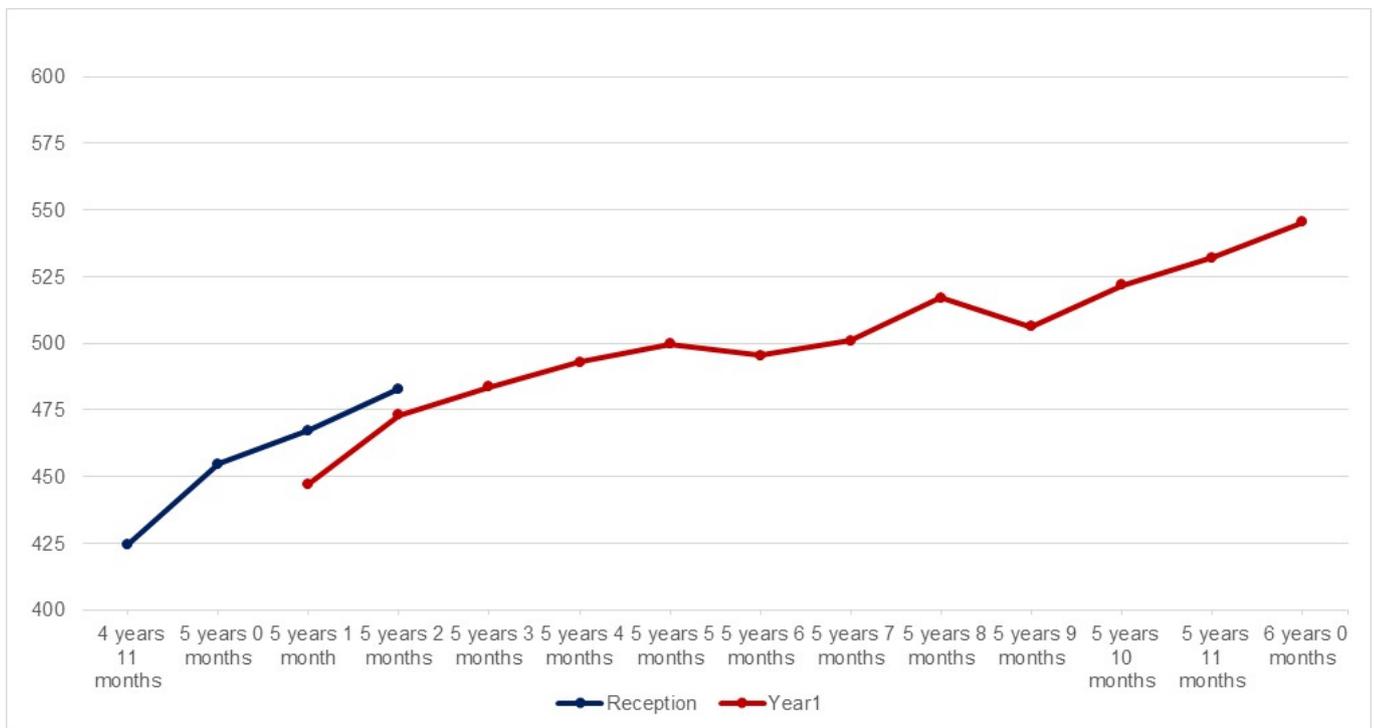
Source: IELS assessment of 2,577 children, age 5, England

Figure 12 The relationship between age, year group and emotion attribution
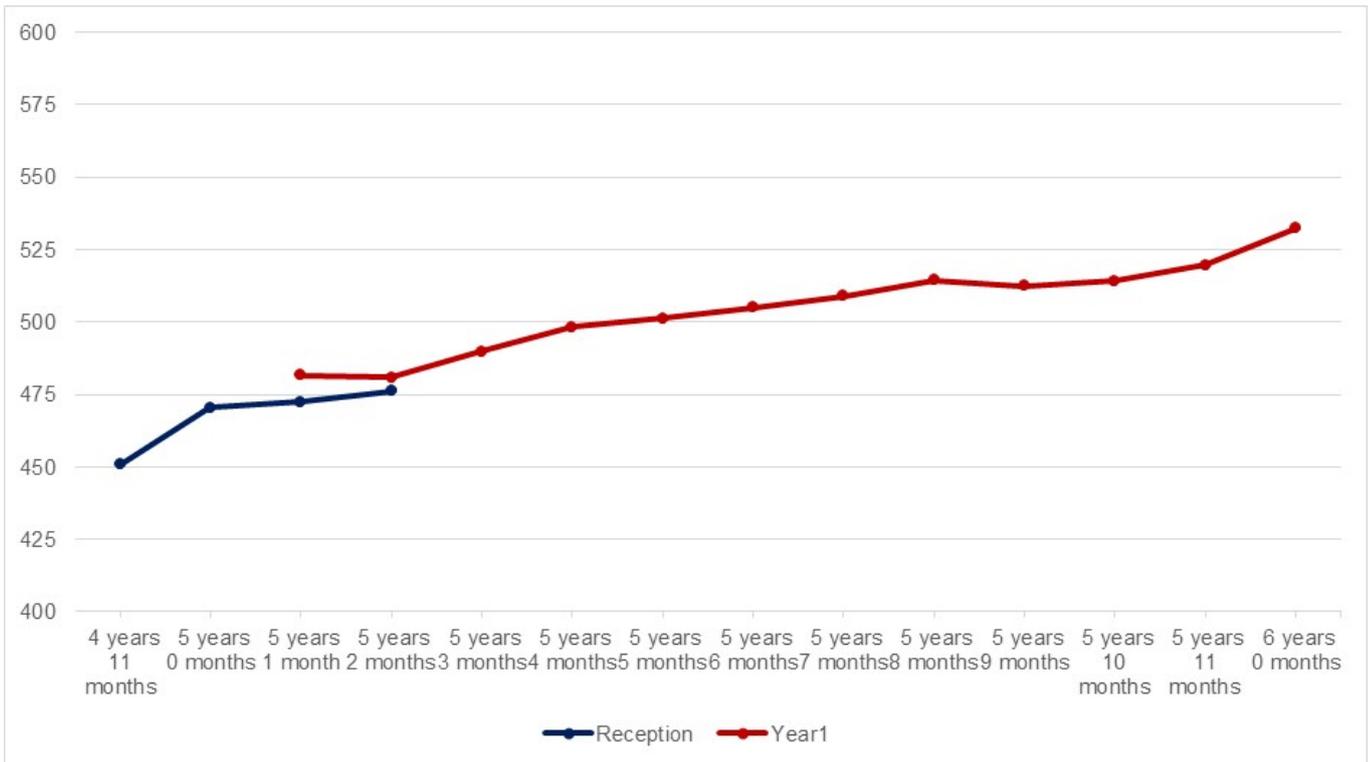
Figure 13 The relationship between age, year group and prosocial behaviour
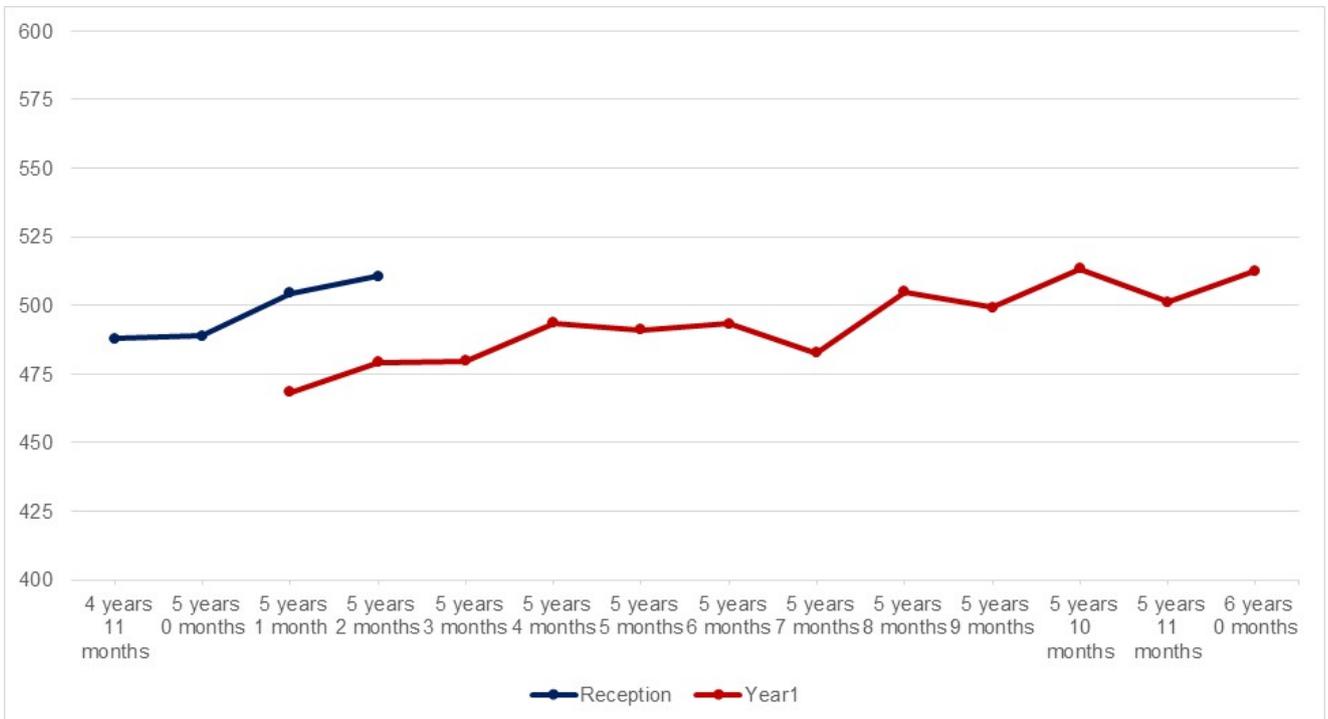
Figure 14 The relationship between age, year group and trust
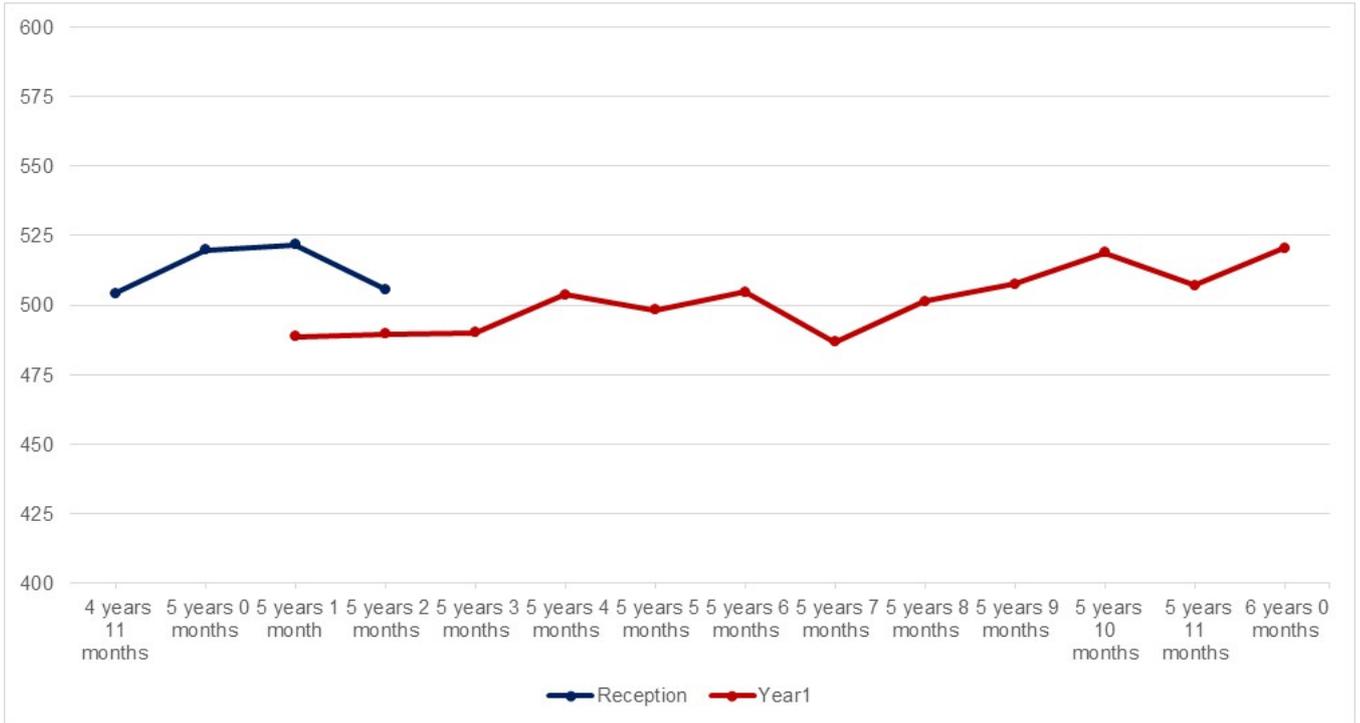
Source: IELS assessment of 2,577 children, age 5, England

Figure 15 The relationship between age, year group and non-disruptive behaviour
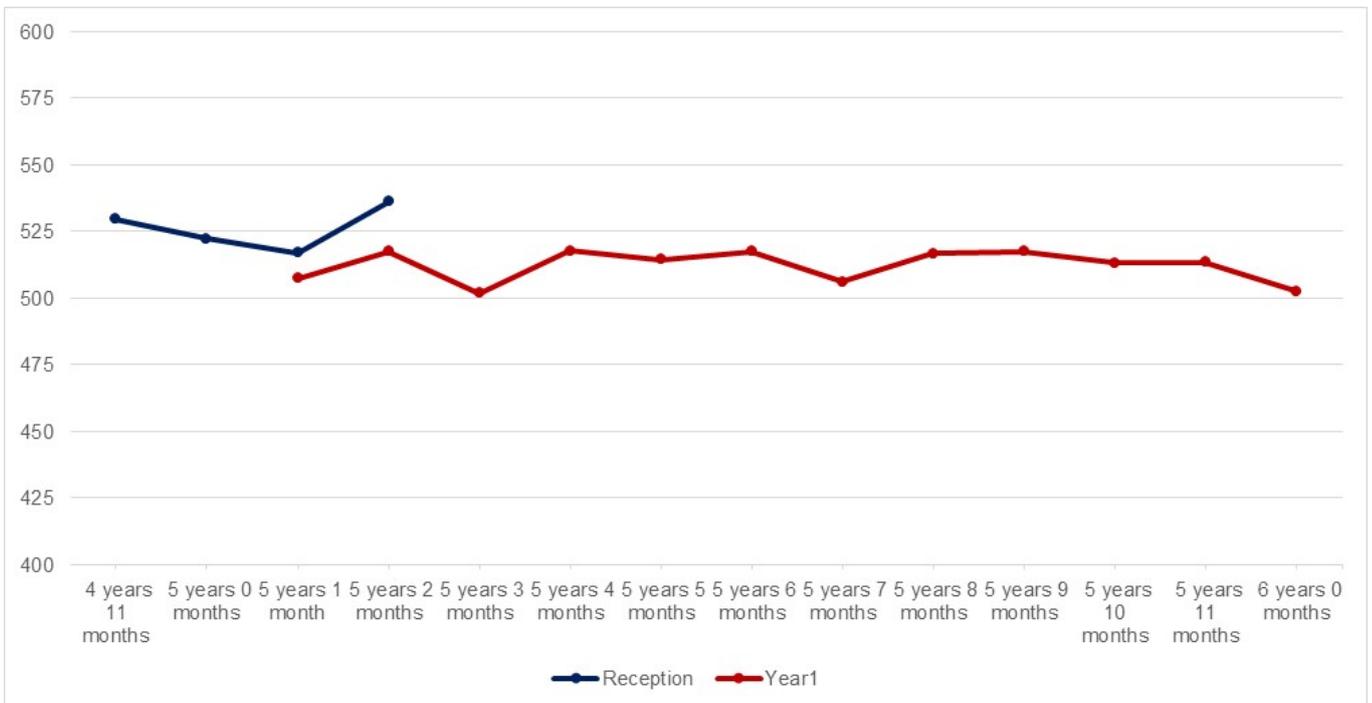
Source: IELS assessment of 2,577 children, age 5, England

The 2 direct measures of empathy showed a clear age-related trend, with older children demonstrating more advanced development, on average, in emotion identification and emotion attribution. The trend for older children to be more advanced in their development is not evident in the other 3 social-emotional measures which relied on indirect assessment by teachers: there was no statistically significant difference in these measures related to children's age. The relationship between children's social-emotional development and their age within a year group was also investigated for the teacher assessments, as it is possible that teachers were comparing the children in the IELS sample with younger children (in Reception) and older children (in Year 1). However, there were no statistically significant differences between children in the youngest and oldest month of birth within a year group in prosocial behaviour, trust or non-disruptive behaviour.

4.5   How does children's social-emotional development relate to their home learning environment?

The Study of Early Education and Development (SEED, Melhuish and Gardiner, 2018; Melhuish and Gardiner, 2020) found that high home learning environment (HLE) scores[45] were associated with higher levels of prosocial behaviour at age 4 and greater EYFSP scores for PSED by age 5.

The IELS study (OECD, 2020b) found statistically significant associations between social-emotional development and the following aspects of children's HLE in England: the number of children's books in the home; the use of digital devices; role play; back-and-forth conversations; being read to; going to special activities; and parental involvement in their school. These findings were statistically significant after adjusting for parental SES and are described below.

- Children who had more than 100 children's books at home (29% of those who responded) had greater development in emotion identification and prosocial behaviour than children who had 26-50 children's books at home (22% of those who responded). However, this relationship was non-linear, suggesting this not as simple as more children's books in the home is related to higher scores in emotion identification and prosocial behaviour.

- Children who used an digital device[46] between 1 and 3 times a month (9% of those who responded) had greater development in trust compared to those who

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[45] The HLE index used in the SEED study measured the frequency of home activities that allow learning opportunities for the child such as the frequency of the child being read to, taken to library, painting/drawing, play with letters/numbers and songs/rhymes.
[46] A desktop or laptop computer, a tablet device or smartphone.

used a digital device more often (more than once a week but not every day, accounting for 46% of those who responded, or every day, accounting for 39% of those who responded).

- Children who did role-play with their parents 1 or 2 days a week (32%) had greater development in emotion attribution than children who never did so (4%).

- Children who had a back-and-forth conversation with their parents about how they feel at least 3 days a week (81%) had greater development in emotion identification than children who did so less than once a week (3%).

- Children who had a back-and-forth conversation with their parents about how they feel at least 5 days a week (53%) had lower development in emotion attribution than children who did so between 1 and 4 days a week (43%). This is not easily explained and warrants further investigation.

- Children who had a back-and-forth conversation with their parents about how they feel at least 5 days a week (53% of those who responded) had greater development in prosocial behaviour than children who did so 3 or 4 days a week (28%).

- Children whose parents read to them at least 5 days a week (59% of those who responded) had greater development in emotion identification and prosocial behaviour than children whose parents read to them once or twice a week (12%).

- Children who regularly attended special or paid activities outside the home (such as sports or dance clubs) 1 or 2 days a week (47% of those who responded) had greater development in emotion identification, emotion attribution and prosocial behaviour than children who never did so (20%); and greater levels of trust than those who did so less than once a week (15%).

- Children who regularly attended special or paid activities outside the home at least 5 days a week (2% of those who responded) had higher levels of non-disruptive behaviour than those who attended 1 or 2 days a week (47%) or never (20%).

- Children whose parents were moderately or strongly involved in their children's school[47] (69%) had greater levels of emotion identification, prosocial behaviour, trust and non-disruptive behaviour compared with those who were slightly or not involved in their child's schooling (31%).

In England a further question was added to the parent questionnaire concerning the frequency of parents doing activities with their children to help them to read words or

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[47] The teacher questionnaire asked teachers to rate how involved each child's parents/carers were in activities (such as school fetes, concerts and parents' evenings) taking place at the school on a 4-point scale ('strongly involved' to 'not involved at all')

sentences (see section 2.5 for details). This had the following relationships with the social-emotional measures (but note that this analysis has not been adjusted for the family SES).

- Children whose parents helped them to read words or sentences at least 3 days per week (73%) had statistically significantly greater development in emotion identification than children whose parents helped them to read less than once a week or never (6%). This was equivalent to 5 months' difference in emotion identification for children whose parents helped them read on 3 or 4 days per week and 6 months' difference for children whose parents did so at least 5 days per week.

- There were no statistically significant differences for the other 4 social-emotional measures related to the frequency with which children's parents helped them to read. This is perhaps not surprising, given that teaching children to read would not necessarily be expected to affect their social-emotional development.

4.6 How does children's early social-emotional development relate to their early childhood education and care (ECEC) experience?

Previous research shows that early childhood education and care (ECEC) provision can play an important role in supporting children's early social, and behavioural development (Sylva and others, 2008; Bonetti and Brown, 2018; Melhuish and Gardiner, 2018). Irrespective of demographic and home environment factors, children who had attended ECEC in some form scored more highly in social and behaviour outcomes at age 5 and age 7 when compared with those who had not (Melhuish and Gardiner, 2018; Sylva and others, 2004; 2008).

The quality of ECEC is important. Children who attended a high quality ECEC setting were more likely to exhibit more pro-social behaviours at age 16 (Sammons and others, 2014 and 2015).

Previous research suggests that starting ECEC at between 2 and 3 years old is linked with more pro-social behaviours when interacting with other children (Sylva and others, 2004; 2008; Melhuish and Gardiner, 2018). The benefits of an early start in ECEC for pro-social behaviour are still evident at the end of KS1.

There is, however, also evidence from the United States that children who spend an average of 30 hours in childcare or more per week during their first 4-and-a-half years of life are more likely to exhibit behavioural issues (NICHD and US Department of Health and Human Services, 2006). Similarly, the SEED longitudinal study in England found that 4-year-olds who had spent over 35 hours per week in formal group ECEC had greater

conduct problems (Melhuish and Gardiner, 2018). At age 5 the SEED study (Melhuish and Gardiner, 2020) found a larger amount of time spent in formal group ECEC settings (such as playgroups and nursery classes) between the age of 2 and starting school was associated with poorer outcomes on a child socio-emotional scales measured during Year 1[48] namely: higher externalising behavior and internalising behavior, lower prosocial behaviour and behavioural and emotional self-regulation (see also Chapter 3). On the other hand, the use of some individual informal ECEC (e.g. from friends and relatives) appeared to counteract the negative social-emotional effects of high formal group ECEC use (Melhuish and Gardiner, 2020).

IELS gathered information from the parent questionnaire about children's prior attendance at ECEC. This analysis was conducted by OECD (2020b) and all results were adjusted for SES. The statistically significant findings are summarised below.

- Children who first attended ECEC when they were under 12 months of age had statistically significantly higher levels of trust than those who started attending ECEC at 3 years of age. However, this relationship differed by gender: there was no significant difference for boys between those who first attended ECEC under 12 months and those who attended aged 4, but girls who first attended ECEC when they were under 12 months had higher trust at age 5 than girls who first attended when they were 3 or 4 years old.

- Children who first attended ECEC at age 3 or older had statistically significantly higher levels of non-disruptive behaviour than children who first attended ECEC at an earlier age.

These findings add to our understanding of the relationship between ECEC attendance and children's social-emotional development and are consistent with the findings from the SEED study (Melhuish and Gardiner, 2020) – which measured children's development at the same age as IELS, although the two studies used different measures of children's social-emotional development.

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[48] The SEED study used the Children's Self-regulation and Behaviour Questionnaire (CSBQ), completed by children's teachers. This produced two socio-emotional problems scales: externalising behaviour (e.g. child loses temper, child argues with other children) and internalising behaviour (e.g. child is easily upset, child is anxious) and five socio-emotional strengths scales: sociability; prosocial behaviour; behavioural self-regulation; cognitive self-regulation and emotional self-regulation.

5 Physical development

5.1 Chapter summary

- Children's physical development is a key aspect of their early development, as recognised in the Early Years Foundation Stage (EYFS) and primary curricula. In England, a teacher-assessed module on physical development, measuring fine and gross motor skills, was added to IELS based on teachers' assessments of children's gross and fine motor development. This was then used to create a single measure of physical development (see appendix 2 for further details).

The relationship between physical development and individual characteristics

- Children with an identified special educational need (SEN) were over 12 months behind in physical development compared with their peers without an identified SEN.

- Girls showed significantly greater levels of physical development than boys, equivalent to approximately 9 months' difference.

- Children who experienced low birthweight showed significantly lower levels of physical development than their peers, equivalent to approximately 9 months' difference.

- Older children showed significantly greater physical development than younger children.

The relationship between physical development and family characteristics

- Children eligible for free school meals (FSM) showed significantly lower levels of physical development than their peers, equivalent to approximately 8 months' difference.

- There were no significant differences in physical development related to ethnicity or English as an additional language (EAL).

The relationship between physical development and the home learning environment

Please note this analysis did not control for socioeconomic status (SES).

- Children who drew pictures or painted 3 or 4 days per week at home showed significantly greater physical development than children who drew or painted less than once a week or never[49]. This was equivalent to approximately 5 months' difference.

- Children who were taken to a special or paid activity outside the home (e.g. sports clubs, dance, swimming lessons, language lessons) between 1 and 4 days a week showed significantly greater physical development than children who were taken to a special or paid activity outside the home less than once a week or never. This was equivalent to approximately 8 months' difference.

- Children who had more than 100 children's books in the home showed significantly greater physical development than children with 10 or fewer children's books. This was equivalent to approximately 7 months' difference.

- There was no significant relationship between children's physical development and the frequency of: doing physical activities outside; doing educational activities on an electronic device; or their parents helping them to read.

5.2 How the physical development measure for IELS was developed

Physical development is a key area of children's early development (Early Education, 2012; Asmusson and others, 2018; DfE, 2018a; Shuey and Kankaras, 2018; Sim and others, 2018). It features as one of 3 prime areas of learning within the EYFS, alongside communication and language development and personal, social and emotional development. Countries participating in IELS were able to add around 5-10 minutes of national items to the questionnaires and in England a short physical development module was developed for inclusion in the teacher questionnaire.

The physical development measure was intended to be similar to the Early Years Foundation Stage Profile (EYFSP) early learning goal (ELG) 04 – moving and handling. It comprised 8 questions from the teacher questionnaire designed to capture a range of areas of fine and gross motor development (see Appendix 2 for further details on the development of this measure, including the full wording of all questions). Figure 16 shows teachers' answers to each question, listed in order of difficulty (from highest to lowest percentage of children whose teachers rated them as 'always' being able to demonstrate each area), rather than the order in which they appeared on the questionnaire.

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[49] Note that none of the analysis of HLE variables presented in this chapter was not adjusted for SES.

Figure 16 Components of the physical development measure
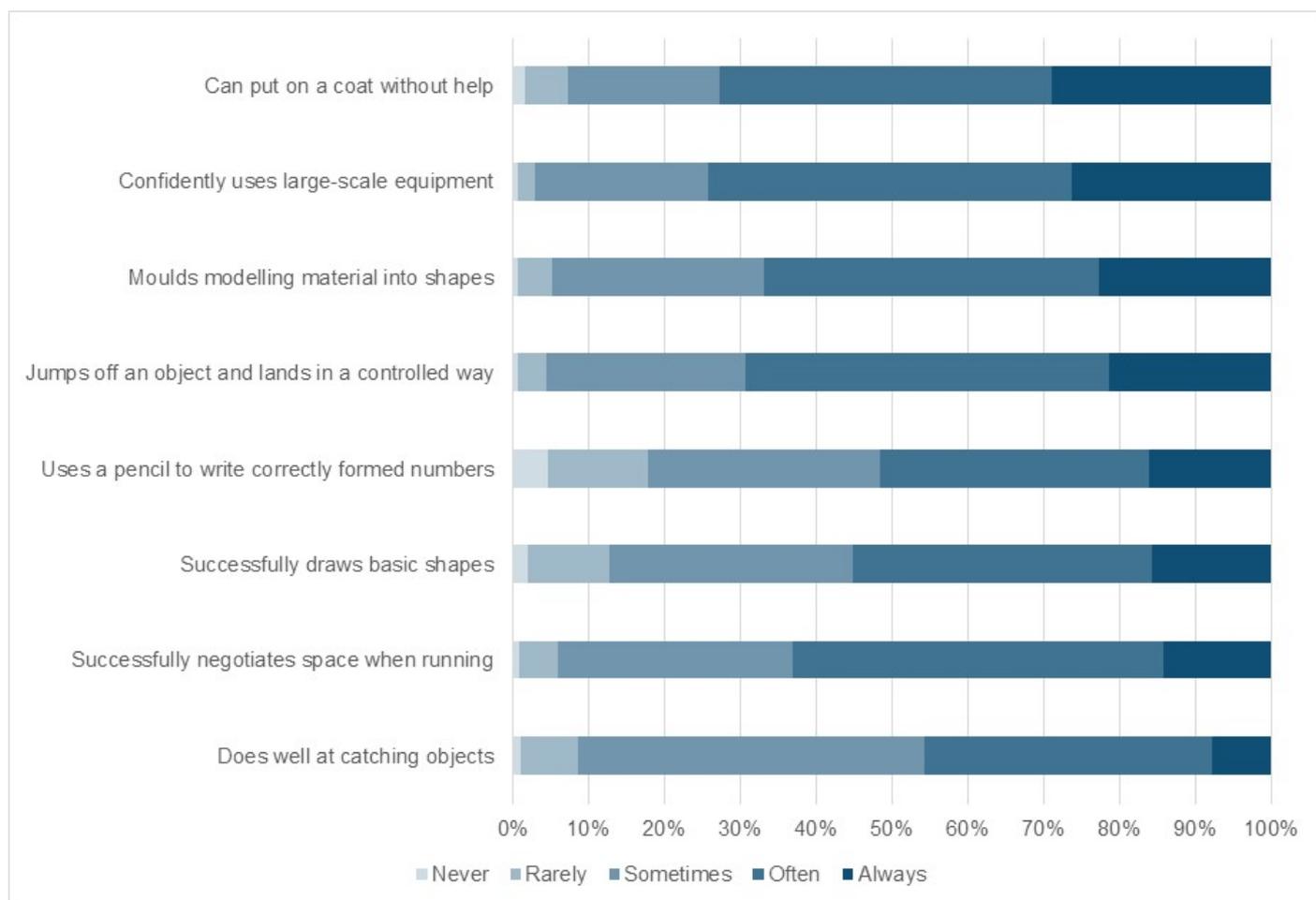
Of the physical development tasks, children at the age of 5 appeared most able to 'Put on a coat without help, including zips and buttons': teachers assessed 29% of children as able to do this 'always' and 44% as able to do it 'often'. In contrast, just 8 per cent of children were rated as 'always' and 37% of children as 'often' for the question 'Does well at games or activities that involve catching objects'. Tasks involving forming numbers correctly and drawing basic shapes had the highest proportion of children rated as 'never' and 'rarely' able to do this.

The responses to each of these questions formed the physical development measure. Analysis demonstrated that the questions grouped together to form a single coherent measure of physical development, rather than separating into two discrete measures of fine and gross motor development. The resulting measure was found to be reliable and of good quality (see Appendix 2 for further information).

The IELS physical development measure was scaled to have a mean of 500 points and standard deviation of 100 points so that it was consistent with the international measures.

Figure 17 shows the distribution of the children's physical development outcomes.

Figure 17 The distribution of children's physical development outcomes
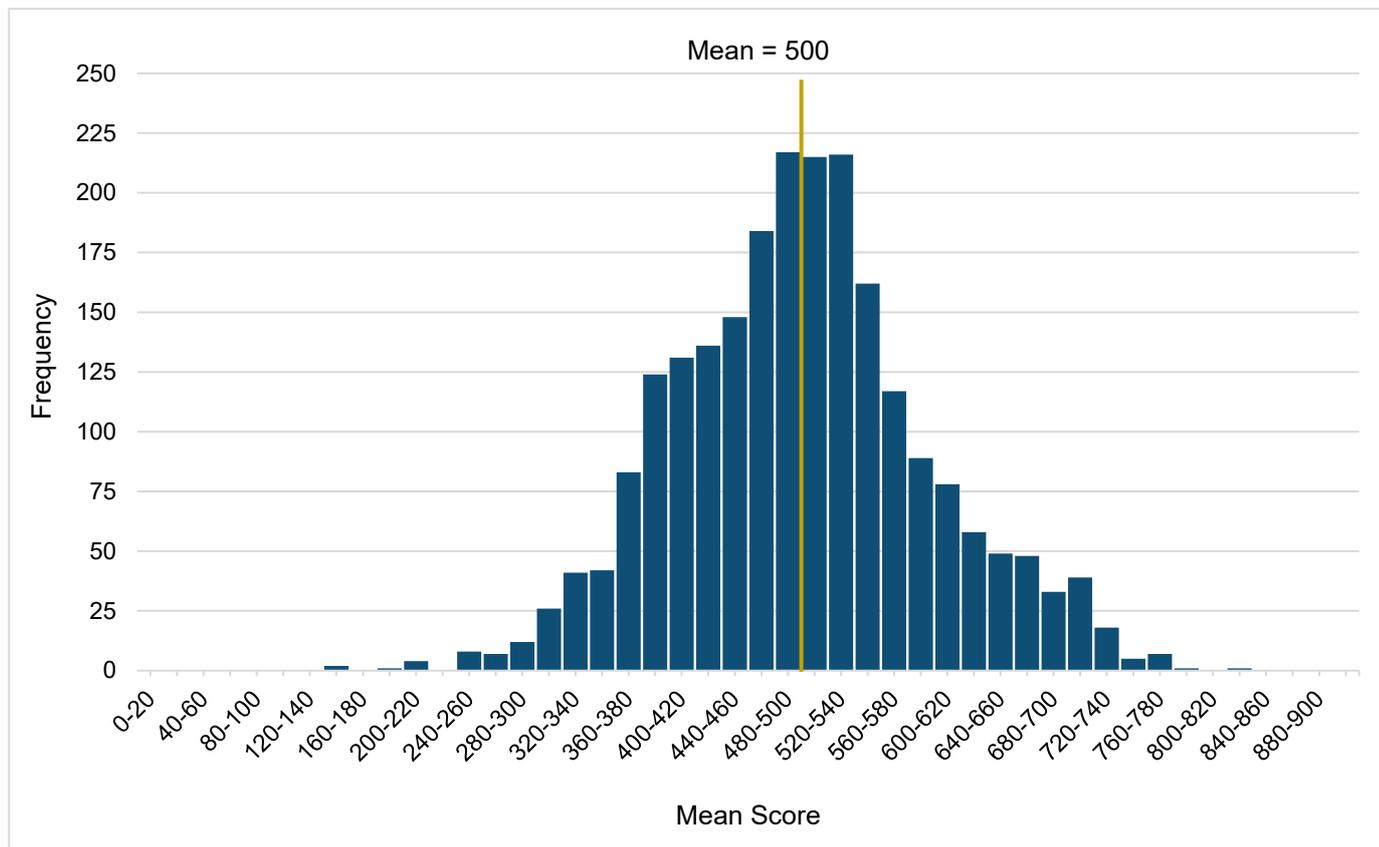
Source: IELS assessment of 2,302 children, age 5, England

5.4   How does children's physical development relate to their individual and family characteristics?

The relationship between early physical development and gender

The 2018 EYFSP results (DfE, 2018b) show a clear gender gap in physical development at the end of the Reception year. The results indicate that girls out-performed boys on the moving and handling ELG by 9 percentage points (94% of girls achieved at least the expected level compared to 85% of boys).

Table 22 shows the relationship between gender and physical development in IELS.

Table 22 The relationship between physical development and gender

Measure	Girls Mean (a)	Boys Mean (b)	Points difference (a-b)	Standard Error of difference	Equivalence of difference in months
Physical development	519.89	483.33	36.56*	3.6	9.27

* This is statistically significant (p < 0.05)

Source: IELS assessment of 2,302 children, age 5, England

IELS found that girls showed a statistically significantly higher level of physical development than boys, which is consistent with the 2018 EYFSP results (DfE, 2018b). Girls were approximately 9 months ahead of boys in physical development.

The relationship between early physical development and socioeconomic status

Previous evidence shows a clear gap in performance associated with socioeconomic status (SES) for physical development. In the 2018 EYFSP results (DfE, 2018b), children eligible for free school meals (FSM) scored on average 9 percentage points lower in moving and handling than children who were not eligible for FSM.

The IELS team in England investigated the relationship between SES and physical development using FSM eligibility as recorded in the national pupil database (NPD).

Table 23 shows the differences between children eligible for FSM and their peers.

Table 23 The relationship between physical development and FSM

Measure	Non FSM Mean (a)	FSM Mean (b)	Points difference (a-b)	Standard Error of difference	Equivalence of difference in months
Physical development	505.65	473.94	31.71*	7.14	8.03

* This is statistically significant ($p < 0.05$)

Source: IELS assessment of 2,191 children, age 5, England matched to NPD data

The analysis showed that children eligible for FSM had significantly lower levels of physical development than their peers. The difference between these groups of children was equivalent to approximately 8 months. This finding is consistent with the national findings from the EYFSP (DfE, 2018b).

The relationship between early physical development and ethnicity

There were some small differences in the 2018 EYFSP physical development results for children from different ethnic backgrounds (DfE, 2018b). Children from White and Mixed ethnic backgrounds performed similarly to each other, and to all pupils on physical development (90% achieved the expected level of development). Children from Asian and Black backgrounds scored slightly lower than all children (by 2 percentage points). Children from Chinese backgrounds scored higher than all children, by 4 percentage points.

The IELS team found no statistically significant differences in physical development when comparing children with White ethnicity to children in the 3 other ethnic groups[50]. The difference between IELS and EYFSP is likely to be influenced by much larger number of children in the EYFSP sample, which allows for a finer-grained analysis by ethnic group.

Further analysis of the IELS results found that there was no statistically significant difference in physical development between children with an immigrant background and those without.

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[50] The analysis used the 'major groups' to compare children from White backgrounds with Asian, Black, Mixed, using data from the NPD. Numbers in each category were too small to allow for a more fine-grained analysis of the relationship with ethnicity. There were no significant differences between the White ethnic group and the other major ethnic groups, whether analysed separately or as a combined ethnic minority group.

The relationship between early physical development and English as an additional language

In the 2018 EYFSP results (DfE, 2018b), children identified as having English as an additional language (EAL) scored on average 2 percentage points lower on moving and handling compared to children whose first language was English.

The IELS national team matched the IELS data with the NPD, which provided the EAL status of 2,190 participating children who also had physical development outcomes. In total, 383 (18%) of these children were identified as having English as an additional language. Analysis found no significant difference on the IELS national measure of physical development between children with EAL and their peers.

The relationship between early physical development and special educational needs status

Having an identified special educational need (SEN) was associated with much lower scores for moving and handling in the 2018 EYFSP (DfE, 2018b). The gap between the percentage of children with and without SEN who achieved at least the expected level was 42 percentage points.

The IELS data was matched to the NPD to obtain information on whether children who participated in IELS had any identified SEN. This information was available for 2,192 children, 271 of whom (12%) had an identified SEN.

Table 24 shows the relationship between SEN status and physical development.

Table 24The relationship between physical development and SEN

Measure	Non SEN Mean (a)	SEN Mean (b)	Points difference (a-b)	Standard Error of difference	Equivalence of difference in months
Physical development	511.10	424.35	86.75*	8.25	12+

* This is statistically significant (p < 0.05)

Source: IELS assessment of 2,192 children, age 5, England matched to NPD data

The analysis found that children with a SEN identified in the NPD had statistically significantly lower scores on physical development than their peers, which is consistent with the EYFSP findings. Children with a SEN identified in the NPD were on average over 12 months behind their peers without SEN.

The relationship between early physical development and low birthweight

Previous research has suggested that children's physical growth and motor skills may be adversely affected by low birthweight (Caputo and Mandell, 1970; Zwicker and Harris, 2008).

In this study, the IELS team found that there was a statistically significant difference in the development of children in England who had experienced low birthweight (defined as a birthweight of less than 2.5kg) and those that had not. The findings below are based on the 1,580 children who had both responses from parents about their birthweight and data from their teachers about their physical development. In total 177 (11%) of the children in this group had a low birthweight.

Table 25 The relationship between physical development and low birthweight

Measure	Not low birthweight Mean (a)	Low birthweight Mean (b)	Points difference (a-b)	Standard Error of difference	Equivalence of difference in months
Physical development	506.81	470.18	36.64*	7.33	9.28

* This is statistically significant (p < 0.05)

Source: IELS assessment of 1,580 children, age 5, England

Children who had experienced low birthweight had a physical development level of 37 points lower than then peers. This is equivalent to approximately 9 months' difference.

The relationship between early physical development and age within a year group

The 2018 EYFSP results (DfE, 2018b) show that a higher proportion of children who were older in the year group achieved the expected level in physical development. There was a performance gap of 8 percentage points between children born in the autumn and summer months[51] who achieved at least the expected level of moving and handling in the EYFSP.

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[51] The EYFSP results are grouped into three age-related categories: autumn born with birthdays in September to December; spring born with birthdays in January to April and summer born, with birthdays in May to August.

The IELS results indicated an age-related trend whereby older children showed greater physical development than younger children, as shown in Figure 18.

Figure 18 The relationship between age, year group and physical development
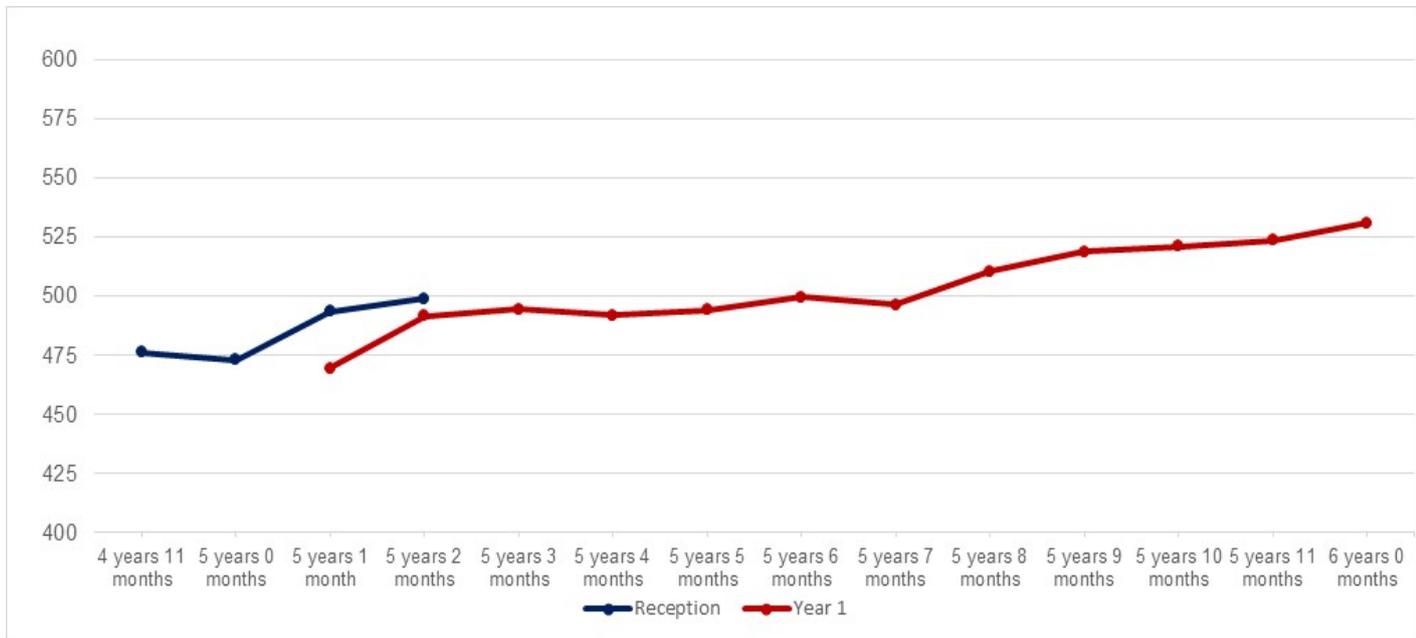
<div align="right">Source: IELS assessment of 2,302 children aged 5, England</div>

The difference between the youngest children in the sample (aged 4 years and 11 months at the time of the study, comprising 2% of the sample) and the oldest children (aged 6 years and 0 months, comprising 3% of the sample) was statistically significant[52]. It was equivalent to over 12 months' difference, which is consistent with actual age difference between these groups of children.

As might be expected, given that they were older and had experienced an additional year in school, children in Year 1 showed statistically significantly greater physical development than children in Reception.

Although children in Reception appeared to have greater levels of physical development than children of the same age in Year 1 (i.e. those who were aged 5 years 1 month and 5 years 2 months at the time of the study), the differences were not statistically significant.

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[52] To control the false discovery rate (FDR) associated with multiple testing, we have applied a Bonferroni adjustment for this analysis. Please see Appendix 2 for further details.

5.5   How does children's physical development relate to their home learning environment?

There is little prior evidence on the relationship between children's physical development and the home learning environment (HLE), although the study of early education and development (SEED, Melhuish and Gardiner, 2020) found a positive relationship between a high quality HLE between the ages of 2-5 years and children's physical development score in the 2018 EYFSP.

The IELS physical development measure was analysed in relation to a selection of 5 activities in the HLE that may reasonably be considered to be related to children's fine or gross motor development. These concerned the frequency with which children did each of the following activities with their parents or another adult in their home: drawing pictures or painting; doing things outside like walking, ball games, swimming, or cycling; doing educational activities on an electronic device[53]; parents taking their child to a special or paid activity outside of the home (e.g. sports clubs, dance, swimming lessons, language lessons); receiving help to read, and the number of children's books in the home.

The main aspects of the HLE which were found to be statistically significantly related to children's physical development were: drawing/painting; attending special or paid activities outside the home; and the number of children's books in the home. However, please note that these results have not been adjusted for SES, which means that some of the observed differences could be due to differences in SES, rather than in the HLE activities themselves.

The findings are summarised below

- Children who drew pictures or painted 3 or 4 days a week (37% of the sample) showed significantly greater physical development than children who drew pictures or painted less than once a week or never (7% of the sample). This was was equivalent to approximately 5 months' difference.

- Children who were taken to a special or paid activity outside of the home between 1 and 4 days a week (63% of the sample) showed significantly greater physical development than children who were taken to a special or paid activity outside of the home less than once a week or never (35% of the sample). This difference was equivalent to approximately 8 months for children who attended these activities between 1 or 2 days a week (47% of the sample) and over 12 months for children who attended 3 or 4 days a week (16% of the sample). There was no

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[53] A desktop or laptop computer, a tablet device or smartphone.

significant difference between children who were taken to a special or paid activity at least 5 days in a week (2%) and those who taken to such an activity less than once a week never. This suggests that moderate attendance (1 to 4 days) appears to be associated with greater physical development than very frequent attendance (5 of more days per week).

- Children who had more than 100 children's books in the home (29% of the sample) showed a significantly greater level of physical development than children with 0-10 children's books (9% of the sample). This equates to approximately 7 months' difference.

- There were no significant differences in physical development between children who regularly did physical activities outside and those who did not.

- There were no significant differences in physical development between children who did educational activities on a computer, tablet or smartphone regularly and those who did not.

- There were no significant differences in physical development between children whose parents helped them to read regularly and those who did not.

6 Relationships between children's areas of development

6.1 Chapter summary

- The findings from IELS indicate that young children's development in one domain of learning is highly related to development in other domains. This suggests that children with lower development in one area (such as their cognitive or physical development) may also have lower development in others (such as self-regulation or social-emotional development) and could benefit from support to strengthen those areas of development.

- Children's development in language and emergent literacy was most strongly related to their development in emergent numeracy.

- Both emergent literacy and emergent numeracy were strongly correlated with the outcome measures of mental flexibility, working memory and emotion identification.

- Mental flexibility and working memory were strongly related. There were moderate correlations between both mental flexibility and inhibition and working memory and inhibition.

- Inhibition was moderately correlated with emergent numeracy and physical development but the relationship between inhibition and most outcome measures was relatively weak. There was no evidence of a significant relationship between inhibition and non-disruptive behaviour.

- There were different relationships between the direct and indirect outcome measures within the social-emotional domain. The 2 direct measures (emotion identification and emotion attribution) were strongly correlated with each other and prosocial behaviour was strongly correlated with the other 2 indirect measures of trust and non-disruptive behaviour. Trust was moderately correlated with non-disruptive behaviour.

- Physical development was most strongly correlated with 2 of the social-emotional outcome measures: prosocial behaviour and trust. It was moderately strongly correlated with all the other outcome measures apart from emotion attribution, which was weakly correlated with physical development.

- Persistence was moderately correlated with 8 of the 11 IELS measures (prosocial behaviour, trust, physical development, emergent literacy, emergent numeracy, non-disruptive behaviour, working memory and mental flexibility) and weakly correlated with inhibition, emotion identification and emotion attribution.

6.2 How would we expect different areas of children's development to relate to each other?

Evidence from previous research suggests that children's development in the early years is highly inter-related, with development in one area affecting development in another. As Shuey and Kankaras (2018) explain:

> The areas of early learning that are of particular importance for many adult outcomes include: language and literacy; numeracy and other non-verbal cognitive development; self-regulation; emotional health, social well-being and social-emotional development. Early learning occurs across these domains with gains in one domain contributing to gains in other domains. This ongoing cycle of reinforcement across domains means that early learning must be assessed using a whole-child approach, recognising the overlapping nature of outcomes for young children.

> *Shuey and Kankaras (2018, page 9).*

IELS explored the following areas of development among 5-year-old children in England: cognitive; self-regulation (including executive function); social-emotional; and physical. As children's development is inter-related, it is important to consider the reinforcement between these areas rather than viewing each one in isolation.

6.3 What does IELS tell us about the relationship between children's development in literacy, numeracy, self-regulation, social-emotional development and physical development?

This chapter presents the correlation coefficients[54] between the different IELS outcome measures. Strong and moderately strong correlations imply a relationship between 2 measures, however, the direction of the relationship cannot be determined. That is to say, it cannot be stated which outcome measure influences the other, rather that the measures are mutually related. As physical development was unique to England, the physical development correlations have been calculated by the IELS team in England.

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[54] A correlation lower than 0.20 is considered relatively weak, between 0.20 and 0.50 is moderately strong, and over 0.50 is strong.

Emergent literacy and numeracy

Evidence from previous research

Early language difficulties predict problems in literacy and reading comprehension, as well as in children's behaviour and other social, emotional and learning outcomes (Law and others, 2017). This suggests that early language development is a primary indicator of child mental health and wellbeing. The emergent literacy activities in IELS focused on listening comprehension, vocabulary knowledge and phonological awareness (OECD, 2020b).

School-entry numeracy competence is the strongest predictor of later academic achievement (Duncan and others, 2007).

Inter-relationships with literacy and numeracy: findings from IELS

The emergent numeracy measure in IELS focused on simple problem-solving and the application of concepts and reasoning in: numbers and counting, working with numbers, shape and space, measurement, and pattern (OECD, 2020b). Table 26 shows the relationships between emergent literacy and emergent numeracy and the other IELS outcome measures. Colour and labels have been used to indicate whether correlations are relatively weak (grey and labelled 'weak'), moderately strong (amber and labelled 'medium') or strong (red and labelled 'strong'). Where a cell has a white background and no label, this is either because the two measures are not significantly correlated with each other or because an outcome is being compared with itself.

Table 26 Relationships between emergent literacy and emergent literacy and other measures

Outcome measure	Emergent literacy	Emergent numeracy
Emergent numeracy	0.83* (strong)	-
Inhibition	0.15* (weak)	0.28*(medium)
Mental flexibility	0.52* (strong)	0.57* (strong)
Working memory	0.65* (strong)	0.74* (strong)
Emotion identification	0.59* (strong)	0.54* (strong)
Emotion attribution	0.34* (medium)	0.34* (medium)
Prosocial behaviour	0.40* (medium)	0.37* (medium)
Trust	0.27* (medium)	0.21* (medium)
Non-disruptive behaviour	0.21* (medium)	0.18* (weak)
Physical development	0.42* (medium)	0.46* (medium)

* The correlation is statistically significant[55]

Source: IELS assessment of 2,577 children (2,302 children for physical development), age 5, England

Table 26 shows that emergent literacy development was statistically significantly related to all of the other areas of development measured in IELS in England. The correlations indicate that children's development in emergent literacy was most strongly related to their development in emergent numeracy, with a correlation coefficient of 0.83[56]. This is the strongest correlation identified from comparing all IELS outcome measures in England to one another. This finding suggests that a child's development of emergent literacy is mutually reinforcing of their development in emergent numeracy.

Emergent literacy was also strongly related to 2 of the 3 cognitive self-regulation outcome measures: mental flexibility and working memory. This supports previous research findings that a child's ability to self-regulate is associated with their development in literacy (Blair and Razza, 2007). However, it is worth noting that the correlation between emergent literacy and inhibition was relatively weak, which suggests that some areas of cognitive self-regulation are less indicative of early literacy development than others.

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[55] When statistical significance is reported, it indicates that the compared means are significantly different at the 5% level, unless stated otherwise.
[56] A correlation lower than 0.20 is considered relatively weak, between 0.20 and 0.50 is moderately strong, and between 0.50 and 0.80 is strong.

With regards to social-emotional development, IELS found that children's development in emergent literacy was strongly correlated with emotion identification and moderately correlated with emotion attribution, prosocial behaviour, trust and non-disruptive behaviour. A child's social-emotional mastery during their early years occurs alongside their cognitive development (Shuey and Kankaras, 2018). Law and others, (2017) suggest that instead of running in parallel, early language development actually predicts a child's social-emotional development, as a child's ability to use language underpins most of their social interactions.

There was also a moderately strong relationship between children's emergent literacy and physical development.

Table 26 also shows that children's emergent numeracy development was statistically significantly related to all of the other areas of development measured in IELS. Areas of executive function play an important role in numeracy development (Raghubar and others, 2010; Clark and others, 2010; Blair and Razza, 2007). This relationship can be seen in the IELS data: emergent numeracy was strongly correlated with working memory and mental flexibility and the relationship between emergent numeracy and inhibition was moderately strong.

Children's development in emergent numeracy was positively related to their social-emotional development. Emergent numeracy was strongly correlated with emotion identification and moderately strongly correlated with emotion attribution, prosocial behaviour and trust. The relationship between emergent numeracy and non-disruptive behaviour was also present but relatively weak. These findings suggest that children's early numeracy development is related to their social-emotional development, though the relationship between emergent numeracy and non-disruptive behaviour is not as strong as between emergent numeracy and the other 4 social-emotional outcome measures.

The relationships between emergent literacy and the other outcome measures were similar to those of emergent numeracy, although the correlation with working memory is higher for emergent numeracy (0.74) than emergent literacy (0.65). There were 2 key differences in strength of correlations: inhibition was moderately correlated with emergent numeracy, but weakly correlated with emergent literacy; and non-disruptive behavior was weakly correlated with emergent numeracy but moderately correlated with emergent literacy.

Self-regulation

Developing self-regulation is considered important in helping children to engage successfully in both cognitive and non-cognitive tasks, which impacts on learning in social, emotional, and cognitive domains (Shuey and Kankaras, 2018).

IELS measures 3 areas of self-regulation; inhibition, mental flexibility and working memory (OECD, 2020b). These are cognitive aspects of self-regulation (or executive function) and it is worth noting that much of the existing research literature on self-regulation focuses on behavioural self-regulation instead. Table 27 shows the relationship between the cognitive self-regulation outcome measures assessed in IELS. Colour and labels have been used to indicate whether correlations are relatively weak (grey and labelled 'weak'), moderately strong (amber and labelled 'medium') or strong (red and labelled 'strong'). Where a cell has a white background and no label, this is either because the two measures are not significantly correlated with each other or because an outcome is being compared with itself.

Table 27 Relationships between measures of self-regulation

Outcome measures	Inhibition	mental flexibility
Mental flexibility	0.39* (medium)	-
Working memory	0.37* (medium)	0.60* (strong)

* The correlation is statistically significant

Source: IELS assessment of 2,577 children, aged 5, England

IELS found evidence that a child's mental flexibility is strongly related to their working memory. Inhibition was also positively related to mental flexibility and working memory to a moderate extent. This suggests that children's development in one area of cognitive self-regulation is positively related to their development in the other areas within self-regulation measured in IELS. Table 28 looks further at how children's development in self-regulation is related to the other domains measured in IELS. Colour and labels have been used to indicate whether correlations are relatively weak (grey and labelled 'weak'), moderately strong (amber and labelled 'medium') or strong (red and labelled 'strong'). Where a cell has a white background and no label, this is either because the two measures are not significantly correlated with each other or because an outcome is being compared with itself.

Table 28 Relationship between self-regulation and other measures

Outcome measures	Inhibition	Mental flexibility	Working memory
Emergent literacy	0.15* (weak)	0.52* (strong)	0.65* (strong)
Emergent numeracy	0.28* (medium)	0.57* (strong)	0.74* (strong)
Emotion identification	0.15* (weak)	0.43* (medium)	0.45* (medium)
Emotion attribution	0.06* (weak)	0.23* (medium)	0.26* (medium)
Prosocial behaviour	0.09* (weak)	0.25* (medium)	0.27* (medium)
Trust	0.06* (weak)	0.12* (weak)	0.11* (weak)
Non-disruptive behaviour	-0.01	0.15* (weak)	0.13* (weak)
Physical development	0.20* (medium)	0.32* (medium)	0.36* (medium)

* The correlation is statistically significant

Source: IELS assessment of 2,577 children (2,302 children for physical development), age 5, England

As shown in Table 28, both mental flexibility and working memory were statistically significantly related to all other IELS outcome measures. Mental flexibility and working memory were most strongly correlated with emergent numeracy, with correlation coefficients of 0.57 and 0.74 respectively. These 2 self-regulation measures were also strongly correlated with emergent literacy and had moderately strong positive relationships with emotion identification, emotion attribution, prosocial behaviour and physical development. Trust and non-disruptive behaviour were weakly correlated with both mental flexibility and working memory. These findings expand on previous literature (Shuey and Kankaras, 2018), suggesting that working memory and mental flexibility relate to children's early literacy, numeracy and physical development as well as to some areas of social-emotional development.

In general, correlations between children's inhibition development and other IELS outcome measures were weaker than for the other 10 IELS measures. It is difficult to know why this was the case, but it does suggest that the Inhibition measure was less indicative of children's development in other areas. Inhibition was moderately correlated with emergent numeracy and physical development. Inhibition was weakly correlated with emergent literacy, emotion identification, emotion attribution, prosocial behaviour and trust. This suggests that a child's cognitive inhibition (i.e. their ability to mentally inhibit a learned response) does not necessarily impact on their social-emotional development, but it does relate to their working memory, mental flexibility, emergent numeracy and physical development.

Social-emotional development

Previous research has found evidence that children's social-emotional development is linked to their cognitive development. In particular, children with weaker social-emotional development typically have weaker cognitive development and vice versa (Chowdry and McBride, 2017; Feinstein, 2015). For example, Chowdry and McBride (2017) found that children who had the most behavioural and emotional problems at age 5 scored lower in cognitive tests than their peers who had the least behavioural and emotional problems, with the top quintile on average 0.4 to 0.45 standard deviations below the bottom quintile.

Five aspects of children's social-emotional development were measured in IELS: empathy (comprising emotion identification and emotion attribution); prosocial behaviour; trust; and non-disruptive behaviour (OECD, 2020b). Empathy was measured directly, whereas the other measures were collected indirectly via the teacher questionnaire. Table 29 shows the correlation coefficients between the social-emotional development outcome measures. Colour and labels have been used to indicate whether correlations are relatively weak (grey and labelled 'weak'), moderately strong (amber and labelled 'medium') or strong (red and labelled 'strong'). Where a cell has a white background and no label, this is either because the two measures are not significantly correlated with each other or because an outcome is being compared with itself.

Table 29 Relationships between measures of social-emotional development

Outcome measures	Emotion attribution	Prosocial behaviour	Trust	Non-disruptive behaviour
Emotion identification	0.61* (strong)	0.30* (medium)	0.16* (weak)	0.15* (weak)
Emotion attribution	-	0.20* (medium)	0.11* (weak)	0.10* (weak)
Prosocial behaviour	0.20* (medium)	-	0.74* (strong)	0.55* (strong)
Trust	0.11* (weak)	0.74* (strong)	-	0.32* (medium)

* The correlation is statistically significant

Source: IELS assessment of 2,577 children, age 5, England

IELS found a strong correlation between the direct measures of emotion identification and emotion attribution, which suggests these aspects of empathy are mutually reinforcing. Prosocial behaviour was strongly correlated with trust and non-disruptive behaviour. Trust and non-disruptive behaviour were moderately correlated.

In addition, prosocial behaviour was moderately correlated with both emotion identification and emotion attribution. Non-disruptive behaviour had a weak correlation with emotion identification and emotion attribution while trust was weakly correlated with emotion identification and emotion attribution.

Table 30 shows the relationship between children's development in social-emotional development and other domains. Colour and labels have been used to indicate whether correlations are relatively weak (grey and labelled 'weak'), moderately strong (amber and labelled 'medium') or strong (red and labelled 'strong'). Where a cell has a white background and no label, this is either because the two measures are not significantly correlated with each other or because an outcome is being compared with itself.

Table 30 Relationships between social-emotional and other measures

Outcome measures	Emotion identification	Emotion attribution	Prosocial behaviour	Non-disruptive behaviour	Trust
Emergent literacy	0.59* (strong)	0.34* (medium)	0.40* (medium)	0.21* (medium)	0.27* (medium)
Emergent numeracy	0.54* (strong)	0.34* (medium)	0.37* (medium)	0.18* (weak)	0.21* (medium)
Inhibition	0.15* (weak)	0.06* (weak)	0.09* (weak)	-0.01	0.06* (weak)
Mental flexibility	0.43* (medium)	0.23* (medium)	0.25* (medium)	0.15* (weak)	0.12* (weak)
Working memory	0.45* (medium)	0.26* (medium)	0.27* (medium)	0.13* (weak)	0.11* (weak)
Physical development	0.31* (medium)	0.18* (weak)	0.63* (strong)	0.33* (medium)	0.52* (strong)

* The correlation is statistically significant

Source: IELS assessment of 2,577 children (2,302 children for physical development), age 5, England

Emotion identification was strongly correlated with both emergent literacy and emergent numeracy, while the correlation between emotion attribution and both emergent literacy and emergent numeracy was moderately strong. This is consistent with the theory that a child's development in empathy is predicted by their cognitive capabilities as suggested by Law and others, (2017). Prosocial behaviour and trust had a correlation with physical development, while emotion identification and non-disruptive behaviour had moderate

correlations with physical development. Emotion attribution had a weak relationship with physical development.

Prosocial behaviour was moderately correlated with most IELS outcome measures, namely: emergent literacy, emergent numeracy, mental flexibility and working memory. Of the 5 social-emotional outcome measures, prosocial behaviour was most strongly correlated with physical development.

IELS found that non-disruptive behaviour was weakly related to a child's development in the cognitive self-regulation and emergent numeracy domains, as indicated by the low correlations for all 4 of these outcome measures. The correlation between non-disruptive behaviour and inhibition was not statistically significant; this was the only relationship between all outcome measures where the IELS results suggested there was no evidence of a positive relationship. There were moderately strong relationships between non-disruptive behaviour and emergent literacy and physical development.

Trust was strongly correlated with physical development and moderately strongly correlated with emergent literacy and emergent numeracy. There was a weak relationship between trust and all 3 cognitive self-regulation measures. None of the 5 social-emotional outcome measures had a strong relationship with inhibition.

Physical development

There is evidence that good physical development during early childhood may have beneficial effects for cognitive development, though the evidence-base is acknowledged to be relatively weak (Asmussen and others, 2018; Carson and others, 2016; EEF, 2019; Timmons and others, 2007; Zeng and others, 2017). In a systematic literature review of the effects of physical activity in early childhood, Zeng and others, (2017) found that greater physical activity was associated with positive changes in language learning, academic achievement, attention, and working memory. Studies indicate that gross motor development helps children to explore and understand their environment while fine motor development facilitates cognitive learning activities such as writing and counting (Asmussen and others, 2018; EEF, 2019). There is some evidence to suggest that young children's fine motor development predicts later academic attainment, particularly in numeracy (Pitchford and others, 2016).

Research into physical development and its relationship with other aspects of child development is not as extensive as is the case for the other IELS domains. To add to the growing body of research on physical development, the IELS team in England designed an indirect measure of children's gross and fine motor development (see Chapter 5 of this report) which formed part of the teacher questionnaire in England. The correlations in Table 31 were calculated by the IELS team in England. Colour and labels have been

used to indicate whether correlations are relatively weak (grey and labelled 'weak'), moderately strong (amber and labelled 'medium') or strong (red and labelled 'strong').

Table 31 Relationships between physical development and other measures

Outcome measures	Physical development
Emergent literacy	0.42* (medium)
Emergent numeracy	0.46* (medium)
Inhibition	0.20* (medium)
Mental flexibility	0.32* (medium)
Working memory	0.36* (medium)
Emotion identification	0.31* (medium)
Emotion attribution	0.18* (weak)
Prosocial behaviour	0.63* (strong)
Trust	0.52* (strong)
Non-disruptive behaviour	0.33* (medium)

* The correlation is statistically significant

Source: IELS assessment of 2,302 children, age 5, England

Table 31 shows that children's physical development was statistically and positively related to all the other IELS measures. Physical development was most strongly correlated with 2 of the social-emotional outcome measures: prosocial behaviour and trust. Physical development had a moderately strong correlation with 2 other aspects of social-emotional development (emotion identification and non-disruptive behaviour). There was a weak relationship between physical development and emotion attribution. This suggests that while a child's physical development does not necessarily impact or rely on their emotional attribution, it does relate to other aspects of their social-emotional development.

In line with previous research (Zeng and others, 2017) this study found that children's physical development was related to their cognitive development and cognitive self-regulation. Physical development had moderately strong correlations with both emergent numeracy and emergent literacy as well as with mental flexibility, working memory and inhibition.

Persistence

Persistence was measured by a single question in the teacher questionnaire on the extent to which the child 'Continues his/her planned course of action in spite of difficulty

or obstacles'. Teachers provided this information for 2,294 children. The correlations between persistence and the other IELS outcome measures were calculated by the IELS team in England and are shown in Table 32. Colour and labels have been used to indicate whether correlations are relatively weak (grey and labelled 'weak'), moderately strong (amber and labelled 'medium') or strong (red and labelled 'strong').

Table 32 Correlations between persistence and IELS outcome measures

Outcome measures	Persistence
Emergent literacy	0.28* (medium)
Emergent numeracy	0.28* (medium)
Inhibition	0.08* (weak)
Mental flexibility	0.21* (medium)
Working memory	0.22* (medium)
Emotion identification	0.19* (weak)
Emotion attribution	0.11* (weak)
Prosocial behaviour	0.45* (medium)
Trust	0.42* (medium)
Non-disruptive behaviour	0.25* (medium)
Physical development	0.41* (medium)

* The correlation is statistically significant

Source: IELS teacher assessment of 2,294 children, age 5, England

Table 32 shows that persistence was statistically significantly related to all of the 11 IELS outcome measures. It was moderately strongly correlated with 8 measures, ranging across cognitive, self-regulation, social-emotional and physical development. The lowest correlations were with inhibition, emotion identification and emotion attribution.

As noted in Chapter 4, the difference between children who were rated as 'often or always' persistent (34% of the sample) compared with those who were 'rarely or never' persistent (18% of the sample) was equivalent to approximately 8 months in emotion identification and 6 months in emotion attribution.

The approximate difference in months for the other outcome measures are given below.

- Children whose teachers rated them as 'often or always' persistent showed statistically significantly greater development in emergent literacy and emergent numeracy than children who were rated as 'rarely or never' persistent. The

difference was equivalent to approximately 11 months in emergent literacy and 8 months in emergent numeracy.

- Children whose teachers rated them as 'often or always' persistent showed statistically significantly greater development in mental flexibility, working memory and inhibition than children who were rated as 'rarely or never' persistent. The difference was equivalent to approximately 10 months in inhibition, 7 months for mental flexibility and 3 months in working memory.

- Children whose teachers rated them as 'often or always' persistent showed statistically significantly greater physical development than children who were rated as 'rarely or never' persistent. The difference was equivalent to approximately 12 or more months in physical development.

7   Discussion and conclusion

IELS is a new international study aiming to illuminate children's learning and development in the early years. Any new study faces potential challenges in achieving sufficient participation to be representative of the wider population, but thanks to the willingness of children, parents and teachers to participate, the study was implemented successfully and involved 2,577 children from 191 schools across England. This means that the findings are robust and representative of children nationally. IELS used both direct and indirect measures to assess young children in cognitive areas (emergent literacy and numeracy), self-regulation and social-emotional development. Using experienced study administrators to deliver the activities on tablet devices proved engaging for children, as well as ensuring that the study was delivered consistently within and between participating countries.

International comparisons revealed that children in England had broadly similar development to children in the United States and Estonia, although they showed evidence of greater development than the other 2 countries in emergent numeracy and lower development in inhibition (i.e. the ability to stop giving a learned response when provided with a new stimulus). For 3 of the measures (namely: emergent literacy, working memory and mental flexibility) children in England and Estonia had similar development to each other and greater development than children in the United States.

The findings demonstrate the inter-relationship of children's development within and between different domains. The IELS results show a strong relationship between children's development in emergent literacy and emergent numeracy, and between the cognitive and self-regulation domains (especially working memory and mental flexibility). Children's development in empathy (emotion identification) was strongly related to their cognitive development, and their prosocial development and trust were both strongly related to their physical development. These findings are supportive of a broad curriculum in the early years, including an emphasis on executive function, social-emotional and physical development as well as early literacy and numeracy.

The IELS national team added an item to the teacher questionnaire on children's persistence (i.e. the extent to which a child continued his or her course of action in spite of difficulties or obstacles). This provided evidence of a positive relationship between children's persistence and their development in all the IELS outcome measures. The fact that persistence is related to all aspects of children's development that IELS measured is worthy of further exploration to better understand this.

The IELS national team added a measure of children's physical development to the teacher questionnaire in England. The findings from this analysis underline the importance of children's fine and gross-motor development. The study identified some of the risk factors for poorer physical development at age 5, including eligibility for free

school meals (FSM), having an identified special educational need (SEN) and low birthweight. These may be important considerations for primary schools, early childhood education and care (ECEC) settings and education and health services focused on the physical wellbeing of young children. As well as considering young children's physical development as important in its own right, the study found strong associations between physical development and other aspects of children's development, especially social-emotional development (prosocial behaviour and trust). One possible explanation for these relationships is that children's physical development is important to enabling them to form relationships with others, through non-verbal interaction and physical play. Physical development was also moderately strongly related to children's cognitive development and self-regulation. Taken together, these findings reinforce the importance of children's physical development and support its status as a key aspect of the early years foundation stage (EYFS) and the primary school curriculum.

Findings on the relationships between children's individual/family characteristics and their development in a range of areas were broadly consistent with the 2018 early years foundation stage profile (EYFSP) results. (DfE, 2018b). Girls showed greater development than boys on a range of measures including: emergent literacy, physical development and all 5 measures of social-emotional development. The gender gap was greatest for physical development (equivalent to approximately 9 months). Girls also showed greater development than boys in emotion attribution (approximately 7 months) and emotion identification (approximately 5 months). The gap was smaller for emergent literacy (approximately 2 months). There were only 2 measures where girls did not show greater development than boys: emergent numeracy and inhibition. IELS showed no significant difference between girls and boys in the direct measure of emergent numeracy, although teachers and parents gave higher ratings to girls' than boys' numeracy development, which may reflect girls being more able to communicate or express their numeracy skills than boys. In inhibition, boys showed greater development than girls, equivalent to approximately one month.

The international comparisons (OECD, 2020b) suggested that there was a stronger link between socioeconomic status (SES) and development at age 5 in England than in Estonia. The link between SES and development was similar in England and the United States for emergent literacy and stronger in the United States for emergent numeracy. Further analysis of the IELS data provided additional evidence of a deprivation gap, with children eligible for free school meals (FSM) showing lower development in all the 3 international domains: cognitive; self-regulation; social-emotional; as well as the physical domain (measured in England only). The extent of the deprivation gap ranged from the equivalent of approximately 8 months for physical development, 6 months for emergent literacy, 5 months for emergent numeracy and 5 months for both empathy measures, to 4 months for mental flexibility and working memory.

IELS revealed few statistically significant differences related to ethnicity, but EAL was a risk factor for children's development in the cognitive, self-regulation and social-emotional domains. As might be expected, the largest EAL-related gap (equivalent to 8 months) was found in emergent literacy, whereas the gap was around 3 months for other measures (emergent numeracy, mental flexibility, working memory and emotion attribution).

Children with an identified special educational need (SEN) made up approximately 12% of the IELS sample in England, the majority of whom had difficulties with communication and interaction. Having an identified SEN was associated with lower scores in almost all of the 11 IELS outcome measures and the associated gaps were larger than those associated with any of the other background characteristics. The greatest gaps in outcomes for SEN were in physical development (equivalent to over 12 months' difference); emergent literacy (12 months); mental flexibility (11 months); and emotion identification (11 months). In contrast, children with SEN were identified by their teachers as being more trusting than other children of the same age. These findings indicate the importance of recognising and supporting children with SEN across all 4 domains.

An interesting new insight provided by IELS is the relationship between birthweight and children's development at age 5. This information was available for two-thirds (66% of the sample), of which 11% had a low birthweight of less than 2.5kg (most of whom were also born prematurely). The results showed that low birthweight is related to lower cognitive and physical development, as well as poorer working memory, but it is not related to children's social-emotional development. The largest development gap associated with low birthweight was found in physical development (equivalent to approximately 9 months). The other gaps were around 3 months (emergent literacy) or 4 months (emergent numeracy and working memory). This builds on the work by Quigley and others, (2012) on the impact of premature birth on children's later development. The IELS findings suggest that low birthweight conveys a similar disadvantage to that of FSM eligibility and is another element that affects a child's risk profile for poorer performance in cognitive and physical development at age 5. This information could be useful to ECEC staff and parents in identifying low birthweight as a risk factor for children's development and considering how best to support them in the early years.

The fact that IELS included children of different ages ranging across two school year groups provided an opportunity to explore the relationship between children's age, year group and development. As expected, children in the oldest age group (6 years 0 months) had significantly greater development than children in the youngest age group (4 years 11 months) and children in Year 1 tended to have greater development than children in Reception on most measures. There was no evidence of an age effect for the 3 indirect measures of children's social-emotional development. Two of the measures (prosocial behaviour and non-disruptive behaviour) showed no evidence of a relationship

with year group but in the case of trust, children in Reception showed greater levels of trust than children in Year 1.

IELS set out to identify factors that foster and hinder children's early learning, both at home and in early childhood education and care (ECEC) programmes. Findings from IELS confirm the key importance of the home learning environment (HLE). IELS found evidence of associations between a number of HLE activities and children's outcomes after controlling for the effects of SES. In particular, greater development in more than one area of learning was associated with parents' reports of: having more than 100 children's books at home; attending a special or paid-for activity between 1 and 4 days a week; having a back-and–forth conversation about children's feelings at least 5 days a week; and reading to their child at least 5 days a week. Interestingly, there were some positive relationships with children's use of digital devices. Low use (once a month) – as reported by parents – was associated with greater development in emergent literacy and higher levels of trust. Using digital devices for educational activities once or twice a week was related to greater development in emotion identification. Higher use of digital devices (weekly or daily) – for any purpose, not just educational activities – was related to greater development in working memory.

There were positive associations between children's development and teachers' reports of parents being more engaged with their child's school. There were also positive relationships between parents' reports of helping their child to read on 3 or more days per week and children's cognitive and self-regulation development (although note this analysis does not account for parents' SES). These findings suggest that education policy should continue to focus on encouraging and supporting a high-quality learning environment at home, especially for children from disadvantaged backgrounds.

In contrast to findings on the HLE, IELS found relatively few significant relationships between children's ECEC experience and their development at age 5, after accounting for SES. This was somewhat unexpected, but it is understandable given the high participation rate of children in ECEC in England, which restricts the ability of the study to compare the findings of children who had and had not experienced ECEC (Balladares and Kankaraš, 2020; OECD 2020b). Melhuish and Gardiner (2020) argue that there has been a general increase in the quality of publicly-funded ECEC in England which may have led to a lack of differentiation in outcomes between children attending different types of ECEC. It is also possible that children's experiences at school, especially for children in Year 1, may allow children with less experience of ECEC to catch up (see Melhuish and Gardiner, 2020).

IELS was able to identify that an earlier start in ECEC (attending for 20 hours per week before the age of 1) was associated with greater development among 5-year-olds in England in emergent literacy and working memory and higher levels of trust after adjusting for SES. This has added to the body of research into the relationships between attending ECEC and children's development at age 5.

On the other hand, attending ECEC later (aged 3 or more) was associated with lower teacher-reported levels of disruptive behaviour, compared with children who started ECEC before the age of 3. This result echoes findings from the Study of Early Education and Development (SEED, Melhuish and Gardiner, 2020), which found that spending longer in formal ECEC settings (such as playgroups and nursery classes) between the age of 2 and start of school was associated with poorer outcomes on a number of socio-emotional measures at age 5. Also, SEED found that the use of some individual ECEC (from childminders, friends and relatives) might be able to mitigate some of the negative social-emotional effects of high formal group ECEC use, though this needs further exploration. This is consistent with the IELS finding that children who had been cared for by a nanny, relative or family friend, instead of attending an ECEC setting when they were 3 years old, had greater development in emotion attribution.

The IELS findings should not be interpreted as implying that attending ECEC at an earlier age has a negative (or positive) effect on children's outcomes, since these are correlations rather than causal relationships. However, they are consistent with the findings from the Effective Provision of Pre-school Project (EPPE, Sylva and others, 2004; 2008) which found evidence of positive benefits of ECEC on children's later development, including on children from disadvantaged backgrounds. The international findings point to the importance of access to high quality ECEC, especially for children from disadvantaged backgrounds, which is characteristic of Estonia and less available in the United States (OECD, 2020a). In the USA, where 20% of children did not attend ECEC before the age of 5, attending ECEC was associated with higher emergent literacy and emergent numeracy even after accounting for SES (see OECD, 2020b).

Conclusion

The IELS study was successfully implemented for the first time in 2018. It provides findings for a nationally representative sample of 5-year-olds in England. Comparisons with the other participating countries suggest that, broadly speaking, children in England had similar development to children in Estonia and the United States. There were two statistically significant differences between results in England and the other 2 countries: children in England showed greater development in emergent numeracy and lower development in inhibition (the ability to resist impulsive responses based on new information). This study can provide evidence on the child and family characteristics

associated with early numeracy and inhibition but was not designed to explain the reasons for the relationships found.

The findings have identified a set of risk factors for lower development in children's family and individual characteristics which could potentially benefit from additional support, including deprivation, SEN, EAL and low birthweight.

IELS findings emphasise the importance of the HLE, suggesting that there are many simple activities that parents can do (such as reading to their children, making sure they have access to many children's books, having conversations with children about their feelings and being involved in their child's school) which are positively associated with children's early development. In most cases, doing these activities more frequently is associated with higher development, but in some cases (especially attending special or paid-for activities and using digital devices) moderate frequency appears to be associated with greater development. The findings related to children's' ECEC participation were relatively few and somewhat contradictory, but the international comparisons are consistent with the importance of continuing to provide high quality ECEC experiences for all children.

In conclusion, IELS is an innovative study which successfully engaged children, their parents and teachers. The findings provide a robust and vivid picture of the development of 5-year-olds in England. They have furthered our early years research knowledge of child development, and identified the relative contribution of children's individual and family characteristics and their ECEC experience, to their development at the age of five.

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Appendix 1: Further information about the administration of the study

The development of the study

The International Early Learning and Child Well-Being Study (IELS) is a new international comparison study run by the Organisation for Economic Cooperation and development (OECD) and administered for the first time in 2018.

IELS was designed and implemented by an international consortium on behalf of the OECD, comprising the Australian Council for Educational Research (ACER), the IEA Data processing and Research Center (IEA DPC) and cApStAn Linguistic Quality Control. The consortium was responsible for the development of the direct assessments, questionnaires and administration manuals and ensuring that all countries meet rigorous quality standards.

The data collection methodology used in IELS was tablet-based direct assessments of the 5-year-old children and questionnaires to collect information from each sampled child's parent(s) or carer(s), and the teachers or staff members who knew the child best. Both the tablet-based assessments and the questionnaires covered the four domains of emergent literacy, emergent numeracy, self-regulation and social and emotional development. The questionnaires also collected information on the children's individual characteristics, home learning environment and background, and early education experiences.

The direct assessment of the children were overseen one-to-one by experienced study administrators, all of whom were experienced current or former teachers with Disclosure and Barring Service (DBS) background checks, and were briefed on child protection and working with young children. The study administrators were trained to avoid placing pressure on children by creating a relaxed atmosphere, engaging each child's interest in the tasks, and giving them encouragement. The tablet-based assessments used interactive stories and games, introduced by two animated child characters who appeared throughout, and made use of pre-recorded audio narration and instructions. All tasks were presented aurally and none of the tasks involved either reading printed text or writing.

Study administration

The overall administration of IELS was carried out on behalf of the OECD by the international consortium led by ACER. The international consortium worked with IELS National Centres within the three countries, through the National Project Manager (NPM). The National Centre for England was the NFER.

Prior to the main study, the three participating countries carried out a field trial in 2017 (please see DfE, 2018c and OECD, 2018 for information on the field trial). In England, the trial took place between November and December 2017. Thirty-two schools and 453 children took part. The purpose of the field trial was to test the processes and procedures for carrying out the study, and to gather item-level data from questionnaires and the direct assessments in order to select items which worked well in each participating country to be taken forward to the main study.

Instrument adaptation

NFER adapted the international study instruments to ensure they were appropriate for use in England, for example that they used British English wording. These instruments included: the teacher and parent/carer questionnaires, the international assessment items, including the script and audio files, as well as other materials, such as cover letters for the online administration of the questionnaires.

Countries were offered the opportunity to add questionnaire items, with the approval of the OECD Secretariat and the International Consortium. England took this opportunity to add 10 questions for teachers on children's physical development. NFER based these items on the Early Years Foundation Stage profile Early Learning Goal 04 – Moving, as well as drawing on pre-existing, well-evidenced assessments of physical development that are associated with either cognitive development or health and wellbeing. They also consulted with members of England's National Advisory Committee for IELS. The national team for England trialled the items with Reception and Year 1 teachers to ensure they were age-appropriate, understandable and asked about skills which teachers would have observed at the time of the IELS study administration. The question items added can be seen in table 33 below and more information on how NFER created this measure can be found in Appendix 2.

Table 33 Physical development questions added to staff questionnaire

For each of the following activities, select the option that best describes the child…	Response categories
Does well at games or activities that involve catching objects.	Never, rarely, sometimes, often, always

For each of the following activities, select the option that best describes the child…	Response categories
Does well at games or activities that involve throwing or kicking objects to reach a target (e.g. to another child or goal).	Never, rarely, sometimes, often, always
Successfully negotiates space when playing running and chasing games (e.g. adjusting speed or changing direction to avoid obstacles).	Never, rarely, sometimes, often, always
Successfully draws basic shapes (e.g. circle, square, triangle).	Never, rarely, sometimes, often, always
Is able to use scissors to cut around a shape.	Never, rarely, sometimes, often, always
Can put on a coat without help, including zips and buttons.	Never, rarely, sometimes, often, always
Confidently uses large-scale equipment (e.g. climbing frame, stepping stones).	Never, rarely, sometimes, often, always
Jumps off an object and lands in a controlled way.	Never, rarely, sometimes, often, always
Uses a pencil to write correctly formed numbers (e.g. 3, 4, 7).	Never, rarely, sometimes, often, always
Moulds modelling material such as clay or dough into shapes (e.g. ball, cube, sausage).	Never, rarely, sometimes, often, always

England also added a question focusing on the child's perceived levels of persistence to the parent and teacher questionnaire, two questions on ECEC and a question relating to the home learning environment to the parent questionnaire. These questions are given below in table 34

Table 34 Additional national questions added to the parent and staff questionnaires

questionnaire	Question	Response categories
Parent	Did you use the entitlement to 15 hours of free childcare available for your child at the following ages?	a) When they were 2 years old (if your child was eligible b) When they were 3 years old c) When they were 4 years old
Parent	What age was your child when you first started to regularly use childcare for more than 10 hours per week? (Do not include care by the child's parents. Include any regular childcare by other relatives, such as grandparents, or by friends of the family.)	Age below 3 months; 3-5 months; 6-8 months; 9-11 months; 12-17 months; 18-23 months; 24-35 months (age 2); 36-47 months (age 3); 48 months or more (age 4 or above); Did not use childcare for more than 10 hours per week at any age
Staff and parent	For each of the following behaviours, select the option that best describes your child: **Continues his/her planned course of action in spite of difficulty or obstacles**	Never; rarely; sometimes; often; always
Parent	In a <u>typical week</u>, how often do you or another person in your home do the following activities with your child: … **Do activities with your child that help them to learn to read words or sentences**	Never; less than once a week; 1-2 days in a week; 3-4 days in a week; 5-7 days in a week

In addition, the IELS team in England asked parents separate questions on whether their child was born prematurely and/or had low birthweight.

The sampling procedure

To ensure the sample was representative of the country as a whole, key characteristics of the total population of schools, such as school type, and region, were taken into

account. Table 35 shows the stratification variables which were used for sampling schools in England to ensure a representative sample:

Table 35 Stratification variables

Name	Description	Number of categories	Implicit / explicit[57]
School type	Maintained by their local authority (maintained), funded directly by government (academy) or privately funded (independent)	3	Explicit
FSM (Free School Meals)	% pupils entitled to free school meals: quintiles, and 'no data available'	6	Explicit
Region	North, Midlands, Greater London, South	4	Implicit

Source: IELS national study

Countries were allowed to exempt a small proportion (less than 5%) of schools from the sampling frame. Special schools and very small schools (with five or fewer five-year-olds) were excluded. An estimated 2.2% of the national population was excluded on these grounds.

The sample of schools was drawn by IEA-DPC following submission of sampling forms to the international consortium. Three samples were drawn – a main sample and 2 replacement samples. Schools in the replacement samples broadly matched the characteristics of their main sample equivalent. Sampling of pupils within schools was done by NFER using software supplied by the consortium. This sampling procedure is designed to produce a representative sample of children within participating countries.

The sample for the main study was set at a minimum of 200 centres and 3,000 children. National circumstances necessitated a small increase to the number of participating schools from 200 to 202, as some English schools had fewer than 15 children in the study age-range. Within all sampled schools/centres, a maximum of 15 children were sampled. If a school/centre had fewer than 15 children, all were sampled. An important aim of the main study was to reach sufficient children to enable meaningful analysis. In

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[57] Explicit stratification entails each stratum being sampled independently. This allows a disproportional sample allocation. 'Implicit' stratification, however, refers merely to a sorting order of centres on the Sampling Frame prior to sampling. Implicit stratification is a simple and effective method to achieve a fairly proportional allocation of the sample to the different strata.

England the minimum recruitment targets were 152 schools and 2,250 children to participate in the study.

England recruited a total of 191 schools, with 164 of these from the main sample. This provided a 95% participation rate of sampled schools (81% from the main sample).

Table 36 School sample sizes

Stage of recruitment	Main sample	First replacement sample	Second replacement sample
Drawn in sample	202	201	202
Invited to participate	202	44	12
Participated in study	164	22	5

Source: IELS national study

In total, 2,803 children were sampled from the 191 participating schools and 2,577 children participated in the study[58] (defined as completing at least 2 domains). This represents a response rate of 92%. Table 37 shows the response rates of the different groups of respondents.

Table 37 Response rates for children parents and staff

	Total sampled from participating schools	Total number participating	Response rate (%)
Participating children	2,803	2,577	91.93
Staff questionnaire on child	2,803	2,318	82.70
Staff questionnaire on themselves	613	568	92.70
Parent questionnaire	2,803	1,734	61.86

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[58] A participating child is defined in the analysis as one who gave at least one answer in at least two assessment domains. Note these participation rates differ slightly to those reported by the OECD (2020a) as they are unweighted and based on children included in the final analysis. The participation rates reported by OECD were weighted and based on children participating in at least one assessment domain.

Administration of the study in schools

NFER worked closely with a school contact (referred to as the 'school coordinator') in each school. The school coordinators were required to: select a suitable week for the study to take place in their school; provide NFER with a list of pupils of the appropriate age to carry out the sampling; organise a room for the administration; and to inform children, parents/carers and other teachers that they would be involved in the study.

Administration of IELS took place between 8 October and 7 December 2018. NFER sent 2 study administrators into each school for 3 days. The study administrators carried out the direct assessments with children and took responsibility for monitoring questionnaire completion (with support from NFER). All of the study administrators were qualified teachers experienced with 5-year-olds. Most of them had previously administered international studies and so understood the need for meeting international standards and administering the study in a consistent manner.

Children completed approximately 1 hour and 40-minutes of direct assessments on a tablet over 2 days, designed to quantify their skills in each of the domains. Each child completed approximately one 50-minute session on day 1 and another 50-minute session on day 2.

Parents/carers and teachers provided indirect information about children's social-emotional skills and trust and other contextual information including the child's family background, home learning environment, as well as children's Early Childhood Education and Care (ECEC) experiences. In addition, the teacher questionnaire provided information on their gender, age, working experience, and educational level. Study administrators were another key source of information as they provided feedback on the child's behaviour and engagement during the administration. Teacher and parent questionnaires were available both online and on paper.

Children's responses to the study

On the whole, study administrators reported that the children enjoyed completing the assessment activities. Out of the 64 study administrators (76%) that responded to NFER's feedback survey, 100% reported that the children were engaged by the domains, either 'actively engaged' (reported by 61% of study administrators) or 'somewhat engaged' (39%). Similarly 100% reported that the children enjoyed completing the activities. Study administrators reported that children particularly enjoyed working one-to-one with an adult and were excited to be working with a tablet.

Overall, 113 (59%) of schools responded to a brief feedback survey to understand how IELS had been implemented and received in schools. Of those who responded, nearly all

felt that the time commitment from children was appropriate (93%), and most reported that the children were either positive about taking part (85%) or neutral (14%). This was reflected in the participation rates in which nearly all children (over 99%) who participated on day 1 also participated on day 2.

Appendix 2: Sample characteristics and representation; derived measures and analyses

This appendix outlines the technical aspects of the IELS study in England. This includes the characteristics of the sample and its representativeness, the method and results for estimating the average months' difference for each outcome, the method used to adjust for multiple comparisons and the approach used to create the Physical Development measure.

Sample characteristics and representation

School level bias analysis

Like many of the International surveys there is a complex sampling process with schools randomly selected to be within the main sample. For each school within the main sample there is at least one, but possibly two replacement schools. If the main sample school is unable to take part then the replacement school is contacted. At the end of the process of data collection there is a mix of main sample and replacement schools.

In order to check if the achieved sample was representative, two logistic models were run to determine if particular school characteristics were significantly associated with and increased or decreased likelihood of taking part. The first model compares the participant schools (191 schools) with main sample schools who were not replaced (11 schools). The second model compares main sample schools who did not participate (38 schools) with the replacement schools that did participate (27 schools).

Variables used in the analysis included school type, eligibility for free school meals (quintile) and region. Dummy variables were created and logistic models run with the dichotomous dependent variable (0=did not participate in ILES, 1=did participate in IELS). Due to the very low N for some of the cells some categories were further collapsed.

Tables 38 and 39 identify that for the variables (for example, academy schools, Low free school meal eligibility, North, etc.) included in the models, no school level bias has been introduced into the design as indicated by the non-statistically significant p value (p<.05). The analysis looks to identify whether particular types of school, as determined by their level of free school meal eligibility, their geographical location or their type, are more or less likely to have participated in the IELS data collection. If any of factors are significant (have a p value less than 0.05) then there is an increased likelihood that the factor is introducing bias into the sample of respondents.

Table 38 Model for participants compared with main sample not replaced

Value	Coefficient	P value
Academy School	.53	0.52
Low free school meal eligibility	.57	0.38
North	.67	0.46
Greater London	.09	0.92
South	-.01	0.99
Constant	2.29	0.00

Default settings were non-academy schools, midlands and high free school meal eligibility

Table 39 Main sample comparing schools that did not take part to replacements that did take part

Variable	Coefficient	P value
Academy school	0.19	0.49
Independent School	-0.01	0.99
Lowest FSM	-0.36	0.75
Low FSM	-0.95	0.37
High FSM	-0.63	0.42
Highest FSM	0.04	0.97
North	0.31	0.69
Greater London	0.23	0.76
South	-0.18	0.84
Constant	-0.14	0.86

Default settings were maintained schools, midlands and the middle 20% of free school meal eligibility

Parent level bias analysis

All parents of children selected to take part in the IELS project were asked to complete a survey, available to complete online or on paper. There was a relatively high response rate from parents (67%), compared to other similar studies. This provided information on their child as well as family background information. However it is important to

understand if those responding to the questionnaire were typical of the sample of parents as a whole. If a particular type of respondent is shown to be less likely to have completed the questionnaire, then it could be said the analysis shows evidence of non-response bias.

The IELS dataset comprised 2,577 children, 843 of whom did not have data from the parent questionnaire. To see if the non-responding group was any different to the responding group a logistic model was run[59] to determine the association between a number of factors and the likelihood of parents completing the questionnaire. The IELS variable PART_PQ was recoded so that 1 indicated that a parent had completed the questionnaire and 0 indicated they had not. Child-level factors within the models included: gender, eligibility for FSM, ethnicity, EAL, Emergent Literacy score[60], SEN, pupil level IDACI (quartiles) and school region.

Table 40 identifies the final model with coefficients and significance levels. A positive coefficient indicates, that with all things being equal, a parent with this characteristic is more likely to have completed the parental questionnaire than the default characteristic. Whilst a negative coefficient indicates a parent is less likely to have completed the questionnaire.

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[59] Analysis was undertaken using the IEA IDBAnalyzer.
[60] The first plausible value for ELITPV was taken as a covariate

Table 40 Logistics model output identifying likelihood of completing parental questionnaire

LABEL	Coefficient	P value	Significant difference
CONSTANT	0.40	0.249	
Emergent literacy plausible value	0.00	0.001	*
North	-0.37	0.040	*
Midlands	-0.19	0.285	
Greater London	-0.43	0.065	
FSM Missing	20.35	0.000	*
Eligible for FSM	-0.38	0.001	*
Girls	-0.30	0.758	
IDACI Missing	-0.79	0.436	
Most Deprived	-0.26	0.138	
2nd Most Deprived	-0.27	0.103	
2nd Least Deprived	-0.34	0.026	*
SEN Missing	-18.52	0.000	*
SEN	-0.14	0.417	
Bangladeshi	-0.11	0.837	
Indian	-0.13	0.760	
Asian Other	0.50	0.309	
Pakistani	-0.26	0.382	
Black African	-0.38	0.922	
Black Caribbean	-1.33	0.009	*
Black Other	-0.99	0.154	
Mixed Other	0.00	0.993	
Mixed White-Asian	-0.12	0.691	
Mixed White-Black African	0.26	0.618	
Mixed White Caribbean	-0.35	0.300	
Not Obtained	-1.08	0.003	*
Other	-0.36	0.303	
White Other	-0.65	0.009	*

LABEL	Coefficient	P value	Significant difference
EAL Unknown	0.19	0.868	
English as an additional language	0.47	0.015	*

'*' Indicates statistically significant coefficient (p < 0.05)

The model identifies that the respondents are representative of the sample on many of the parent characteristics. However there were 4 significant differences. As a child's literacy score increases the parent is more likely to have completed the questionnaire. If the child is eligible for FSM the parent is less likely to have completed the questionnaire and if a child has EAL the parent is more likely to have completed the questionnaire. Parents in the North were also less likely to have completed the questionnaire than those in the South.

Due to the bias in the parent sample, and the analysis of national questions not controlling for SES in this report, the additional national questions on ECEC take up were not analysed for this report.

Default settings are; South, Not eligible for FSM, Boy, Least deprived, No SEN, White UK, Not EAL.

Estimating average months' difference for IELS measures

For all outcome measures, IELS data are scaled to have means around 500 and standard deviations around 100. This means that the data have approximately normal distributions. To report differences in means in terms of months, an average monthly difference variable was calculated. A linear regression was run to estimate the average monthly difference (equivalence of difference in months) for each outcome. All 14 groups of children by age in months (4 years and 11 months to 6 years and 0 months) were used in the estimation. Table 41 reports the average monthly difference, the standard error (S.E.) and the confidence interval for each outcome.

Table 41 Average monthly difference for each outcome

Outcome	Monthly difference mean	Monthly difference S.E.	Confidence Interval
Emergent Literacy	7.29	0.57	± 1.12
Emergent Numeracy	9.80	0.57	± 1.12
Inhibition	6.96	0.58	± 1.14
Mental Flexibility	6.28	0.75	± 1.47
Working Memory	7.59	0.57	± 1.12
Emotional attribution	4.72	0.73	± 1.43
Emotional identification	6.55	0.64	± 1.25
Prosocial Behaviour	-	-	-
Non-Disruptive Behaviour	-	-	-
Trust	-	-	-
Physical Development	3.95	0.72	± 1.41

Source: OECD IELS England database matched to NPD

Table 41 provides information to assess the confidence intervals for all measures included in the study. For example, the monthly difference mean for the Emergent Literacy outcome was 7.29 with a standard error of .57 and a confidence interval of ± 1.12 (1.96 X 0.57). What this confidence interval means is that if we took an infinite number of samples from the population, the confidence interval for each of these samples would, in 95% of the samples, contain the population mean which would lie between 6.17 (7.29 – 1.12) and 8.41 (7.29 + 1.12). Thus, for the Emergent Literacy outcome, every difference of 7.29 is equivalent to 1 month. In other words, a mean difference of 16.29 is equivalent to 2.24 (16.29 / 7.29 = 2.24) months. The 'true' months' difference is found in the interval between 1.94 (16.29 / 8.41) and 2.64 (16.29 / 6.17), 95% of the time.

It should be noted that confidence intervals also exist for mean differences. For measures where the mean difference between the youngest group of children (4 years and 11 months) and the oldest group of children (6 years and 0 months) was not statistically significant, the monthly mean difference was not estimated or reported (-).

The relationship between low birth weight and prematurity

IELS asked parents whether their child was born prematurely and/or had low birthweight (defined at less than 2.5 Kg). In total, 1,707 (66%) parents of children in the sample provided information for both of these characteristics. Table 42 shows the strong relationship between premature birth and low birthweight. A total of 184 children (11% of the sample for whom data was available) had one or both of these characteristics, and all of the 153 children identified by their parents as having been born prematurely also had low birthweight.

Table 42 Relationship between prematurity and low birth weight

	Low birthweight	Not low birthweight	Total
Premature	153	0	153
Not premature	31	1,523	1,554
Total	184	1,523	1,707

Source: IELS parent questionnaire data for 1,707 children

Because of the strong inter-relationship between these two characteristics, the report focuses on the larger category of children with low birthweight. When considering low birthweight alone, it was possible to include data for 18 additional children, as their parents had provided information on their child's birthweight but not prematurity.

Developing a measure of physical development

In order to appropriately measure physical development, The IELS national team in England constructed an interval-level item response theory (IRT) scale from the ordinal level Likert-scale questionnaire response items provided by teachers. This is outlined below in Table 43.

Table 43 The original physical development scale with 10 items

Item number	Question (rated on a scale of Never, Rarely, Sometimes, Often, Always)	Motor development subtype
1	Does well at games or activities that involve catching objects	Gross
2	Does well at games or activities that involve throwing or kicking objects to reach a target (Note that this item was removed from the final measure.)	Gross
3	Successfully negotiates space when playing running and chasing games	Gross
4	Successfully draws basic shapes	Fine
5	Is able to use scissors to cut around a shape (Note that this item was removed from the final model.)	Fine
6	Can put on a coat without help, including zips and buttons	Fine
7	Confidently uses large-scale equipment	Gross
8	Jumps off an object and lands in a controlled way	Gross
9	Uses a pencil to write correctly formed numbers	Fine
10	Moulds modelling material such as clay or dough into shapes	Fine

Source: IELS main study Parent Questionnaire

Half of the 10 items focused on fine motor development and the other half focused on gross motor development, and a requirement of the Physical development IRT scale was that it should assess each of these domains equally with no bias towards one or the other. Responses to these questions were provided on a 5-point scale of 'never', 'rarely', 'sometimes', 'often' or 'always'.

The IELS dataset included 2,577 individual children who had participated in the IELS direct assessment. Children who had more than 50% missing item responses from the

physical development questions were excluded from the dataset meaning the final number of cases from which to construct IRT measures of Physical development was 2,302. Items were coded 'never' as 0, 'rarely' as 1, 'sometimes' as 2, 'often' as 3 and 'always' as 4, ready for IRT analysis.

IRT Model Construction

NFER mirrored the approach undertaken by the IELS International Consortium which developed the international IELS measures. The NFER team constructed a Physical development IRT scale from a simple 1-parameter logistic generalised partial credit model (Muraki, 1992), which was found to fit the observed responses well, after selecting the appropriate items as determined from graphical and chi-square analysis. Under this model, the only parameter that was allowed to differ between items was difficulty and all items had a common slope value, but this was optimised for the observed data rather than being fixed at 1 (as it would be in a polytomous Rasch model).

In order to correctly estimate standard errors in the analysis it was necessary to draw 5 plausible values from individual posterior ability distributions for the calculation of measurement variability. This was done using the Metropolis-Hastings Robbins-Monro (MH-RM) estimation method (Cai, 2010a; Cai, 2010b) implemented in the IRT software Flexmirt (version 3.5.1; Cai, 2017). To avoid using item or person parameter values before the model had time to fully converge the first 50 draws were discarded from the MH sampler for assumption checking statistics and 500 for the final Physical development scale. The thinning parameter in the final model was set to 100, meaning that every 100th draw of the MH sampler was retained. Model assumption checking was done on a single draw of ability values to avoid repeating the analysis 5 times. All models were weighted using the person weights provided by the International Consortium (CHILDWGT).

Model Assumption Checking

Model assumption checking was done to ensure that the observed responses fitted the IRT model appropriately, that the items acted together to create a coherent measure of physical development and that the assessment was not biased towards certain subgroups of the population. Four assumption checks were done on the data, as outlined below.

Item Fit: To ensure that observed data fitted the IRT measurement model the expected item characteristic curves and the response category characteristic curves were plotted and matched against the observed data. This ensured that the each of the items fitted the IRT model used and sufficiently measured the same common trait tapped into across items.

146

Dimensionality: As the physical development IRT scale was intended to measure physical development in general, it was necessary to ensure that the observed data were sufficiently unidimensional. This was of particular concern as the scale was constructed from both gross and fine motor items. These two classes of items needed to measure a common general physical development trait sufficiently in order to work together in creating an appropriate scale.

Differential Item Functioning (DIF): DIF analysis was conducted on the final 8 item items used to construct the physical development scale and revealed that no item was biased towards either boys or girls. This finding was confirmed graphically and statistically through a chi square analysis.

Local Dependence: In order to ensure that the items were not too narrowly focused on any particular areas of physical development a Q3 analysis (Yen, 1984; Yen, 1994) was performed on the residuals between observed responses and expected performance. This was intended to highlight any systematic similarities in the observed responses after accounting for the physical development ability of children as assessed by our IRT model.

Once all these assumption checks had been applied, a decision was taken on whether to exclude certain items while still retaining a balanced scale that equally measured fine and gross motor development. Once an adequate item selection had been made a conditioned model was run using demographic variables and then 5 plausible values were drawn from child posterior ability distributions for the calculation of appropriate standard errors later in the inferential analysis. These plausible value draws were scaled to have an overall mean of 500 and an overall standard deviation of 100 in line with OECD standards.

The first IRT Model included all 10 questions. The 4 assumption checks were carried out on this model with the following outcomes:

- the observed data fit the expected scores on the items well, indicating that the items worked well together to measure a common trait.
- to explore the degree to which the IELS physical development data was unidimensional, an exploratory factor analysis was run in Mplus (Version 5.2, Muthen and Muthen, 2008) on the observed data, weighted by the CHILDWGT variable. The results suggest that the data was sub-optimally unidimensional.
- In order to check for redundant items that might bias the assessment towards an overly specific element of physical development a Q3 analysis was performed. This highlighted that the residuals between observed and expected scores for 2 items (item 1 'Does well at games or activities that involve catching objects' and item 2 'Does well at games or activities that involve throwing or kicking objects to reach a target') were highly correlated with each other, over the 0.7 threshold that Linacre identifies as indicating problematic local dependence (Linacre p. 414, 2019).

147

- We examined DIF by sex and found that item 5 (Is able to use scissors to cut around a shape) showed significant DIF in a chi square analysis of the observed scores by ability band and sex. No other items showed significant DIF.

Based on the local dependence between questions 1 and 2 and the DIF shown on question 5, questions 2 and 5 were removed from the scale so that it was not overly focused on throwing and catching activities and fairly assessed both girls and boys. Question 1 was chosen instead of question 2, as it had slightly higher classical discrimination.

The IELS national team in England then ran the IRT model with questions 2 and 5 removed. The 4 assumption checks were carried out on this model with the following outcomes:

- The IRT model fitted to the selection of 8 questions showed a good fit to the observed data, both graphically and in terms of chi-square statistics.

- Two methods were used to consider unidimensionality. Hu and Bentler (2009) recommend a Tucker Lewis index of 0.95 or greater, with a root mean square error of less than 0.05. The Tucker Lewis index for this scale was 0.787 and its root mean square error was 0.204, which suggests that the data is sub-optimally unidimensional. However, Hambleton and others, (1991) recommend a minimum the ratio of the first to the second Eigen value of 5. The physical development measure was found to have a ratio of 5.82, which suggests that the underlying data is sufficiently unidimensional. All residual correlations were below the 0.7 threshold recommended by Linacre (2019) for local independence.

- With the revised item selection none of the items showed statistically significant differential item functioning by sex at the $p < 0.05$ level.

Overall, the second model, with items 2 and 5 removed, showed suitable item fit, conditional independence and differential item functioning statistics. In terms of dimensionality, the Eigen value statistics suggested that the data were sufficiently unidimensional, even though the Tucker Lewis index was below the recommended level. Therefore this model, which included 8 items, was adopted as the final physical development measure.

Model conditioning and Z-score rescaling

The IELS national team in England conditioned the IRT model by key demographic variables to prevent child ability values from centring together away from their true values due to the nature of IRT ability estimation algorithms. The following variables were used as conditioning variables: ELLITPV1 (Emergent Literacy plausible value 1), ELNUMPV1 (Emergent Numeracy plausible value 1), ELEEIPV1 (Emotion Identification plausible

value 1), ELECAPV1 (Emotion Attribution plausible value 1), ELINHPV1 (Inhibition plausible value 1), ELWMEPV1 (Working Memory plausible value 1), ELMFXPV1 (Mental Flexibility plausible value 1), ELEDPPV1 (teacher Prosocial plausible value 1), ELEDDPV1 (teacher Non-disruptive Behaviour plausible value 1), ELEDTPV1 (teacher – trust plausible value 1), ITAGE (age of child at date of assessment), ITSEN (SEN status listed on tracking form), ITSEX (Gender listed on tracking form). The OECD International Consortium used the first principle components in their conditioning and their model explained 95% of the variation in the data constructed from all variables available. However this method was not practical in our case as there was a high degree of missing data which meant that it was only possible to construct principle components for a small number of cases that had values for all variables. IRT model was conditioned using the variables outlined above that had values present for all cases. Using this conditioning procedure the IRT model was used to draw 5 plausible values from child posterior ability distributions, setting the burn-in parameter to 500 and the thinning to 100 as previously described.

The OECD International Consortium scaled each of their IRT measures to have a mean of 500 and a standard deviation of 100. To provide comparability with these measures, the physical development measure was treated in the same way. The plausible values were scaled overall so that the mean of all 5 draws collectively was set to 500 and their standard deviation to 100, this meant that the relative differences between plausible values were preserved and imputation variance, established as variation between the means of plausible value draws, could be calculated.

Adjusting for multiple comparisons

When performing multiple hypothesis testing, the probability of observing a significant result when one does not exist (false positive) increases with the number of multiple comparisons being made. The Bonferroni (1936) adjustment is a simple technique to control for false positives when making multiple comparisons. To calculate the Bonferroni adjustment, divide the p-value (i.e. 0.05) by the number of multiple tests performed (n). The IELS team in England used a Bonferonni adjustment when performing multiple comparisons. The team calculated the corresponding t-statistic required for a Bonferroni adjustment. Table 44 illustrates the p-values (.05/n) for different numbers of multiple tests.

Table 44 Bonferroni adjustment p-values

Number of tests	p-value
1	p <0.05
2	p <0.025
3	p<0.0166
4	p<0.0125

This table shows that when two hypothesis tests are conducted, the p-value (p) for either one of those tests needs to be less than 0.025 (p <0.025) to signify a statistically significant result. When three hypothesis tests are performed, the p-value for any one of those tests needs to be less than 0.0166 (p<0.0166) to signify a statistically significant result and so on. Consequently, using a Bonferroni adjustment, minimises the chance of reporting a statistically significant result when one does not really exist.

NFER was contracted to carry out IELS in England on behalf of the Department for Education (DfE) and this report includes analysis of pupil administrative data from the DfE's National Pupil Database (NPD). However the views expressed in this report are the authors' and do not necessarily reflect those of the DfE.

Please note that this work was produced using statistical data from ONS. The use of the ONS statistical data in this work does not imply the endorsement of the ONS in relation to the interpretation or analysis of the statistical data. This work uses research datasets which may not exactly reproduce National Statistics aggregates.