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Research Report

Play and prosociality are associated with fewer externalizing problems in children with developmental language disorder: The role of early language and communication environment

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Abstract

Background: Children with developmental language disorder (DLD) are at higher risk of poorer mental health compared with children without DLD. There are, however, considerable individual differences that need to be interpreted, including the identification of protective factors.
Aims: Pathways from the early language and communication environment (ELCE, 1–2 years) to internalizing (peer and emotional problems) and externalizing (conduct problems and hyperactivity) problems in middle childhood (11 years) were mapped using structural equation modelling. Specifically, the role of indirect pathways via social skills (friendships, play and prosociality) in childhood (7–9 years) was investigated.
Methods & Procedures: Secondary analysis of existing data from the Avon Longitudinal Study of Parents and Children (ALSPAC) was undertaken. The study sample consisted of 6531 children (394 with DLD).
Outcomes & Results: The pathways from the ELCE to internalizing and externalizing problems were similar for children with and without DLD. For both groups, a positive ELCE was associated with more competent social play and higher levels of prosociality in childhood, which in turn were associated with fewer externalizing problems in middle childhood. Furthermore, better friendships and higher levels of prosociality in childhood were both associated with fewer internalizing problems in middle childhood.
Conclusions & Implications: A child's ELCE is potentially important not only for the development of language but also for social development. Furthermore, in the absence of adequate language ability, play and prosocial behaviours may allow children with DLD to deploy, practise and learn key social skills, thus protecting against externalizing problems. We suggest that consideration be given to play- and prosociality-based educational and therapeutic services for children with DLD.

Keywords: early language and communication environment, developmental language disorder, play, prosociality, friendships, psychopathology.

What this paper adds

What is already known on this subject

- On the whole, children with DLD tend to have poorer mental health compared with their unaffected peers. There are, however, considerable differences and poor outcomes are not inevitable.

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What this study adds to the existing knowledge

- We demonstrate that children's ECLE is important for the development of social play behaviours and prosociality. Whilst children with DLD tend to have less competent social play and lower levels of prosociality compared with their unaffected peers, those with more competent social play and higher levels of prosociality are likely to have fewer externalizing problems later in childhood. We speculate that in the absence of adequate structural language ability, play and prosocial behaviours allow children with DLD to deploy, practise and learn key relationship skills, alongside behavioural and emotional regulation skills, thus protecting against externalizing problems.

What are the potential or actual clinical implications of this work?

- Understanding the relationships among play, prosociality and externalizing problems may pave the way for play- and prosociality-based interventions in children with DLD. This may be particularly appealing for practitioners as such interventions capitalize on one of the most intuitive means of learning in childhood: play with friends. The likelihood of acceptability and engagement with such interventions may be higher in children than for traditional adult-led, paper-and-pencil activities.

Introduction

Many factors bear on the success or otherwise of social developmental progress. Individual differences among children, such as language ability, are likely to impact on their relations with others. Language ability itself may be influenced by structural variables, such as families' socioeconomic status (Arriaga *et al.* 2008), and by microenvironmental features, such as the richness of parent–child interactions (Schwab and Lew-Williams 2016). As children grow older and extend social relationships beyond the home, their competency at social play and peer relations may both reflect and reinforce emergent characteristics from the earlier home environment. The extent to which the early home environment influences and reinforces social relationships in childhood and their effect on later developmental processes is unclear. In the present study we investigate the interplay of these factors in explaining individual differences in both internalizing and externalizing problems for children with and without developmental language disorder (DLD).

DLD affects between 5% and 7% of children (Norbury *et al.* 2016, Tomblin *et al.* 1997). It is characterized by problems with using and/or understanding spoken language in the absence of biomedical causes such as deafness or autism spectrum disorders (ASDs) (Bishop *et al.* 2017). Individuals with DLD are at increased risk for mental health problems compared with their peers without DLD (Botting *et al.* 2016a, 2016b, Snowling *et al.* 2006, van Daal *et al.* 2007, Yew and O'Kearney 2013).

Mental health problems in childhood can take many forms and co-occurrence of different types of difficulties is common. Both internalizing (e.g., depression, anxiety, social withdrawal, etc.) and externalizing problems (e.g., bullying, violence, rule breaking, etc.) reflect this overarching psychopathology factor in middle childhood (Patalay *et al.* 2018) and thus to some extent can be viewed as different manifestations of underlying difficulties (Sallis *et al.* 2019). Notwithstanding this, the characterization of childhood mental health into internalizing and externalizing problems remains common in clinical practice, and they have been shown to follow divergent patterns of development among subgroups of children with DLD (St Clair *et al.* 2011). Different types of internalizing and externalizing problems co-occur. For example, emotional and peer problems tend to develop concurrently in children with DLD (Conti-Ramsden *et al.* 2019), as do conduct problems and hyperactivity (Pickles *et al.* 2016). There is, however, considerable heterogeneity in the profiles of internalizing and externalizing problems, such that adverse outcomes are not inevitable (Conti-Ramsden *et al.* 2019, Pickles *et al.* 2016). This may reflect DLD as a spectrum whereby disorders of some, but not all, aspects of language are associated with mental health problems (Toppelberg and Shapiro 2000). Indeed, language ability and mental health problems may also be linked through shared genetic (Newbury *et al.* 2019) and family factors (Helland *et al.* 2020).

It is likely that nature and nurture interact in the development of DLD. There is sound evidence for the genetic basis of DLD. The heritability estimates vary but are typically approximately 50% or more (Bishop and Hayiou-Thomas 2008, Bishop *et al.* 1995, DeThorne *et al.* 2006, Lewis and Thompson 1992, Tomblin and Buckwalter 1998), meaning that inherited genetic differences account for at least half of variation in DLD in the population. In spite of this, there are higher concentrations of children with DLD in lower socioeconomic families (Tomblin *et al.* 1997). Economically disadvantaged families suffer higher stress levels, higher

intra-familial conflict and tend to have lesser resources (e.g., time, leisure, finances) to devote to child-rearing activities (Conger *et al.* 1994, Heberle and Carter 2015). This poses constraints upon the amount and quality of the early language and communication environment (ELCE) available to the child, which is broadly defined as what parents do to promote the language and communication skills and what they have, in terms of resources, to facilitate their child's language and communication (Roulstone *et al.* 2011). For example, compared with children from high socioeconomic backgrounds, children from low socioeconomic backgrounds are exposed to fewer words and less child-directed speech (Romeo *et al.* 2018, Schwab and Lew-Williams 2016), thereby potentially providing a poorer environment in which to develop language skills (Fernald *et al.* 2013). Children who experience a positive ELCE tend to have better language and literacy development compared with those who do not (Frijters *et al.* 2000, Levy *et al.* 2006, Roulstone *et al.* 2011). A high genetic propensity for DLD may lead to a higher prevalence of the disorder in poorer economic or social environments whereas, the same genetic propensity coupled with a richer economic or social environments may lead to a lower prevalence of DLD (Belsky 1997).

Children with DLD may have less meaningful early social interactions and thus a poorer ELCE. Recent research supports this assertion. Children at risk of DLD have a poorer relationship with their primary caregiver compared with those without DLD, which is perhaps indicative of fewer opportunities to learn from parental social exchanges (St Clair *et al.* 2019). With reference to specific aspects of the ELCE, children with language difficulties benefit less from shared reading as they ask fewer questions (Sulzby and Kaderavek 1996) but do engage more with shared book reading when the caregiver provides emotional and instrumental support as a form of encouragement (Skibbe *et al.* 2008). Additional challenges for some children with DLD, however, may arise in families where parents and/or siblings also have DLD (Tomblin 1989), which may further limit the meaningful social interactions, thus contributing to a poorer ELCE compared with children without DLD.

A poor ELCE is not independent of how children engage with the social world and may put children with DLD at risk of future social difficulties. Early interactions with primary caregivers are considered vital in the socialization of appropriate behaviours (Bronfenbrenner 1979). Specifically, developing a secure attachment with the primary caregiver is seen as vital for developing cognitive empathy (Bowlby 1969), which contributes to the development of friendships (van den Bedem *et al.* 2019) and buffers against internalizing and externalizing problems in children with DLD (Bakopoulou and Dockrell 2016). Thus, a high-quality ELCE will comprise several factors: opportunities for play and interaction, stimulation through toys and other resources, following the child's lead and interests (Tomasello 2009).

As children grow older, the social interactions that were initially dominated by parents are gradually supplemented with the increasing presence and influence of peers. In contrast to parent–child relationships, in which there is a dominance of power and assertation, peer relationships are relatively more power neutral (Piaget 1932). Peers provide opportunities to extend skills and develop characteristics that support subsequent development. Here, we consider three important dimensions of peer relations, namely friendship quality, the competency of social play and prosocial behaviour.

There is extensive evidence that positive peer relations and higher friendship quality are associated with well-being and successful social adjustment during childhood and adolescence (McDonald *et al.* 2010, Peters *et al.* 2011, van Harmelen *et al.* 2016). Friendships provide developmentally matched environments for skill practise and learning, as well as bases for exploration and buffers against adversity. Children with DLD tend on average to have fewer and/or lesser quality friendships (Andres-Roqueta *et al.* 2016, Gertner *et al.* 1994), but again some individuals are more fortunate. For example, Durkin and Conti-Ramsden (2007) found that approximately 60% of adolescents with DLD reported good-quality friendships. Furthermore, positive friendship features are associated with favourable social outcomes in children with DLD (van den Bedem *et al.* 2019). Hence, we reasoned that those children with DLD who do have better quality friendships would be in turn less likely to manifest internalizing and externalizing problems.

Similarly, it is well established that engaging in play with peers is important for the development and practice of social and communication skills (Howes *et al.* 1994, Pellis and Pellis 2007). Social play with peers is a key context in which children deploy, practise and learn key relationship skills, such as turn-taking, negotiation, and behavioural and emotional regulation skills (Baines and Blatchford 2010). On average, children with developmental disorders, such as DLD, have difficulties integrating into peer social play (Gibson *et al.* 2011, 2013). Furthermore, the social play behaviours of children with DLD have less sophistication and higher levels of atypicality when compared with neurotypical peers (DeKroon *et al.* 2002, Gibson *et al.* 2011). However, there are individual differences in this respect and some children with DLD do develop adequate play skills. Hence, we expected that children whose social play is evaluated more positively should have fewer internalizing and externalizing problems.

Finally, prosocial behaviours are conducive to positive social relations. Prosocial children are more accepted and more popular among their peers (Asher and Coie 1990, Zimmer-Gembeck *et al.* 2005). In turn, prosociality is associated with fewer internalizing and externalizing problems (Coulombe and Yates 2018, Griese and Buhs 2014, Troop-Gordon and Unhjem 2018). For children and adolescents with DLD, again, being prosocial is associated with fewer internalizing and externalizing problems (Toseeb and St Clair 2020, Toseeb *et al.* 2017). In line with previous work, we expected that children who were more prosocial would go on to have fewer internalizing and externalizing problems.

We investigated the interplay among ELCE in the first two years of life, language, social development in childhood, and internalizing and externalizing problems in middle childhood for children with and without DLD. We expected that positive indicators of friendships, play and prosociality at around ages 7–9 years would be predictive of lower levels of internalizing and externalizing problems at age 11 years. To the best of our knowledge, we address for the first time the question of whether a positive ELCE is associated with fewer internalizing and externalizing problems in children with DLD and whether this effect is mediated by language ability and social development.

Methods

Ethical approval

Ethical approval for the study was obtained from the Avon Longitudinal Study of Parents and Children (ALSPAC) Ethics and Law Committee and the Local Research Ethics Committees. Ethical approval for the secondary analysis of existing ALSPAC data was obtained from the University of York Education Ethics Committee (reference number 18/5).

Study sample

Data from the ALSPAC sample were used. All pregnant women in the old administrative region of Avon, whose estimated delivery was between April 1991 and December 1992, were eligible to participate. The ALSPAC enrolled sample consisted of 14,775 live-born children from 15,247 pregnancies. This resulted in a total number of 15,458 children (including multiple births), which was reduced to 15,445 after withdrawals. Parents and children provided biological samples, questionnaire data and took part in direct assessments. Full details of the cohort are reported elsewhere (Boyd *et al.* 2013, Fraser *et al.* 2013). The study website contains details of all the data available and provides a fully searchable data dictionary and variable search tool (http://www.bristol.ac.uk/alspac/researchers/our-data/).

DLD status

DLD status was determined at ages 8–9 years using a previously reported framework (Newbury *et al.* 2019, Scerri *et al.* 2011). Children were categorized as having DLD if they met at least two of the following four criteria:

- Pragmatic language >1 SD below the standardized mean. The parent-report Children's Communication Checklist (CCC; Bishop 1998) was used to measure pragmatic language at age 9 years. A sum score ranging from 98 to 162 was created using the pragmatic language subscales: inappropriate initiation, coherence, stereotyped conversation, use of conversational context and conversational rapport subscales. The internal reliability of the CCC has been reported as relatively high (Cronbach's alpha = 0.87) (Bishop 1998). Higher scores indicate better pragmatic language.
- Non-word repetition >1 SD below the standardized mean. An adapted version of the Non-word Repetition Test (Gathercole *et al.* 1994) was administered by direct in-clinic assessment at age 8 years. Previous studies have demonstrated that children with DLD perform significantly poorer on the non-word repetition task compared with unaffected peers (Archibald and Gathercole 2006). For the task, the child was asked to listen and repeat out loud three-, four- and five-syllable non-words. Responses were coded on a binary scale (0 = incorrect, 1 = correct) and then summed to create a score ranging from 0 to 12. Higher scores indicate better non-word phonological memory.
- Receptive language > 1 SD below the standardized mean. The Wechsler Objective Language Dimensions (WOLD; Rust 1996) was administered by direct in-clinic assessment at age 8 years. The child was shown a picture and listened to a paragraph about the picture. The child then had to make inferences about what was read to them and answer the questions verbally. In total, the child was asked 16 questions and responses were coded on a binary scale (0 = incorrect, 1 = correct). Responses were summed to create a score of between 0 and 16. Higher scores indicated better receptive language. As reported in the user manual (Rust 1996), the internal reliability of the subscale is high (Cronbach's alpha = 0.84).
- Positive response to 'child has ever had speech/language therapy' at age 8 years. The

parent was asked whether their child has ever had speech/language therapy (0 = no, 1 = yes).

Children with DLD most frequently met the DLD criteria based on the non-word repetition test and whether they had ever had speech/language therapy. Children were excluded from the DLD group if they had ASD or hearing problems. ASD was defined as mothers responding positively that their child had autism, Asperger's or ASD at the age of 9 years. At age 7 years, children underwent a hearing test. Hearing problems were defined as hearing conductive and/or otitis media with effusion in either or both ears. Over 99% of the sample had English as a first language, as determined by school records. All children who did not meet the criteria for DLD were included in the analysis as part of the comparison group. Children with DLD fared significantly worse on measures of language taken at various time points during early and middle childhood (see appendix A and table A1). As shown in figure 1, there were 394 children (59% male) who met these criteria for DLD and 6137 children (49% male) who did not, yielding a prevalence estimate of approximately 6%. This is approximately in line with previous estimates of the prevalence of DLD (Norbury *et al.* 2016, Tomblin *et al.* 1997).

Measures

All children, irrespective of whether or not they had DLD, received the same testing. The measures are described in detail below.

ELCE (18–24 months)

When the child was aged 18–24 months, a measure previously used by Roulstone *et al.* (2011) was used to assess ELCE. Although this measure is not a direct measure of language and communication use in the home, it reflects the kinds of resources and activities likely to characterize environments that are facilitative for communication. Higher scores on this measure indicate positive home environmental support for language and communication. The ELCE measure includes five subscales: mother–child direct teaching (e.g., mum teaches songs), mother–child activities (e.g., frequency mum has physical play with child), other–child interactions (e.g., child sung to), resources (e.g., number of toy vehicles child has at home) and other activities (e.g., frequency child taken to park). Pairwise correlations between these five subscales are shown in table A2 (Appendix A). The sum scores from these five subscales were used to create a continuous latent variable within a structural equation modelling (SEM) framework (comparative fit index [CFI] = 0.952, Tucker-Lewis index [TLI] = 0.904, root mean square error of approximation [RMSEA] = 0.063, Standardized root mean square residual [SRMR] = 0.028 ($\chi^2(10) = 130.29$, $p < 0.001$). A continuous latent variable can be interpreted in the same way as a composite score, but with less measurement error. This is because the extent of the associations between the subscales and the continuous latent variable can vary, whereas with a composite score they cannot. For example, in a composite score, it is assumed that all five subscales contribute equally to ELCE. In a continuous latent variable, if one of the subscales is more important for ELCE, then this is accounted for. For further details of the measure, see appendix B (along with details of measurement invariance testing); for details about the implementation of the measure within an SEM framework, see the statistical analyses section.

Socioeconomic status

A composite measure of socioeconomic status was adapted from Roulstone *et al.* (2011), who used a measure validated by Schoon *et al.* (2004). The measures, which were taken at 8 and 32 weeks of gestation, were coded as described by Roulstone *et al.* (2011), except that the car ownership variable was removed because of 95% of the sample owning a car. Responses were coded on a binary scale for paternal occupation (0 = manual, 1 = non-manual), maternal education (0 = lower than A Level, 1 = A Level or higher), house tenure (0 = not owned, 1 = owned), home overcrowding (0 = more than one person per room, 1 = less than one person per room), and financial difficulties (0 = financial difficulties reported, 1 = no financial difficulties reported). These binary variables were then summed to create a socioeconomic status score ranging from 0 to 5. Higher scores indicated higher socioeconomic status.

Language (8 years)

Direct in-clinic assessments were taken of receptive and expressive language. For each measure a sum score was created. For the SEM, a continuous latent variable of language was created using the expressive and receptive language sum scores (as previously described for the ELCE variable).

Receptive language at 8 years

As previously described, the WOLD (Rust 1996) was used to measure receptive language.

Expressive language at 8 years

The WOLD (Rust 1996) was also used to measure expressive language by direct in-clinic assessment. The

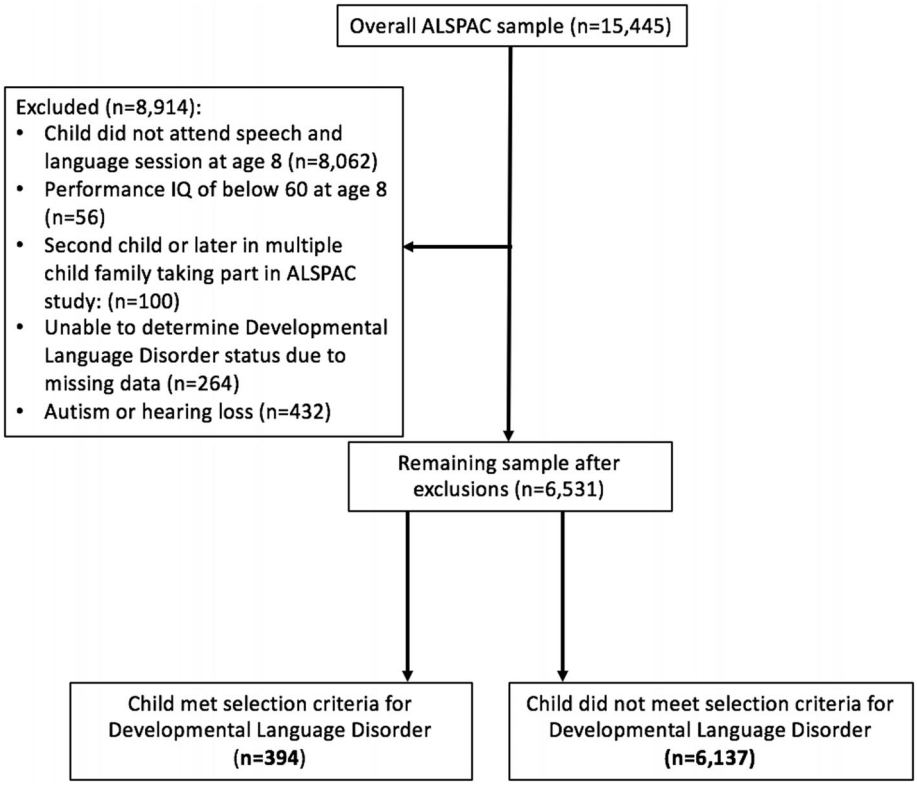

Figure 1. Flow diagram representing the final sample selection at age 8–9 years.

child was shown 10 pictures and asked to name them, which allowed for the assessment of the child's expressive vocabulary. Responses were coded on a binary scale (0 = incorrect, 1 = correct) and then summed to create a score ranging from 0 to 10. Higher scores indicate better expressive language. As reported in the user manual (Rust 1996), the internal reliability of the subscale is high (Cronbach's alpha = 0.91).

Social development (7–9 years)

Friendships at 9 years

Parents were asked to respond to five statements about their child's friendships on a five-point scale (1 = not true, 2 = mostly untrue, 3 = partly true, 4 = mostly true, 5 = true). Sample statements were: 'child has a lot of friends', 'child makes friends easily' and 'other kids want child to be their friend'. For a full list of statements, see appendix C. The internal reliability of the friendships measure was high (Cronbach's alpha = 0.81). Responses were summed to create a total score ranging between 5 to 25, with higher scores indicating better friendships.

Play at 7 years

Parents were asked several questions about their child's social play competencies. Sample items were: 'share toys with other children', 'takes turns in a game without fuss' and 'plays board games'. For a full list of items, see appendix D. Responses to each item were recoded onto a three-point scale (0 = has not yet done/unable to try this/not had chance, 1 = yes but not well, 2 = yes can do well) and a mean score was calculated. Scores ranged between 1 and 2, with higher scores indicating more competent social play interactions. The internal reliability of the play is acceptable in our sample (Cronbach's alpha = 0.59).

Prosociality at 7 years

The prosocial subscale of the Strengths and Difficulties Questionnaire (SDQ; Goodman 1997) was completed by the mother. The internal reliability of the prosocial subscale is acceptable (Cronbach's alpha = 0.65) (Goodman 2001). The scores ranged from 0 to 10, with higher scores indicating higher prosociality.

Internalizing and externalizing problems (11 years)

When the child was 11 years old, parents were asked to complete the SDQ (Goodman 1997). Sum scores were generated for peer, emotional, conduct problems and hyperactivity subscales, with higher scores indicating more problems. The SDQ is a widely used instrument with

good reliability (mean Cronbach's alpha = 0.73) (Goodman 2001). For the SEM, these sum scores were used to create two continuous latent variables, as previously described for the ELCE variable, internalizing (peer and emotional subscales) and externalizing problems (conduct and hyperactivity subscales).

Statistical analyses

SEM using standardized values were run using Mplus version 7.3 (Muthen and Muthen 2012). All other analyses were run in Stata/SE 14.2 (StataCorp 2019). Independent samples *t*-tests were run to investigate differences on all measures for children with and without DLD. For the standardized beta-coefficients, the values are reported to three decimal places.

Using SEM, pathways between ELCE and two continuous latent variables (internalizing and externalizing problems in middle childhood) were investigated. This included direct paths and also indirect paths via language (continuous latent) and social development (sum scores) variables in childhood. The SEMs allow for a measurement and structural model to be run concurrently within a single model. That is, to allow for latent factor and path analyses to be run in the same model. Instead of allowing individual items to load directly onto the two latent factors, parcelling was used (Little *et al.* 2013). Thus, composite scores were created for each of the subscales (for ELCE and internalizing and externalizing problems) and these scores were treated as observed variables for the purposes of the latent factor loadings.

Group comparisons on measures of social development in childhood and internalizing and externalizing problems in middle childhood showed group differences (see the Results section). Combined with the growing body of literature on the group differences in internalizing and externalizing problems for children with and without DLD and support from measurement invariance testing (see table A3), this provided a strong rationale for a group-based approach. The SEM was, therefore, run for each group separately using the GROUPING command in Mplus, which analyses both groups in the same model in a multi-group analysis. The MLR estimator was used, which calculates robust standard errors, is robust to non-normality and it uses the full information maximum likelihood method to deal with missing data. There was adequate model fit (CFI = 0.963, TLI = 0.944, RMSEA = 0.026, SRMR = 0.023 ($\chi^2(138) = 452.61$, $p < 0.001$). Residual variances for all variables in childhood were correlated with each other. The MODEL INDIRECT command was used to test for indirect paths between ELCE and internalizing and externalizing problems in middle childhood. In line with other literature (MacKinnon *et al.* 2000, St Clair *et al.* 2015), all indirect paths were tested rather than just when there was a significant main effect. This allowed potential suppressor effects to be revealed that would not be possible if indirect effects were only tested when there was a significant main effect, as suggested by Baron and Kenny (1986). We also tested whether the strength of all parameters was significantly different between groups. To do this, the reference model was saved (i.e., that for which model fit statistics are provided above) and a comparison model was run with the significant path(s) constrained. The reference model was then compared with the comparison model using the Satorra–Bentler test of nested models using scaled chi-square (Satorra 2000).

Missing data

As with most longitudinal studies, there was sample attrition and thus missing data. After applying the exclusion criteria to the total sample (figure 1), there was no significant difference in sample attrition for children with and without DLD ($\chi^2(1, N = 6531) = 0.09$, $p = 0.758$. Girls $\chi^2(1, N = 6527) = 4.38$, $p = 0.036$) and children from low socioeconomic backgrounds were more likely to drop out ($t(6206) = 13.81$, $p < 0.001$). For the SEM, the full information maximum likelihood method was used to deal with missing data.

Results

Characteristics of the sample

Psycholinguistic, psychosocial and SES characteristics of the two groups are shown in tables 1 and A1 (Appendix A). As a group, children with DLD fared worse than their unaffected peers on all subscales of the ELCE measure. Children with DLD, as expected, had lower levels of receptive and expressive language as well as lower levels of prosociality and play competency in childhood compared with children without DLD. As a group, the children with DLD also had significantly more peer problems, emotional problems, conduct problems and hyperactivity, but the means for the DLD group did not reach levels of clinical significance. They did not, however, score more poorly on the friendships measure compared with children without DLD. Finally, children with DLD were more likely to be from lower SES households than children without DLD.

Table 1. Psycholinguistic and psychosocial characteristics for children with and without developmental language disorder

	Overall			Without DLD, mean (SD)	With DLD, mean (SD)	Test statistic	Mean difference [95% CI]	Effect size *d*
	n	Mean (SD)	Range					
Early language and communication environment (18–24 months)								
Mother–child direct teaching	5890	8.06 (1.55)	0–10	8.09 (1.53)	7.63 (1.76)	$t(5888) = 5.51^{***}$	0.56 [0.30, 0.63]	0.30
Mother–child activities	5875	32.87 (3.18)	14–40	32.92 (3.15)	32.07 (3.65)	$t(5873) = 4.95^{***}$	0.86 [0.52, 1.20]	0.27
Other–child interactions	5715	28.13 (2.04)	5–30	28.16 (2.02)	27.56 (2.27)	$t(5713) = 5.36^{***}$	0.60 [0.38, 0.82]	0.29
Resources	5711	21.56 (2.13)	6–24	21.57 (2.12)	21.32 (2.35)	$t(5709) = 2.23^{*}$	0.26 [0.03, 0.49]	0.12
Other activities	5876	8.39 (1.92)	2–15	8.41 (1.91)	7.99 (2.01)	$t(5874) = 4.04^{***}$	0.42 [0.22, 0.63]	0.22
Socioeconomic status	6208	3.15 (1.27)	0–5	3.17 (1.27)	2.79 (1.25)	$t(6206) = 5.65^{***}$	0.38 [0.25, 0.51]	0.30
Childhood measures (7–9 years) Language								
Receptive language	6525	7.56 (1.90)	2–15	7.68 (1.84)	5.83 (1.97)	$t(6523) = 19.23^{***}$	1.85 [1.66, 2.04]	1.00
Expressive language	6508	7.55 (1.75)	0–10	7.63 (1.70)	6.28 (1.98)	$t(6506) = 15.11^{***}$	1.35 [1.18, 1.53]	0.79
Social development								
Friendships	5462	19.29 (4.31)	5–25	19.31 (4.28)	19.12 (4.65)	$t(5460) = 0.78$	0.19 [–0.28, 0.66]	–
Play	5295	1.74 (0.19)	1–2	1.74 (0.19)	1.69 (0.20)	$t(5293) = 5.41^{***}$	0.05 [0.04, 0.78]	0.30
Prosociality	5186	8.22 (1.71)	1–10	8.23 (1.70)	7.97 (1.75)	$t(5184) = 2.74^{**}$	0.26 [0.07, 0.45]	0.15
Internalizing problems (11 years)								
Peer problems	4751	0.97 (1.40)	0–9	0.94 (1.37)	1.48 (1.68)	$t(4749) = -6.51^{***}$	–0.54 [–0.70, –0.38]	–0.39
Emotional problems	4992	1.38 (1.65)	0–10	1.35 (1.64)	1.68 (1.75)	$t(4920) = -3.47^{***}$	–0.33 [–0.52, –0.14]	–0.20
Externalizing problems (11 years)								
Conduct problems	4902	1.14 (1.35)	0–10	1.10 (1.32)	1.63 (1.61)	$t(4900) = -6.67^{***}$	–0.52 [–0.67, –0.37]	–0.39
Hyperactivity	4892	2.61 (2.16)	0–10	2.53 (2.10)	3.85 (2.55)	$t(4890) = -10.59^{***}$	–1.31 [–1.56, –1.07]	–0.62

Notes: $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

Direct effects between ELCE, language and social development in childhood, and internalizing and externalizing problems in middle childhood

As shown in table 2 and figure 2, for children with DLD, ELCE was associated with better childhood language, more competent social play and higher levels of prosociality, but not friendships or internalizing and externalizing problems in middle childhood. For children without DLD, all associations with ELCE, except internalizing problems, were significant. That is, for both children with and without DLD, a positive ELCE was associated with better language, more competent social play and higher levels of prosociality, and for children without DLD, a positive ELCE was also associated with better friendships and fewer externalizing problems. As shown in table A4, there were no significant differences between the groups in the strength of the direct effects from ELCE to language ($\chi^2(1, N = 6531) = 0.02$, $p = 0.919$), friendships ($\chi^2(1, N = 6531) = 0.03$, $p = 0.857$), play ($\chi^2(1, N = 6531) = 0.15$, $p = 0.700$), prosociality ($\chi^2(1, N = 6531) = 0.05$, $p = 0.828$), and externalizing problems in middle childhood ($\chi^2(1, N = 6531) = 1.05$, $p = 0.304$). The effect of the ELCE on internalizing problems in middle childhood was stronger for children with DLD ($\chi^2(1, N = 6531) = 5.65$, $p = 0.017$), but given that this path was not significant in either group, it is not interpreted further.

Direct effects between language and social development in childhood, and internalizing and externalizing problems in middle childhood

As shown in table 2 and figure 2, for children with DLD, better friendships and higher levels of prosociality in childhood were associated with fewer internalizing problems in middle childhood. There was no association between play in childhood and internalizing problems in middle childhood. Furthermore, more competent social play and higher levels of prosociality in childhood were associated with fewer externalizing problems in middle childhood for those with DLD. Within the sample of children with DLD, variability in language was not associated with internalizing or externalizing problems. For children without DLD, better friendships, more competent social play and higher levels of prosociality in childhood were all associated with fewer internalizing and externalizing problems in middle childhood. Furthermore, language ability was associated with fewer externalizing, but not internalizing, problems in middle childhood for those without DLD. That is, for both children with and without DLD, more competent social play and prosociality in childhood were associated with fewer externalizing problems in middle childhood. As shown in table A4, there were, however, no significant differences between the groups in the strength of the direct effects to internalizing problems in middle childhood from language ($\chi^2(1, N = 6531) = 0.02$, $p = 0.881$), friendships ($\chi^2(1, N = 6531) = 0.39$, $p = 0.534$), play ($\chi^2(1, N = 6531) = 0.73$, $p = 0.394$), or prosociality ($\chi^2(1, N = 6531) = 1.43$, $p = 0.231$). Similarly, there were no significant differences between the groups in the strength of the direct effects to externalizing problems in middle childhood from language ($\chi^2(1, N = 6531) = 0.69$, $p = 0.405$), friendships ($\chi^2(1, N = 6531) = 0.32$, $p = 0.074$), play ($\chi^2(1, N = 6531) = 0.48$, $p = 0.488$), or prosociality ($\chi^2(1, N = 6531) = 0.52$, $p = 0.469$).

Indirect pathways from ELCE to internalizing and externalizing problems in middle childhood

As shown in table 2 and figure 2, for children with DLD, there were no significant indirect paths from ELCE to internalizing problems. For children without DLD however, the indirect paths via friendships, play and prosociality (but not language) were all significant. This suggests that, for children without DLD, better friendships, more competent social play and higher levels of prosociality mediate the relationship between ELCE and internalizing problems in middle childhood.

A different pattern of results was observed for externalizing problems. For children with DLD, the pathway from ELCE to externalizing problems in middle childhood was significant via play and prosociality, but not via language or friendships. This suggests that, for children with DLD, more competent social play and higher levels of prosociality mediate the relationship between ELCE and externalizing problems in middle childhood. For children without DLD, all indirect paths between ELCE and externalizing problems in middle childhood were significant. Therefore, for children without DLD, the relationship between ELCE and externalizing problems in middle childhood is mediated by language ability, better friendships, more competent social play and higher levels of prosociality. There were, however, no significant differences between the groups in the strength of the pathways to internalizing problems via language ($\chi^2(2, N = 6531) = 0.01$, $p = 0.999$), friendships ($\chi^2(2, N = 6531) = 0.01$, $p = 0.997$), play ($\chi^2(2, N = 6531) = 0.01$, $p = 0.994$), or prosociality ($\chi^2(2, N = 6531) = 0.02$, $p = 0.990$). Similarly, there were no significant differences between the groups in the strength of the pathways to externalizing problems via language ($\chi^2(2, N = 6531) = 0.01$, $p = 0.994$), friendships ($\chi^2(2, N = 6531) = 0.04$, $p = 0.982$), play ($\chi^2(2, N = 6531) = 0.01$, $p = 0.995$), or prosociality ($\chi^2(2, N = 6531) = 0.01$, $p = 0.996$).

Table 2. Coefficients for the structural equation model (SEM)

	Without DLD	With DLD
Latent variable factor loadings		
Mother–child direct teaching → ELCE	0.454 [0.427, 0.481]***	0.508 [0.452, 0.563]***
Mother–child activities → ELCE	0.656 [0.629, 0.683]***	0.740 [0.684, 0.796]***
Other–child interactions → ELCE	0.668 [0.635, 0.700]***	0.741 [0.693, 0.788]***
Resources → ELCE	0.314 [0.285, 0.344]***	0.354 [0.305, 0.403]***
Other activities → ELCE	0.379 [0.354, 0.405]***	0.426 [0.376, 0.475]***
Receptive language → language	0.483 [0.451,0.515]***	0.437 [0.374, 0.499]***
Expressive language → language	0.727 [0.685, 0.769]***	0.658 [0.562, 0.753]***
Peer problems → internalizing problems	0.636 [0.599, 0.673]***	0.611 [0.511, 0.711]***
Emotional problems internalizing problems	0.565 [0.528, 0.602]***	0.534 [0.437, 0.631]***
Conduct problems → externalizing problems	0.692 [0.63, 0.722]***	0.706 [0.648, 0.765]***
Hyperactivity → externalizing problems	0.680 [0.652, 0.708]***	0.725 [0.656, 0.795]***
Path coefficients		
ELCE → language	0.197 [0.163, 0.231]***	0.236 [0.105, 0.368]**
SES → language	0.315 [0.285, 0.344]***	0.251 [0.137, 0.364]***
ELCE → friendships	0.080 [0.049, 0.111]***	0.101 [–0.004, 0.198]
SES → friendships	–0.031 [–0.056, –0.006]*	0.039 [–0.049, 0.128]
ELCE → play	0.142 [0.112, 0.172]***	0.187 [0.076, 0.298]**
SES → play	0.077 [0.053, 0.101]***	0.119 [0.030, 0.208]*
ELCE → prosociality	0.168 [0.139, 0.197]***	0.176 [0.072, 0.279]**
SES → prosociality	–0.007 [–0.031, 0.018]	0.038 [–0.053, 0.130]
ELCE → internalizing problems	–0.024 [–0.070, 0.023]	0.163 [0.022, 0.304]
SES → internalizing problems	–0.124 [–0.161, –0.087]***	–0.077 [–0.219, 0.065]
Language → internalizing problems	0.013 [–0.038, 0.063]	–0.006 [–0.214, 0.203]
Friendships → internalizing problems	–0.294 [–0.333, –0.254]***	–0.255 [–0.409, –0.101]**
Play → internalizing problems	–0.192 [–0.234, –0.149]***	–0.127 [–0.265, 0.011]
Prosociality → internalizing problems	–0.106 [–0.144, –0.067]***	–0.221 [–0.371, –0.071]*
ELCE → externalizing problems	–0.065 [–0.107, –0.022]*	0.029 [–0.123, 0.181]
SES → externalizing problems	–0.131 [–0.165, –0.098]***	–0.186 [–0.303, –0.069]**
Language → externalizing problems	–0.115 [–0.158, –0.073]***	–0.012 [–0.184, 0.160]
Friendships → externalizing problems	–0.082 [–0.116, –0.048]***	0.036 [–0.075, 0.146]
Play → externalizing problems	–0.184 [–0.220, –0.148]***	–0.227 [–0.346, –0.109]**
Prosociality → externalizing problems	–0.277 [–0.310, –0.243]***	–0.317 [–0.433, –0.201]***
Indirect paths		
ECE → language → internalizing problems	0.003 [–0.007, 0.013]	–0.001 [–0.051, 0.048]
ECE → friendships → internalizing problems	–0.024[–0.033, –0.014]***	–0.026 [–0.055, 0.004]
ECE → play → internalizing problems	–0.027 [–0.036, –0.019]***	–0.024 [–0.053, 0.006]
ECE → prosociality → internalizing problems	–0.018 [–0.025, –0.011]***	–0.039 [–0.075, –0.003]
ECE → language → externalizing problems	–0.023 [–0.032, –0.013]***	–0.003 [–0.044, 0.038]
ECE → friendships → externalizing problems	–0.007[–0.010, –0.003]**	–0.004 [–0.008, 0.015]
ECE → play → externalizing problems	–0.026 [–0.034, –0.019]***	–0.043 [–0.077, –0.008]*
ECE → prosociality → externalizing problems	–0.046 [–0.056, –0.037]***	–0.056 [–0.095, –0.017]*
Residual correlations		
Mother–child direct teaching with SES	0.077 [0.051, 0.103]***	0.118 [0.022, 0.213]*
Mother–child activities with SES	0.135 [0.103, 0.166]***	0.098 [–0.018, 0.214]
Other–child interactions with SES	0.253 [0.217, 0.288]***	0.264 [0.141, 0.387]***
Resources with SES	0.163 [0.138, 0.189]***	0.198 [0.111, 0.285]***
Other activities with SES	0.148 [0.123, 0.173]***	0.175 [0.084, 0.265]**
Language with friendships	–0.137 [–0.169, –0.105]***	–0.086 [–0.210, 0.038]
Language with play	0.064 [0.031, 0.097]**	0.084 [–0.054, 0.221]
Language with prosociality	0.007 [–0.025, 0.039]	–0.107 [–0.241, 0.027]
Friendships with play	0.061 [0.034, 0.087]***	0.079 [–0.018, 0.176]
Friendships with prosociality	0104 [0.077, 0.130]***	0.084 [–0.011, 0.179]
Play with prosociality	0.339 [0.316, 0.362]***	0.196 [0.100, 0.291]**
Internalizing problems with externalizing problems	0.579 [0.524, 0.634]***	0.620 [0.422, 0.818]***

Notes: Values are standardized beta-coefficients [95% confidence intervals].
$*p < 0.05$, $**p < 0.01$, $***p < 0.001$.

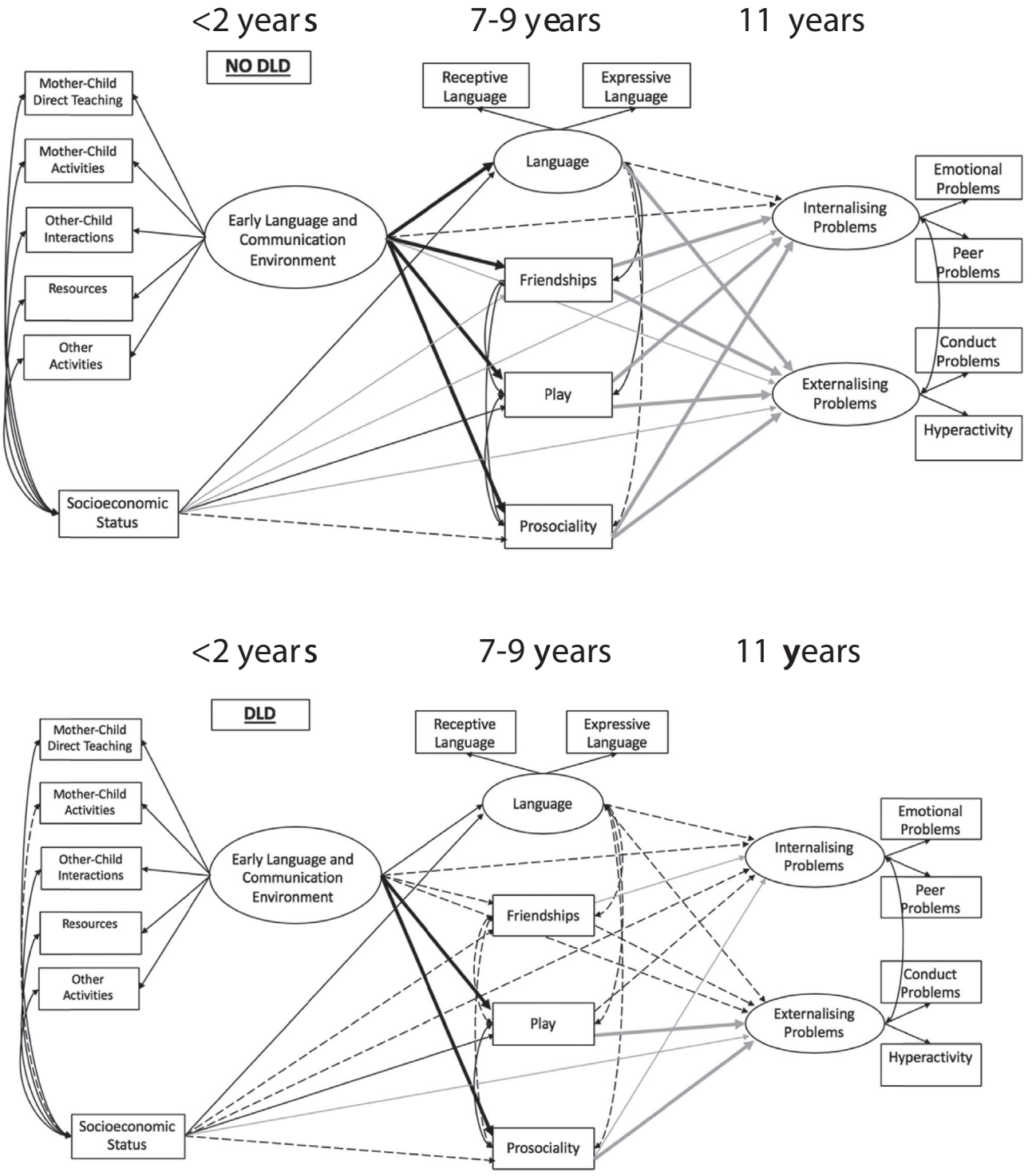

Figure 2. Pathways to internalizing and externalizing problems in middle childhood for children with and without DLD. Dot–dashed lines depict non-significant paths; solid black lines depict significant direct paths (positive) at $p < 0.05$ or lower. Solid grey lines depict significant direct paths (negative) at $p < 0.05$ or lower. Bold solid lines depict significant indirect pathways at $p < 0.05$ or lower.

Discussion

The pathways from ELCE internalizing (peer and emotional problems) and externalizing problems (conduct problems and hyperactivity) are similar for children with and without DLD. For both groups, a more positive ELCE is associated with more competent social play and higher levels of prosociality in childhood, which in turn are associated with fewer externalizing problems in middle childhood. Our findings make a unique contribution to the existing literature as we demonstrate the specific role of the ELCE in the development of social play and prosociality for children with DLD, both of which are associated with fewer externalizing problems in middle childhood.

ELCE

As predicted, more favourable ratings on ELCE were associated with higher levels of language and social development in childhood. This is consistent evidence that a child's interactions with the primary caregiver and the role of the primary caregiver as a socialization agent for child's relationships with others are beneficial later in childhood (Bowlby 1969, Bronfenbrenner 1979). The activities that children undertake that serve to promote language and communication development during the first two years of life also contribute to subsequent social development. The first two years of life involve rapid growth and structural changes in brain regions associated with cognitive development (Knickmeyer *et al.* 2008). One explanation for our findings is that during the first two years of life a positive ELCE provides cognitive stimulation which in turn promotes structural development in the brain regions that are associated with language, higher cognitive function and social skills. A further possibility is that the ELCE provides a medium for conversations about feelings which are known to increase emotion recognition later in childhood (Dunn *et al.* 1991). We did not test these possibilities specifically in our analyses but if our interpretations are confirmed in future research, then they would carry important implications for early provision of services to children with DLD. Whilst we included socioeconomic status in the statistical models, there are some other confounders, like parental genotype, that may affect the ELCE, that were not tested and thus cannot be discounted. Nonetheless, our findings suggest that, to some extent, children who are exposed to language and communication rich environments have fewer subsequent externalizing problems and that for children at risk of DLD provision of such an environment may be particularly beneficial.

Protective factors in social development

Our findings show that social play and prosociality are key factors that predict externalizing problems in middle childhood. For both children with and without DLD, those who are more competent in social play or are more prosocial in childhood have fewer externalizing problems in middle childhood. These findings support the plethora of research in neurotypical populations on the protective nature of prosociality against internalizing and externalizing problems (Baines and Blatchford 2010, Coulombe and Yates 2018, Griese and Buhs 2014, Troop-Gordon and Unhjem 2018). This is also in line with other work, specific to children and adolescents with DLD, indicating that being prosocial is associated with fewer internalizing and externalizing problems (Conti-Ramsden and Durkin 2016, Toseeb and St Clair 2020, Toseeb *et al.* 2017).

On the whole, children with developmental disorders, such as DLD, have difficulties integrating into peer social play (Gibson *et al.* 2011, 2013). The present study confirms that children with DLD are less competent in social play compared with their peers without DLD. For the first time, however, using a large longitudinal sample, we demonstrate that children with DLD who successfully engage in social play aged 7 have fewer externalizing problems aged 11 years. This suggests that whilst children with DLD tend to have less competent social play, those with more competence in this respect are likely to have fewer externalizing problems later in childhood. If future research confirms a causal link between play and externalizing problems, it may pave the way for play-based interventions in children with DLD. This is a particularly appealing prospect for practitioners as such interventions capitalize on one of the most appealing and intuitive means of learning in childhood, play with friends, meaning the likelihood of acceptability and engagement with such interventions may be higher than for traditional adult-led, paper-and-pencil activities.

A somewhat unexpected finding was that within the DLD group, variability in language ability was not associated with social development nor with internalizing and externalizing problems. One possible explanation for this it that there is a non-linear relationship between language and social competence such that a certain level of linguistic ability must be attained before significant impact on social outcomes is observed. Another possibility is that the measure of language ability is not fine-grained enough to detect meaningful differences in ability between those at the lower end of the scale. We recommend that future studies could investigate these relations with more sensitive measures and non-linear analyses.

Strengths and limitations

A major strength of the research reported here is the large community-based sample. Studies of clinical populations suffer from issues such as referral bias, which may lead to inaccurate estimates. The ALSPAC cohort is largely representative of the UK population when compared with 1991 Census data; there is, however, differential attrition that has led to underrepresentation of some ethnic minorities and less affluent groups (Boyd *et al.* 2013). This should be borne in mind when interpreting our findings. A further consideration is that because of the indirect nature of the ELCE measure, it is not possible to determine the exact quality of language and communication used in the home. Unmeasured factors such as parenting style or sensitive responding to the child's needs are likely to be important too. We also acknowledge the very small mediated effect sizes. This is not surprising given that children's development occurs in the context of multiple systems (Bronfenbrenner 1979). A large effect size would suggest that a single factor is predictive of internalizing and externalizing problems in childhood, which we know is not the case. Future work should include a comprehensive investigation of the covariates to understand the mechanisms involved in the effects we observed. Finally, although longitudinal analyses overcome some drawbacks associated with cross-sectional data, causality cannot be inferred. We cannot rule out the possibility that the association between ELCE, language and social development, and internalizing and externalizing problems is caused by a third unmeasured factor, such as genetics.

Conclusions

The present analyses show that a positive ELCE is associated with better language development, more competent play, and higher levels of prosociality in childhood. This holds for both children with DLD and for their peers without DLD. In turn, more competent social play and higher levels of prosociality predict fewer externalizing problems, which is particularly important for children with DLD because, while these children tend to score less favourably on a range of abilities and social measures, they are found to fall in the typical range in respect of prosociality (Toseeb and St Clair 2020, Toseeb *et al.* 2017). This suggests an area of relative strength, for at least some of these children. We speculate that in the absence of adequate language ability, play and prosocial behaviours allow children with DLD to deploy, practise and learn key relationship skills such as turn-taking and negotiation, alongside behavioural and emotional regulation skills, thus protecting against externalizing problems. Thus, we suggest that consideration be given to play- and prosociality-based educational and therapeutic services for children with DLD.

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Appendix A: Early child language measures used to confirm DLD status

The early language profiles of children with and without DLD were examined in order to confirm DLD status. The measures used are described below.

Measures of children's early language (15–24 months)

For the parent report measures at 15–24 months, a modified version of the MacArthur–Bates Communicative Development Inventories (Fenson *et al.* 1993) was used. The MacArthur–Bates Communicative Development Inventories has been shown to have good validity at a population level (Dale *et al.* 1989, Feldman *et al.* 2005).

Receptive language at 15 months

Parents were shown a list of phrases and asked whether their child understands. Samples phrases include 'Are you sleepy?' and 'Don't touch'. Responses were coded on a binary scale (0 = no, 1 = yes) and then summed to create a score ranging from 0 to 12. Higher scores indicated better receptive language.

Vocabulary at 15 months

When the child was 15 months old, parents were given a list of words/phrases and asked whether their child 'understands but doesn't say' (1), 'understands and says' (2) or 'neither' (0). Words/phrases were age appropriate and included words such as 'bed', 'nose' and 'hot'. Responses were summed to create a score ranging from 0 to 268. Higher scores indicated better vocabulary.

Vocabulary at 24 months

When the child was 24 months old, parents were given a list of words/phrases and asked whether their child 'understands' (1), 'says' (2) or 'neither' (0). Words were age appropriate and included 'hello', 'dinner' and 'chicken'. Responses were summed to create a score ranging from 0 to 246. Higher scores indicated better vocabulary.

Grammar at 24 months

Parents were given four examples of grammar rules and asked whether their child has begun use these rules in their spoken language. Parents were asked about grammar rules such as adding 'ing' to the end of words and adding 's' to signify plural. Responses were coded as 'not yet' (0), 'sometimes' (1), 'often' (2) and then summed to create a score ranging from 0 to 8. Higher scores indicated better grammar.

As expected, and shown in table A1, on all measures of language in early and middle childhood, those with DLD scored significantly lower than those without DLD. In total, 62% ($n = 220$) of children with DLD had impairment in receptive language and/or grammar

Table A1. Language characteristics of children with and without DLD

	Overall			Without DLD, mean (SD)	With DLD, mean (SD)	Test statistic	Mean difference [95% CI]	Effect size
	n	Mean (SD)	Range					
Early childhood								
Receptive language 15 months	5829	9.19 (2.42)	0–12	9.21 (2.41)	8.90 (2.51)	$t(5827) = 2.36^{*}$	0.31 [0.05, 0.57]	0.13
Vocabulary 15 months	5826	88.56 (43.73)	0–268	89.50 (43.78)	74.17 (40.36)	$t(5824) = 6.45^{***}$	15.33 [10.67, 19.99]	0.35
Vocabulary 24 months	5719	157.78 (53.81)	0–246	160.45 (52.62)	117.36 (55.58)	$t(5717) = 14.87^{***}$	43.08 [37.41, 48.77]	0.82
Grammar 24 months	5719	3.60 (2.55)	0–8	3.71 (2.54)	1.92 (2.12)	$t(5717) = 12.95^{***}$	1.78 [1.52, 2.06]	0.71
Childhood								
Non-word repetition 8 years	6517	7.40 (2.43)	0–12	7.61 (2.29)	4.14 (2.16)	$t(6515) = 28.20^{***}$	3.47 [3.23, 3.70]	1.52
Pragmatic language 9 years	5125	151.65 (6.71)	98–162	152.25 (6.00)	143.81 (9.84)	$t(5122) = 24.52^{***}$	8.44 [7.77, 9.12]	1.33
Receptive language 8 years	6525	7.67 (6.71)	2–15	7.68 (1.84)	5.83 (1.97)	$t(6523) = 19.23^{***}$	1.85 [1.66, 2.04]	1.00
Child ever had speech/language therapy 8 years	5126	415 (8%)	–	221 (5%)	194 (54%)	$\chi^2(1, N = 5126) = 1100.00^{***}$	–	–

Notes: For continuous variables, values are mean (standard deviation). For binary variables, values are yes response, *n* (%). For the early childhood measures, a modified version of the MacArthur–Bates Communicative Development Inventories was used (Fenson *et al.* 1993). For middle childhood, the following tests were used: the non-word repetition test (Gathercole *et al.* 1994), children's communication checklist (Bishop 1998) for pragmatic language, and the Weschler Objective Language Dimensions (Rust 1996) for receptive language. Whether the child ever had speech/language therapy was assessed by parental report.
$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

Table A2. Pairwise correlations between early language and communication environment (ELCE) subscales

	1	2	3	4	5
1. Mother–child direct teaching	1				
2. Mother–child activities	0.41***	1			
3. Other–child interactions	0.33***	0.48***	1		
4. Resources	0.14***	0.21***	0.32***	1	
5. Other activities	0.21***	0.29***	0.29***	0.22***	1

Note: $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

Table A3. Measurement invariance for the early language and communication environment (ELCE) variable

Model	Chi^2	d.f.	*p* (for comparison with the configural model)	CFI	TLI	RMSEA	SRMR
Configural model	130.289	10	–	0.952	0.904	0.063	0.028
Metric model	120.922	14	0.999	0.957	0.939	0.050	0.028
Scalar invariance model	124.379	18	0.999	0.957	0.953	0.044	0.028

Table A4. Parameter testing for between group differences

Path	Chi^2	*p*	CFI	TLI	RMSEA	SRMR
ELCE → language	0.010	0.919	0.963	0.945	0.026	0.023
ELCE → friendships	0.032	0.857	0.963	0.945	0.026	0.023
ELCE → play	0.148	0.700	0.963	0.945	0.026	0.023
ELCE → prosociality	0.047	0.828	0.963	0.945	0.026	0.023
ELCE → internalizing problems	5.649	0.017	0.963	0.944	0.026	0.023
ELCE → externalizing problems	1.053	0.304	0.963	0.944	0.026	0.023
Language → internalizing problems	0.022	0.881	0.963	0.945	0.026	0.023
Language → externalizing problems	0.693	0.405	0.963	0.944	0.026	0.023
Friendships → internalizing problems	0.386	0.534	0.963	0.945	0.026	0.023
Friendships → externalizing problems	3.190	0.074	0.963	0.944	0.026	0.023
Play → internalizing problems	0.728	0.394	0.963	0.944	0.026	0.023
Play → externalizing problems	0.480	0.488	0.963	0.944	0.026	0.023
Prosociality → internalizing problems	1.432	0.231	0.963	0.944	0.026	0.023
Prosociality → externalizing problems	0.523	0.469	0.963	0.944	0.026	0.023
ELCE → language → internalizing	0.001	0.999	0.963	0.945	0.026	0.023
ELCE → language → externalizing	0.010	0.994	0.963	0.945	0.026	0.023
ELCE → friendships → internalizing	0.006	0.997	0.963	0.945	0.026	0.023
ELCE → friendships → externalizing	0.036	0.982	0.963	0.945	0.026	0.023
ELCE → play → internalizing	0.013	0.994	0.963	0.945	0.026	0.023
ELCE → play → externalizing	0.009	0.995	0.963	0.045	0.026	0.023
ELCE → prosociality → internalizing	0.021	0.990	0.963	0.945	0.026	0.023
ELCE → prosociality → externalizing	0.007	0.996	0.963	0.945	0.026	0.023

Note: The path column refers to the path that was constrained. *t* refers to the Satorra–Bentler scaled Chi^2 statistic.

when they were 15–24 months old compared with 31% ($n = 111$) of children without DLD.

Appendix B: Early language and communication environment (ELCE)

When the child was aged 18–24 months, the mother was asked about the child's ELCE. These questions were previously coded by Roulstone *et al.* (2011) and used as a measure of communication environment. The framework, proposed by Roulstone *et al.*, included proximal and distal language and communication stimulation, children's development and welfare, maternal attitudes, and maternal support. Two components of the Roulstone *et al.* framework were used here: language and communication stimulation and children's development and welfare. Each item used was screened for duplicates (some questions were asked at two separate time points). Items within each of the subcategories of language and communication stimulation and children's development and welfare were then analysed using factor analysis (1) to confirm that the items loaded on to a single factor within each construct (decisions were based on Eigenvalues of ≥ 1 and visual inspection of a scree plot) and (2) to remove items that loaded poorly on to the main factor (factor loadings of < 0.4 were removed). In summary, five subscales of ECLE were created (mother–child

direct teaching, mother–child interaction, other–child interaction, resources and other activities). Further details of each of the five subscales is provided below.

Mother–child direct teaching

This measure consisted of 10 items such as 'mum teaches clapping games' and 'mum teaches songs'. Responses were coded on a binary scale (0 = no, 1 = yes) and then summed to create a score ranging from 0 to 10. Higher scores indicated that the mother taught the child a wider variety of things. The scale had good internal consistency (Cronbach's alpha = 0.63). The variance explained by the latent factor in the SEM (without DLD: 23%, with DLD: 27%).

Mother–child activities

This measure consisted of eight items such as 'frequency mum sings to child' and 'frequency mum has physical play with child'. Responses were coded on a five-point scale (1 = never, 2 = less than once per week, 3 = one to two times per week, 4 = three to five times per week, 5 = almost daily) and then summed to create a score ranging from 8 to 40. Higher scores indicated that the mother and child engaged in activities more frequently. The scale had good internal consistency (Cronbach's alpha = 0.70). The variance explained by the latent factor in the SEM (without DLD: 44%, with DLD: 55%).

Other–child interactions

This measure consisted of six items relating to others such as 'child sung to' and 'child kissed or cuddled'. Responses were coded on a five-point scale (1 = never, 2 = rarely, 3 = once a week, 4 = several times a week, 5 = every day) and then summed to create a score ranging from 6 to 30. Higher scores indicated that the child was more frequently engaged in interactions with other people (not exclusive to but not excluding the mother). The scale had good internal consistency (Cronbach's alpha = 0.54). The variance explained by the latent factor in the SEM (without DLD: 43%, with DLD: 53%).

Resources

This measure consisted of six items such as 'number of toy vehicles at child has at home' and 'number of interlocking toys child has at home'. Responses were coded on a four-point scale (1 = none, 2 = one, 3 = two or three, 4 = four or more) and then summed to create a score ranging from 6 to 24. Higher scores indicated that more resources to underpin development were available to the child. The scale had good internal consistency (Cronbach's alpha = 0.58). The variance explained by the latent factor in the SEM (without DLD: 12%, with DLD: 15%).

Other activities

This measure consisted of three items: frequency child taken to 'park', 'places of interest' and 'places of entertainment'. Responses were coded on a five-point scale (1 = never, 2 = a few times per year, 3 = once per month, 4 = once per week, 5 = nearly every day) and then summed to create score ranging from 3 to 15. Higher scores indicated that the child was frequently taken places outside of the home. The scale had good internal consistency (Cronbach's alpha = 0.59). The variance explained by the latent factor in the SEM (without DLD: 14%, with DLD: 17%).

Measurement invariance

Measurement invariance for the ELCE variable between children with and without DLD was examined in Mplus 7.3. Robust maximum likelihood (MLR) estimation and the 'model = configural metric scalar' statement was used to fit configural, metric and scalar invariance models. As shown in table 1, the configural model had adequate fit, and thus so subsequent models were examined for potential decreases in fit resulting from measurement non-invariance. The metric invariance model was not significantly different to the configural invariance model and the scalar invariance model was not significantly different to the metric invariance model. Therefore, measurement invariance can be assumed.

Appendix C: Friendships at 9 years

The measure of friendships consisted of five statements, which the parent rated on a five-point scale (1 = not true, 2 = mostly untrue, 3 = partly true, 4 = mostly true, 5 = true). The statements were 'child has lots of friends', 'child makes friends easily', 'other kids want child to be their friend', 'child has more friends than most other kids' and 'most other kids like child'.

Appendix D: Play at 7 years

The measure of play consisted of eight questions, which the parent responded to on a five-point scale (1 = yes can do well , 2 = yes but not well, 3 = has not yet done, 4 = unable to try this, 5 = not had chance). The questions were 'Does she share her toys with other children?', 'Does she share the toys of other children, understanding that they are not hers?', 'Does she feel sympathy for someone if they are hurt?', 'Does she think of things to do to please you?', 'Does she take turns in a game without fuss?', 'Can she play card games (e.g.,

snap)?', 'Can she play any board games (e.g., Monopoly, Snakes & Ladders)?' and 'Can she play chess?'

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