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Concurrent and longitudinal associations of developmental language disorder with peer victimization in adolescence: evidence from a co-twin study

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Background: Children with developmental language disorder (DLD) experience higher levels of peer victimization than their peers. However, it is not known if such associations reflect genetic and environmental confounding. We used a co-twin control design to investigate the association of language difficulties (DLD and separately poor pragmatic language) with peer victimization and compare the developmental trajectories of peer victimization across adolescence for those with and without language difficulties. **Methods:** Participants were 3,400 pairs of twins in the Twins Early Development Study (TEDS), a UK-based population birth cohort. Language abilities were assessed via online tests at age 11 and peer victimization was self-reported at ages 11, 14 and 16. Language difficulties were defined as language abilities at least −1.25 *SD* below the mean of the TEDS sample. We performed linear regressions and latent growth curve modeling at a population level and within monozygotic and same-sex dizygotic twin pairs. **Results:** At population level, youth with DLD experienced higher levels of peer victimization at ages 11 (β = 0.27, 95% Confidence Interval (CI) 0.20–0.35), 14 (β = 0.15, 95% CI 0.03–0.27) and 16 (β = 0.17, 95% CI 0.03–0.32) and a sharper decline in peer victimization between ages 11 and 16 compared to their peers without DLD. The associations between DLD and peer victimization were reduced in strength and not statistically significant in within-twin models. Moreover, there was no difference in the rate of change in peer victimization between twin pairs discordant for DLD. Results were similar for the association of poor pragmatic language with peer victimization. **Conclusions:** Associations between language difficulties (DLD and separately, poor pragmatic language) and peer victimization were confounded by genetic and shared environmental factors. Identifying specific factors underlying these associations is important for guiding future work to reduce peer victimization among adolescents with language difficulties. **Keywords:** Developmental language disorder; bullying victimization; behavioral genetics; pragmatic language; adolescence.

Introduction

Peer victimization is the experience of being the target of hostile acts and behaviors done intentionally by peers to inflict harm (Finkelhor, Turner, & Hamby, 2012). It affects one in three young people worldwide (UNESCO, 2019) and is associated with wide range of mental health problems (Arseneault, 2018; Oncioiu et al., 2021; Schoeler, Duncan, Cecil, Ploubidis, & Pingault, 2018). Children and adolescents who have language difficulties, such as those with Developmental Language Disorder (DLD), are more likely to experience peer victimization (e.g. Durkin & Conti-Ramsden, 2010; Øksendal et al., 2021; van den Bedem Neeltje, Dockrell, van Alphen Petra, Kalicharan, & Carolien, 2018), but the reasons for this association are not clear. We used a longitudinal and genetically sensitive design to further our understanding of why young people with DLD are more likely to experience peer victimization.

DLD is characterized by persistent problems with understanding and using home language effectively (Bishop, Snowling, Thompson, & Greenhalgh, 2017). DLD is not rare, with a prevalence of around 7% (Norbury et al., 2016). While those with DLD are at risk for emotional, behavioral and peer problems (Chow, Ekholm, & Coleman, 2018; Forrest, Gibson, Halligan, & St Clair, 2020), the literature points to a complex pattern over development. Some studies report an increase in socioemotional and behavioral problems with age for those with DLD (Conti-Ramsden et al., 2019; Curtis, Frey, Watson, Hampton, & Roberts, 2018) whereas others do not find evidence for it (Forrest et al., 2020). Moreover, longitudinal studies reveal considerable heterogeneity in the magnitude and stability of peer, emotional and behavioral difficulties over time among children and young people with DLD (Conti-Ramsden et al., 2019; Pickles, Durkin, Mok, Toseeb, & Conti-Ramsden, 2016; Toseeb, Vincent, Oginni, Asbury, & Newbury, 2023).

To date, the association between DLD and peer relationships has been studied mainly in childhood

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(Lloyd-Esenkaya, Russell, & Clair, 2020). In a population-based sample, Øksendal et al. (2021) observed an association between language difficulties and peer victimization in 8-year-olds, and the association was strongest for those with persistent language difficulties from age 3 to 8 years. Additionally, Forrest, Gibson, Halligan, and St Clair (2018) found that language difficulties at age 5 were associated with peer victimization at age 7, which in turn were associated with emotional problems at age 14. However, Jelen, Griffiths, Lucas, Saul, and Norbury (2023) did not find support for this mediation mechanism as language difficulties were not associated with peer problems. Finally, Lloyd-Esenkaya et al. (2020) documented that not all children with DLD report peer problems. There is evidence that adolescents with DLD from a clinical sample reported more peer victimization than peers without DLD (van den Bedem Neeltje et al., 2018). Moreover, persistent peer problems across childhood and adolescence were observed in another sample of young people with DLD (Conti-Ramsden et al., 2019). As language skills are essential for building and sustaining relationships (Nippold, 1998) and adolescence is a critical period for the development of the social brain (Blakemore, 2008), it is important to better understand the role of DLD for peer victimization in adolescence.

Language is a complex trait. One aspect that may be particularly relevant for peer victimization is pragmatics, defined as the appropriate use of language in a social context. Some people with DLD have difficulties with pragmatics. They may, for example, provide too much or too little information during conversation or show insensitivity to social cues such as eye gaze or turn-taking; and have difficulty with figurative language. Plausibly, variation in these aspects of language has been shown to be closely related to peer victimization (Conti-Ramsden et al., 2019; Janik Blaskova & Gibson, 2021). However, it should be noted that pragmatic impairments in context of unimpaired structural language are rare (Saul, Griffiths, & Norbury, 2023).

Why might DLD be associated with peer victimization? One explanation sees language as salient for building and sustaining relationships via social exchange. On this view, individuals are the target of peer victimization as poor language manifests as difficulties with conflict resolution, negotiation and problem-solving (Forrest, Lloyd-Esenkaya, Gibson, & St Clair, 2023; Griffiths et al., 2021; van den Bedem Neeltje et al., 2018). Alternatively, it could be that confounding factors increase the risk of having DLD, and simultaneously increase the risk of peer victimization. One source of confounding that has not been accounted for previously is genetic liability. DLD is heritable (Bishop & Hayiou-Thomas, 2008), and even if peer victimization is an environmental exposure in itself, it is associated with traits that are heritable, for example mental health symptoms, BMI or risk-taking behavior (Bowes et al., 2013; Schoeler et al., 2019). Consistent with the idea that common genetic factors might be at play, Newbury et al. (2019) found that a polygenic score for expressive language at age 8 years was associated with peer problems at 11 years. To our knowledge, no study has used a genetically informed design to account for genetic liability as a possible source of confounding in the relationship between DLD and peer victimization.

The co-twin control design is an informative way to account for factors shared within families (i.e. genetic and environmental). Twins brought up together share a major part of their environments (measured and unmeasured), and in addition, monozygotic twins (MZ) have the same genotype. The co-twin control design tests whether twins that differ in an exposure (e.g. discordant on DLD status) differ in an outcome (e.g. peer victimization). If within-twin pair differences in DLD status are associated with within-twin pair differences in peer victimization, this provides evidence of potential causal effect that cannot be explained by shared genetic or environmental factors (McAdams, Rijsdijk, Zavos, & Pingault, 2021; Vitaro, Brendgen, & Arseneault, 2009).

In this preregistered study (https://osf.io/9d78v), we addressed two key limitations of the current evidence base on the effect of DLD on peer victimization: reliance on clinical DLD samples in adolescence and genetic confounding. We used the co-twin design to disentangle potential explanations for the association of DLD with peer victimization (note, no data on peer aggression are available in the dataset). In a cohort of 3,400 twin pairs from the United Kingdom, we tested for associations of DLD assessed at age 11 years with peer victimization concurrently, and later in development at 14 and 16 years. Next, we described and compared the developmental trajectories of peer victimization across adolescence for those with and without DLD. As well as accounting for familial confounders by design, we adjusted for key individual confounders, including mental health symptoms and nonverbal IQ. We hypothesized that:

1 adolescents with DLD will experience higher levels of peer victimization concurrently, and over longer periods of time, compared to adolescents without DLD.
2 Adolescents with poor pragmatic language will experience higher levels of peer victimization concurrently, and over longer periods of time, compared to adolescents without poor pragmatic language, independent from the effects of poor structural language.
3 Any association observed between DLD/poor pragmatic language and peer victimization in adolescence would be at least partially

confounded by genetic and environmental factors shared within families.

Within these hypotheses, we tested whether any relationships observed varied depending on whether peer victimization was self-reported or parent-reported, given evidence that mental health symptoms are reported differently by individuals versus parents in some studies of DLD (Jelen et al., 2023). Finally, we tested whether any associations varied according to sex, following previous findings indicating sex differences in the relationship between DLD and socioemotional and behavioral symptoms (e.g. Helland, Røysamb, Wang, & Gustavson, 2018; Hentges, Devereux, Graham, & Madigan, 2021).

Methods

Participants

The Twin Early Development Study (TEDS) is an ongoing observational longitudinal study of over 16,000 twin pairs born between 1994 and 1996 in England and Wales recruited through national birth records. Participation in the study was voluntary and written consent was obtained from parents during childhood, and from twins themselves from age 16 onwards prior to each wave of data collection. TEDS was approved by King's College London Research Ethics Committee and more information about the cohort can be found elsewhere (Lockhart et al., 2023). The exclusion criteria in TEDS (teds.ac.uk/datadictionary/exclusions.htm) match those used in previous studies of DLD (Forrest et al., 2020; Toseeb, Oginni, & Dale, 2022). Here, we excluded families in which one or both twins had a medical disorder associated with language impairment (e.g. nonverbal autism, chromosomal disorders such as Down syndrome, profound deafness or complete blindness). Moreover, for the current study, we also excluded those for whom English was not the only language spoken at home.

We used data collected at 11, 14 and 16 years and restricted the analyses to families where information was available for both twins on language abilities at age 11 and on one or more of the three repeated measures of peer victimization at ages 11, 14 or 16 (n = 3,400 families). The wave-specific analytical sample size comprised 3,313, 1,875 and 1,323 twin pairs at 11, 14 and 16 years respectively. Note that at age 16, only a random subsample of participants was invited to participate, reducing the available sample size. Our subsample is fairly representative of the UK population, despite some attrition. We note that a higher proportion of study participants had parents with at least A-level education compared to national averages (Table S1).

Measures

Table 1 lists the instruments used to assess outcome, exposure and covariates – including examples of items, reliability measures (i.e. Cronbach's α) and references. To describe how DLD status covaries with socioeconomic, behavioral, cognitive, and communication-related characteristics, we used a wide range of factors measured from 1.5 to 11 years old (instruments listed in footnote of Table 2).

Outcome. Peer victimization was measured via self-report using web-based questionnaires. At 11 and 14 years twins answered 16 questions referring to face-to-face victimization and at 16 years, a shorter 6-item version of the same scale. At each wave, we computed the mean score across items for all participants who answered at least half of the peer victimization items (i.e. we excluded those who answered 7 or less items on the 16-item scales and 2 or less items on the 6-item scale). As the peer victimization distribution was skewed, we applied the natural log transformation log (y + 1). The log-transformed peer victimization score ranged from 0 to 1.098. We then standardized the log-transformed score (Z-score, mean 0, SD = 1) using the TEDS analytical sample (n = 3,400 twin pairs). A higher score indicates a higher intensity of peer victimization. For the latent growth analyses, at age 11 and 14 years, we derived the score of peer victimization using only the 6 items which were common to questionnaires at ages 11, 14 and 16 and then log-transformed those scores.

Exposure. Language was assessed with four standardized tests covering vocabulary, syntax, figurative language and pragmatics, that is language in social context. All tests were administered online and used written formats accompanied by an audio recording. We derived a composite score for overall language by averaging the Z scores of all four language measures (composite measure Cronbach's α = 0.65, see Hayiou-Thomas et al., 2007; Hayiou-Thomas, Smith-Woolley, & Dale, 2021). Additionally, pragmatic language ability was indexed by averaging the Z scores for figurative language and pragmatics, and structural language was estimated by averaging the Z scores for vocabulary and syntax. The three language scores (overall, pragmatic, structural) were standardized to have a mean of 0 and standard deviation of 1 (with reference to the TEDS sample, after applying exclusory criteria, n = 3,568 twin pairs). We defined DLD as overall language abilities of at least −1.25 SD below the mean (similar to Dale, McMillan, Hayiou-Thomas, & Plomin, 2014) and derived a binary variable indexing DLD (1) and no DLD (0). Poor pragmatic language (regardless of structural language ability) and poor structural language (regardless of pragmatic language abilities) were defined in the same way with scores at least −1.25 SD below the TEDS sample mean.

Covariates. In the sensitivity analyses, we adjusted for individual-level factors, known to be associated with language difficulties and/or peer victimization: nonverbal cognitive ability and parent-reported symptoms of mental health difficulties at age 11.

Statistical methods

To compare individual and family factors between participants with and without DLD, we used standardized mean difference (SMD). The SMD is the absolute difference in sample means divided by an estimate of the pooled standard deviations of the variable in the two groups (Austin, 2008).

To test the first hypothesis, we conducted two types of analysis. First, to estimate the association of DLD with peer victimization at ages 11, 14 and 16, we used linear regression models. Second, to compare the growth of peer victimization over time by DLD status, we used conditional latent growth models. To test the second hypothesis, we run the same analyses as above, testing the association of poor pragmatic language with peer victimization while adjusting all the models for poor structural language. To test the third hypothesis, that is whether environmental and genetic factors were confounders in the association between DLD (poor pragmatic language) and peer victimization, we run all the analyses above within dizygotic same-sex (DZSS) and (monozygotic) MZ pairs and compared these estimates with the population-level estimates. For simplicity, the models below refer only to DLD, but note that the same models were run for poor pragmatic language. For the linear regression and latent growth curve models, we used code provided by Baldwin, Ayorech, Rijsdijk,

Table 1 Description of the instruments used to assess the outcome, exposure, and covariates

Measure	Participants' age	Example of items	Reliability[a] Cronbach's α	References
Outcome				
Self-reported peer victimization	11, 14 years	16 items referring to face-to-face/traditional peer victimization: physical (e.g. punched me), verbal victimization (e.g. called me names), social manipulation (e.g. tried to make my friends turn against me; refused to talk to me) and property attacks (e.g. deliberately damaged some property of mine) 6 items (same as at age 16) for the trajectory analyses Response options: three-point scale 'not at all' (indexed as 0), 'once' (indexed as 1) and 'more than once' (indexed as 2)	16 items: Age 11: 0.91 Age 14: 0.90 6 items: Age 11: 0.79 Age 14: 0.79	Multidimensional Peer Victimization Scale (Mynard & Joseph, 2000)
	16 years	Shorter 6-item version of the scale used at 11 and 14 years (i.e. tried to get me into trouble with my friends, took something of mine without permission, hurt me physically in some way, refused to talk to me, made fun of me for some reason, swore at me) Response options: 'not at all' (indexed as 0), 'once' (indexed as 1) and 'more than once' (indexed as 2)	0.80	
Parent-reported peer victimization	14 years	Same as self-reported peer victimization at age 14 years with items re-worded to be administered to parents	0.89	
Exposure				
Vocabulary	11 years	Self-administered online test covering the meaning of 30 words; 3 or 4 response options for each item: 'What is a clock? (A) a lock, (B) something with numbers, (C) something that tells time'; 'What does strenuous mean? (A) tiring for your muscles, (B) requiring great effort, (C) sinuous, (D) painful'	0.88	Multiple-choice receptive task adapted from the Wechsler Intelligence Scale for Children (WISC) – Third Edition (Kaplan, 1999)
Syntax	11	Self-administered online test including 35 tasks in which participants were required to select two sentences with similar meaning: for example (A) The hamburger came with a free Coke; (B) With a hamburger, the Coke was free; (C) You get a free hamburger with a Coke. The sentences were presented auditorily only	0.94	Listening grammar subtest of the Test of Adolescent Language–3 (Hammill, Brown, Larsen, & Wiederholt, 1994)

(continues)

Table 1 (continued)

Measure	Participants' age	Example of items	Reliability[a] Cronbach's α	References
Figurative language	11 years	Self-administered online test including 11 situations in which participants were asked to match expression having similar meanings. The participant heard the sentence orally and chose one of four answers, presented both in written and oral forms. Situation: 'A boy talking about a girl at a school dance'. Expression: 'She casts a spell over me.'; Response options: (A) In her life, every day is Halloween; (B) She spells much better than I.; (C) I am out from under her spell.; (D) She is totally bewitching to me	0.66	Figurative language subset from the Test of Language Competence (Expanded Edition) (Wiig, Secord, & Sabers, 1989)
Pragmatics	11 years	Self-administered online test. Participants were asked to make causal inferences about the possible causes of 11 situations. The participant chose two of four responses: for example Situation: Jack went to a Mexican restaurant. He left without giving a tip. Jack didn't leave a tip because (A) The restaurant was closed when he arrived. (B) He only had enough money to pay for the meal. (C) The food and service were excellent. (D) He was dissatisfied with the service	0.58	Pragmatic languages subtest from the Test of Language Competence (Expanded Edition) (Wiig et al., 1989)
Covariates				
Nonverbal cognitive ability	11 years	Self-administered online tests. Composite score of the standardized scores for 30 items of the Picture Completion Web Test (identify the part missing in pictures of recognizable objects or scenes) and 24 items of the Ravens Progressive Matrices (identify the missing part in a series of incomplete patterns)	Picture completion: 0.72 Ravens matrices: 0.76	Wechsler Intelligence Scale for Children-Third Edition UK (WISC-III-UK); Raven's Progressive Matrices and Vocabulary Scales (John & Raven, 2003)
Parent-reported symptoms of mental health difficulties	11 years	Total sum score of 15 items covering symptoms of emotional, conduct and behavioral problems (e.g. loses temper or has tantrums, rather solitary, prefers to play alone)	0.78	Strengths and Difficulties Questionnaire (Goodman, 2001)

[a]Cronbach's α for the language measures and for the nonverbal cognitive ability were retrieved from Haworth et al. (2007).

Table 2 Characteristics of adolescents with and without DLD at age 11 years in the analytical sample[a,b]

n	DLD 403	No DLD 2,997	Standardized mean difference (SMD)[c]
Socioeconomic and family factors, mean (*SD*)			
Ethnicity: White (%)	380 (94.3)	2,874 (96.0)	0.077
Socioeconomic disadvantage	0.35 (0.85)	−0.32 (0.96)	0.733
Cohabiting natural mother and father (%)	356 (88.3)	2,819 (94.1)	0.203
Has siblings (%)	217 (53.8)	1,527 (51.0)	0.058
Father age at birth	32.19 (5.06)	33.44 (4.68)	0.257
Mother's age at birth	34.47 (5.76)	35.84 (5.79)	0.237
Smoking during pregnancy (%)	17 (4.3)	99 (3.3)	0.052
Drinking during pregnancy (%)	23 (5.9)	332 (11.3)	0.196
Maternal depression age 4	7.88 (4.80)	6.73 (4.52)	0.246
Life events age 4	0.69 (0.80)	0.66 (0.78)	0.034
Parental harsh discipline age 7	0.22 (0.92)	−0.06 (0.96)	0.299
Child cognitive and behavioral characteristics, mean (*SD*)			
Male (%)	170 (42.2)	1,330 (44.4)	0.044
Peer Victimization age 12	0.41 (0.30)	0.34 (0.28)	0.225
Peer Victimization age 14	0.37 (0.32)	0.35 (0.28)	0.078
Peer Victimization age 16	0.44 (0.35)	0.40 (0.32)	0.129
Parent-reported peer victimization age 14	0.84 (0.70)	0.68 (0.64)	0.247
Language abilities age 7	−0.73 (0.87)	0.22 (0.96)	1.034
Mental health difficulties SDQ age 11 (parent-reported)	8.94 (5.74)	6.49 (4.87)	0.459
Nonverbal cognitive abilities age 11	−0.71 (0.85)	0.16 (0.77)	1.067
Communication-related factors, mean (*SD*)			
Language input: corrective feedback (age 4)	0.01 (1.00)	0.00 (0.99)	0.011
Language input: stimulation (age 4)	−0.13 (1.07)	0.08 (0.94)	0.215
Concerns about speech and language age 4	68 (20.4)	321 (12.6)	0.21

[a]We selected one twin at random from each family for the comparisons presented in this table.
[b]Information on the characteristics listed in this table can be found on TEDS website https://www.teds.ac.uk/datadictionary/home.htm. Socioeconomic disadvantage: family SES composite scale (standardized); computed from five derived variables relating to parent qualifications and employment and mother's age at birth of first child; the higher the score, the worse the disadvantage; Smoking during pregnancy: 11 or more cigarettes/day; Drinking during pregnancy: 3 or more alcohol units/week; Maternal depression: Edinburgh Postnatal Depression Scale; Life events: change in the following aspects: marital status of parents, new siblings, mother's pregnancy, job changes, serious illness/accident; Parental harsh discipline age 7: 4 items about smacking, shouting, ignoring when child is misbehaving and withdrawing privileges; Language abilities at age 7: composite score of vocabulary and verbal reasoning, Language input and stimulation – Adapted from Home Observation for Measurement of the Environment: 'How you talk to your twins?'
[c]A SMD of 0 means that there is no difference between the groups. A higher SMD corresponds to a greater imbalance in the variables between the two groups compared.

Schoeler, and Pingault (2021) and Lim et al. (2018), respectively.

Population-level associations of DLD with peer victimization. We first estimated unadjusted associations between DLD at age 11 and peer victimization at ages 11, 14 and 16. For this, we conducted Generalized Estimating Equations (GEE) linear regression with exchangeable correlation structure to account for the nonindependence of observations within twin pairs and the 'robust' method for the estimation of standard error (Carlin, Gurrin, Sterne, Morley, & Dwyer, 2005).

Second, we used conditional latent growth curve modeling (LGCM) to describe and compare the developmental trajectories of peer victimization across adolescence for those with and without DLD. We used structural equation modeling (SEM) to estimate the latent growth parameters, that is, the intercept (describing the average baseline level of peer victimization) and the slope (the growth rate at the initial mean level of peer victimization within and across twin pairs). The comparison of the unconditional intercept-only and the linear growth models indicated that the linear growth model had a better fit (Table S2). We estimated the linear growth model conditional on DLD at the population level while accounting for the nonindependence of observations (Yuan-Bentler correction for the estimation of standard errors). We tested whether the average growth parameters between the DLD and non-DLD co-twins were statistically significant (using Wald test).

Co-twin analyses for the association of DLD with peer victimization. The co-twin control design uses one twin in a pair as the matched control for the co-twin and involves comparing outcomes between twins with DLD and co-twins without DLD (McAdams et al., 2021). First, we used GEE linear regression with exchangeable correlation structure modeling the 'within-twin pair' effects of DLD on peer victimization among DZSS and MZ twins while accounting for the 'between-twin pair' effect (for details see Model 2, Carlin et al., 2005). The DZSS estimates are adjusted fully for shared environmental factors (DZ twins share 100% of their shared environments) and partially for genetic factors (DZ twins share 50% of their segregating genes). The MZ estimates are adjusted fully both for shared environmental factors and genetic factors as the twins share 100% of the shared environment and 100% of their segregating genes. To reveal the extent to which genetic and shared environmental factors contribute to the association of DLD with peer victimization, we compared the population level estimates with the co-twin control estimates. A statistically significant

MZ estimate would indicate a potential causal effect (McAdams et al., 2021). While the co-twin design adjusted for factors that were shared by the twins, individual characteristics or experiences of each twin may still explain the association between DLD and peer victimization. Therefore, all models were further adjusted for twin-specific individual factors (nonverbal ability and mental health symptomology).

Second, to derive the developmental trajectories of peer victimization in DZSS and MZ twin pairs discordant for DLD, we estimated the latent growth curve model using SEM framework for dyads (Olsen & Kenny, 2006).

Missing data: Participants retained in the study at ages 14 and 16 had better language and nonverbal ability and lower levels of mental health difficulties at age 11 compared with nonparticipants (Table S3). For the GEE unadjusted models, we used only observations with complete information for both peer victimization and DLD/poor pragmatic language. In the GEE-adjusted models, we used observations with complete data for covariates (e.g. 3.4% – 6% reduction in sample size compared with the unadjusted sample). For the latent growth curve modeling we used full information maximum likelihood to deal with missing data.

Sensitivity analyses: We ran GEE models to test: (a) sex as a moderator of the association between DLD and self-reported peer victimization in linear regression models; (b) the association of language abilities as a continuous variable with self-reported peer victimization and (c) the association of DLD with parent-reported peer victimization at age 14. We also run the main analyses with language difficulties defined as language abilities at least −1.5SD below the TEDS mean, a cut-off used in previous population-based studies (e.g. Norbury et al., 2016). The deviations from the preregistered protocol for the main analyses are available online (https://osf.io/bfmtr/).

Results

Out of the 3,400 participants (corresponding to one twin randomly selected from each family), 403 participants (11.85%) were categorized as having DLD, having scored below −1.25 *SD* on the overall language composite at age 11 years. Those with DLD differed from their peers without DLD on the majority of the measured factors (Table 2). For example, they were more likely to have grown up in families with socioeconomic disadvantage, to present higher level of mental health difficulties, lower cognitive abilities at age 11 and lower language abilities at age 7. The same pattern was observed when comparing the characteristics of participants with and without poor pragmatic language (Table S4). Note that 192 participants (5.6%) presented with both pragmatic and structural language difficulties, 200 (5.9%) with pragmatic-only and 228 (6.7%) with structural-only difficulties (Figure 1).

Associations between DLD and self-reported peer victimization at population level

At population level, better language skills (as indexed by the continuous overall language composite) were associated with lower peer victimization levels (Table S5). Moreover, adolescents with DLD had higher peer victimization scores at age 11 (β = 0.274, 95% CI (0.198; 0.350)), 14 (β = 0.146, 95% CI (0.026; 0.267)) and 16 years (β = 0.173, 95% CI (0.025; 0.321)) compared to their peers without DLD. When adjusting for nonverbal cognitive abilities and mental health difficulties, the strength of the associations reduced and remained statistically significant only at age 11 (Table 3).

For participants with DLD, the trajectory of peer victimization had a higher initial level compared to that of participants without DLD. Over time, levels of peer victimization decreased for adolescents with DLD and increased slightly for those without DLD, and the difference in the rate of change was statistically significant (Table 4). Therefore, the difference in the level of peer victimization reduced over time between the two groups, but adolescents with DLD maintained slightly higher levels of peer victimization (Table 4; Figure 2).

Associations between poor pragmatic language and self-reported peer victimization at population level

After adjusting for co-occurring poor structural language, adolescents with poor pragmatic language (pragmatic-only, or in the context of both poor pragmatic and poor structural language) had higher scores on peer victimization when compared to those without poor pragmatic language at age 11, 14 and 16, but the association was statistically significant only at age 11 [β = 0.194, 95% CI (0.118; 0.270)] and marginally significant at age 16 [β = 0.133, 95% CI (−0.004; 0.270)] (Table 5). Over time, levels of peer victimization decreased for adolescents with poor pragmatic language and increased slightly for those without, but the difference in the rate of change between the two trajectories was not statistically significant (Table 5; Figure 3).

Co-twin analyses for the association of DLD with peer victimization

In the co-twin analyses, the linear associations between DLD and peer victimization at ages 11, 14, 16 were not statistically significant. Additionally, the strength of these associations reduced by 47%–85% in DZSS analyses and by 6%–78% in MZ analyses relative to the population-level models. Moreover, the strength of associations reduced further in all models when adjusting for nonverbal cognitive abilities and mental health difficulties (Table 3).

DZSS twins discordant for DLD, followed trajectories with similar baseline level of peer victimization and no growth over time. For MZ twins, peer victimization levels declined at similar pace between ages 11 and 16 irrespective of the DLD status, but participants with DLD maintained slightly higher levels of peer victimization throughout adolescence. However, the differences in the intercept and slope between the DLD groups were not statistically significant (Table 4; Figure 2).

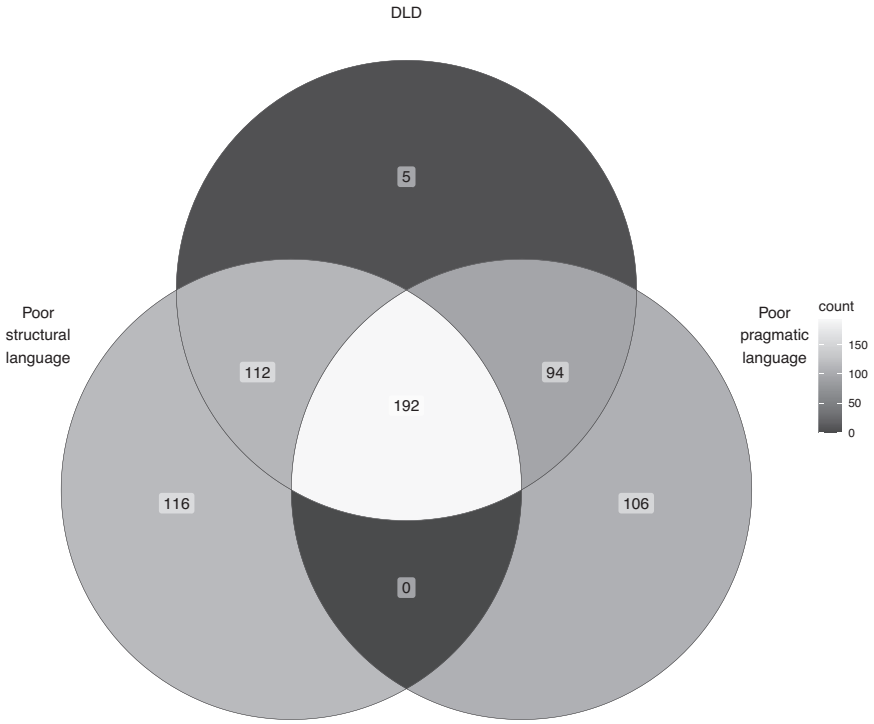

Figure 1 Overlap between DLD, poor structural language and poor pragmatic language. The gradient of the color is proportional to the overlap in terms of number of participants. Only participants classified as having DLD (n = 403), poor structural language (n = 286) or poor pragmatic language (n = 249) are represented in this diagram

Table 3 The concurrent and longitudinal association of DLD with self-reported peer victimization in adolescence (11–16 years old)[a]

	Number of discordant/total twin pairs		Linear GEE models					
	Initial model	Model adjusted for individual-specific factors	Initial model[b]			Adjusted for individual-specific factors[c]		
Outcome: Peer victimization	*n*	*n*	Beta	95% CI		Beta	95% CI	
Age 11 years								
Population level	3,313	3201	0.274	0.198	0.350	0.098	0.019	0.177
Within-twin pair								
DZSS	170/1077	161/1042	0.043	−0.123	0.210	−0.037	−0.217	0.143
MZ	134/1241	131/1199	0.056	−0.103	0.216	0.025	−0.137	0.186
Age 14 years								
Population level	1875	1803	0.146	0.026	0.267	−0.015	−0.139	0.109
Within-twin pair								
DZSS	89/614	82/591	0.045	−0.205	0.294	−0.010	−0.285	0.264
MZ	69/736	67/705	0.112	−0.12	0.343	0.099	−0.131	0.329
Age 16 years								
Population level	1,323	1244	0.173	0.025	0.321	0.051	−0.105	0.207
Within-twin pair								
DZSS	56/430	46/406	0.091	−0.26	0.443	−0.018	−0.403	0.367
MZ	48/521	44/485	0.165	−0.108	0.437	0.056	−0.216	0.329

[a]All regression coefficients are standardized. The log-transformed peer victimization score was standardized (Z-score, mean 0, SD = 1) using the analytical sample (n = 3,400 twin pairs).
[b]Average change in the point estimates between initial (unadjusted) population-level and DZSS models: 85% (age 11), 73% (age 14), 47% (age 16) and between population-level and MZ models: 78% (age 11), 27% (age 14), 6% (age 16).
[c]Adjusted for nonverbal cognitive abilities at age 11 and parent-reported symptoms of mental health difficulties at age 11 (see Table 2 for description of covariates). In models adjusted for individual-specific factors, we run complete case analyses.

Co-twin analyses for the association of poor pragmatic language with peer victimization

With one exception (i.e. age 16, DZSS model), the linear associations of poor pragmatic language with peer victimization were not statistically significant in the MZ and DZSS analyses, and the direction and strength of the associations varied by age/wave of measurement (e.g. reduced effect at age 11 in MZ models, reversed direction of association compared to population-level models at ages 11 and 14 in DZSS models and at age 16 in MZ model) (Table 4).

Table 4 Development of peer victimization from ages 11 to 16 years for adolescents with and without language difficulties

	Twins with language difficulties	Twins without language difficulties	Comparison between twins with and without language difficulties
	Parameter (SE)	Parameter (SE)	Effect size (95% CI)
DLD			
Population level (1)			
Intercept	0.500 (0.013)	0.417 (0.005)	0.083 (0.057; 0.110)
Linear slope	−0.081 (0.044)	0.030 (0.014)	−0.111 (−0.202; −0.020)
DZSS (2)			
Intercept	0.456(0.023)	0.455 (0.022)	0.001 (−0.047; 0.049)
MZ (3)			
Intercept	0.461 (0.027)	0.427 (0.027)	0.034 (−0.018; 0.086)
Linear slope	−0.157 (0.092)	−0.124 (0.08)	−0.033 (−0.212; 0.147)
Poor pragmatic language			
Population level (4)			
Intercept	0.503 (0.012)	0.416 (0.005)	0.087 (0.061; 0.113)
Linear slope	−0.091 (0.041)	0.031 (0.014)	−0.123 (−0.208; −0.038)
DZSS (5)			
Intercept	0.453 (0.021)	0.462 (0.020)	−0.009 (−0.051; 0.033)
MZ (6)			
Intercept	0.496 (0.023)	0.466 (0.024)	0.030 (−0.014; 0.075)
Linear slope	−0.107 (0.083)	−0.042 (0.081)	−0.064 (−0.231; 0.102)

Note. As the variance of the slope was very small, we divided the loadings for the slope by 10 in all analyses. For the MZ and DZSS models, within each discordant twin pair, we set Twin 1 as having language difficulties. We kept only those twin pairs discordant for DLD: 144 DZSS and 137 MZ distinguishable dyads on DLD status and 192 DZSS and 159 MZ distinguishable dyads on poor pragmatic language.
(1) Model estimated using growth function in lavaan with clustering and Yuan-Bentler correction for the estimation of standard errors. Model fit: CFI: 0.976; TLI: 0.928; RMSEA: 0.073; SRMR: 0.025.
(2) We could not fit the linear model as the variance of the slopes was negative. Model fit: CFI: 0.98; TLI: 0.977; RMSEA: 0.03; SRMR: 0.09.
(3) We fitted linear growth curve models with the residual variances (error term) constrained to be equal at all three waves, but different for each twin. Model fit: CFI: 1; TLI: 1.105; RMSEA: 0; SRMR: 0.044.
(4) Model estimated using growth function in lavaan with clustering and Yuan-Bentler correction for the estimation of standard errors. Model fit: CFI: 0.976; TLI: 0.927; RMSEA: 0.074; SRMR: 0.025.
(5) We could not fit the linear model as the variance of the slopes was negative. Model fit: CFI: 0.966; TLI: 0.970; RMSEA: 0.034; SRMR: 0.087.
(6) We fitted linear growth curve models with the residual variances unconstrained (residual variances were specified to be different for each twin at each wave). Model fit: CFI: 1.000; TLI: 1.086; RMSEA: 0.00; SRMR: 0.017.

Poor pragmatic language was associated with peer victimization at age 16 in the DZSS model (β = 0.415, 95% CI (0.139; 0.692)).

When contrasting peer victimization trajectories between MZ and DZSS twins with and without poor pragmatic language (Table 4; Figure 3), no differences in the intercept and in growth between ages 11 and 16 were observed.

Sensitivity analyses

Parent-reported peer victimization. The correlation between self- and parent-reported peer victimization at age 14 was 0.56 (Figure S1). At the population level, DLD was associated with parent-reported peer victimization at age 14. However, in DZSS and MZ models, the association had reduced strength and was no longer statistically significant. The results were similar for the association of poor pragmatic language with parent-reported peer victimization at age 14 (Table S6).

Sex differences. There was no statistical evidence of sex differences in the association between DLD and self-reported peer victimization. However, at the population level, the strength of the association between DLD and self-reported peer victimization was higher for males than for females at ages 14 and 16. We found statistical evidence for sex differences in the association of DLD with parent-reported peer victimization in population level and DZSS, but not in MZ models. Males with DLD had higher levels of, while females with DLD had lower levels of peer victimization when compared to their counterparts without DLD (Table S7). The same pattern of results was observed for sex differences in the association of poor pragmatic language with self- and parent-reported peer victimization (Table S8).

More stringent cut-off for defining language difficulties. When DLD was defined as language abilities at least −1.5 *SD* below the mean of the TEDS

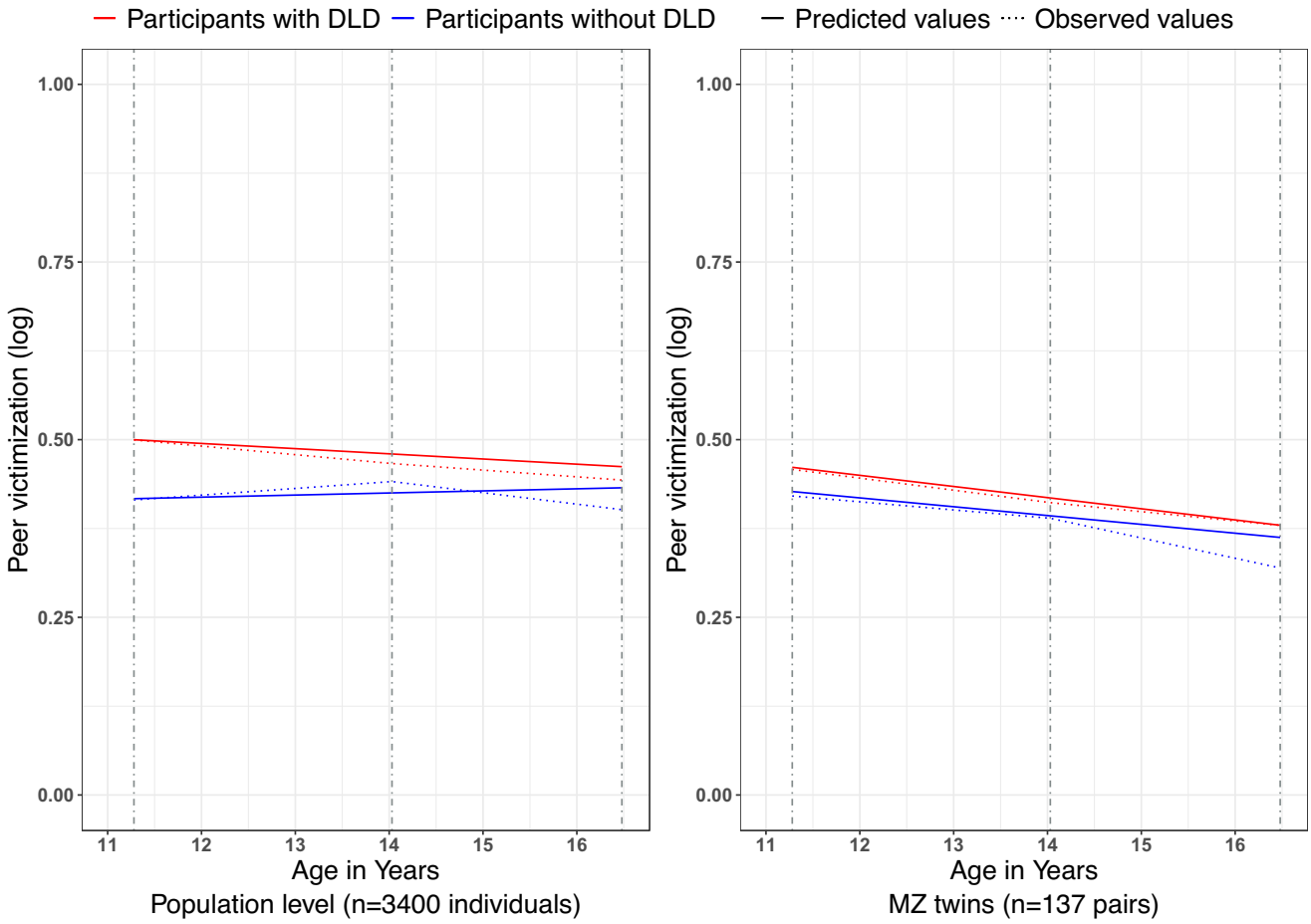

Figure 2 Trajectories of self-reported peer victimization from ages 11 to 16 by DLD status. Red lines represent participants with DLD. Blue lines represent participants without DLD. Solid line represent predicted values of peer victimization. Dotted lines represent observed values of peer victimization

sample, 8.7% (n = 271) participants were classified as having DLD (Figure S2). All the other results were broadly similar as detailed in the Supporting Information (Tables S9–S11).

Discussion

We found that, on average, adolescents classified as having DLD based on language abilities at age 11 years were more likely to experience peer victimization across adolescence than their peers. Focusing on pragmatic language abilities, we found that adolescents with poor pragmatic language were more likely to experience peer victimization at age 11 years, but not at ages 14 and 16 years, even when structural language skills were held constant. Turning to the stringent cotwin control analyses, we found that all these associations had reduced strength and were not statistically significant, suggesting the relationship at population level between DLD (and separately poor pragmatic language) and peer victimization is confounded by genetic and environmental factors shared by the twins.

Our findings from this population-based sample of adolescents complement and extend previous longitudinal work in the context of clinically identified DLD adolescents (Conti-Ramsden et al., 2019) as well as population-based cohorts focused earlier in childhood (Forrest et al., 2020; Øksendal et al., 2021). We showed that between ages 11 and 16, the trajectory of peer victimization started with higher levels, and then declined faster, for adolescents with DLD compared to those without DLD. Therefore, the difference in the level of peer victimization between groups, which was already minimal, reduced even more over time. The steeper decline in the level of peer victimization for the group with the highest initial levels (i.e. DLD group) is in line with the general pattern of decline in peer victimization with age (Oncioiu et al., 2020; Sumter, Baumgartner, Valkenburg, & Peter, 2012).

As variation in the social use of language might play a special role in peer relations and socio-emotional adjustment (Mok, Pickles, Durkin, & Conti-Ramsden, 2014; Nippold, 1998), we hypothesized that pragmatic language skills may be of particular importance in adolescence. We found some evidence that over and above structural language skills, poor pragmatic language was associated with peer victimization cross-sectionally, at age 11 years, but not later in adolescence. These findings extend those on the role of pragmatic

Table 5 The concurrent and longitudinal association of pragmatic language difficulties with self-reported peer victimization (PV) in adolescence (11–16 years old): adjusted for structural language[a]

	Number of discordant/total twin pairs		Linear GEE models					
	Adjusted for structural language	Fully adjusted model	Adjusted for structural language[b]			Adjusted for individual-specific factors[c]		
Peer victimization	*n*	*n*	Beta	95% CI		Beta	95% CI	
Age 11 years								
Population level	3,313	3,201	0.194	0.118	0.270	0.101	0.025	0.177
Within-twin pair								
DZSS	185/1077	177/1042	−0.108	−0.259	0.044	−0.131	−0.284	0.021
MZ	156/1241	152/1199	0.046	−0.095	0.186	0.028	−0.115	0.172
Age 14 years								
Population level	1875	1803	0.095	−0.020	0.211	0.020	−0.094	0.134
Within-twin pair								
DZSS	99/614	90/591	−0.031	−0.267	0.206	−0.038	−0.281	0.205
MZ	85/736	82/705	0.117	−0.073	0.306	0.151	−0.034	0.337
Age 16 years								
Population level	1,323	1,244	0.133	−0.004	0.270	0.099	−0.043	0.241
Within-twin pair								
DZSS	59/430	51/406	0.415	0.139	0.692	0.313	0.021	0.605
MZ	47/521	43/485	−0.035	−0.319	0.250	−0.098	−0.387	0.192

[a]All regression coefficients are standardized. The log-transformed peer victimization score was standardized (*Z*-score, mean 0, *SD* = 1) using the analytical sample (*n* = 3,400 twin pairs).
[b]Adjusted for structural language difficulties (binary variable); average change in the point estimates between population-level and DZSS models: 156% (age 11), 133% (age 14), −212% (age 16) and between population-level and MZ models: 76% (age 11), −23% (age 14), 126% (age 16).
[c]Adjusted for structural language difficulties (binary variable); nonverbal cognitive abilities at age 11 and parent-reported symptoms of mental health difficulties (see Table 2 for description of covariates). In models adjusted for individual-specific factors, we run complete case analyses.

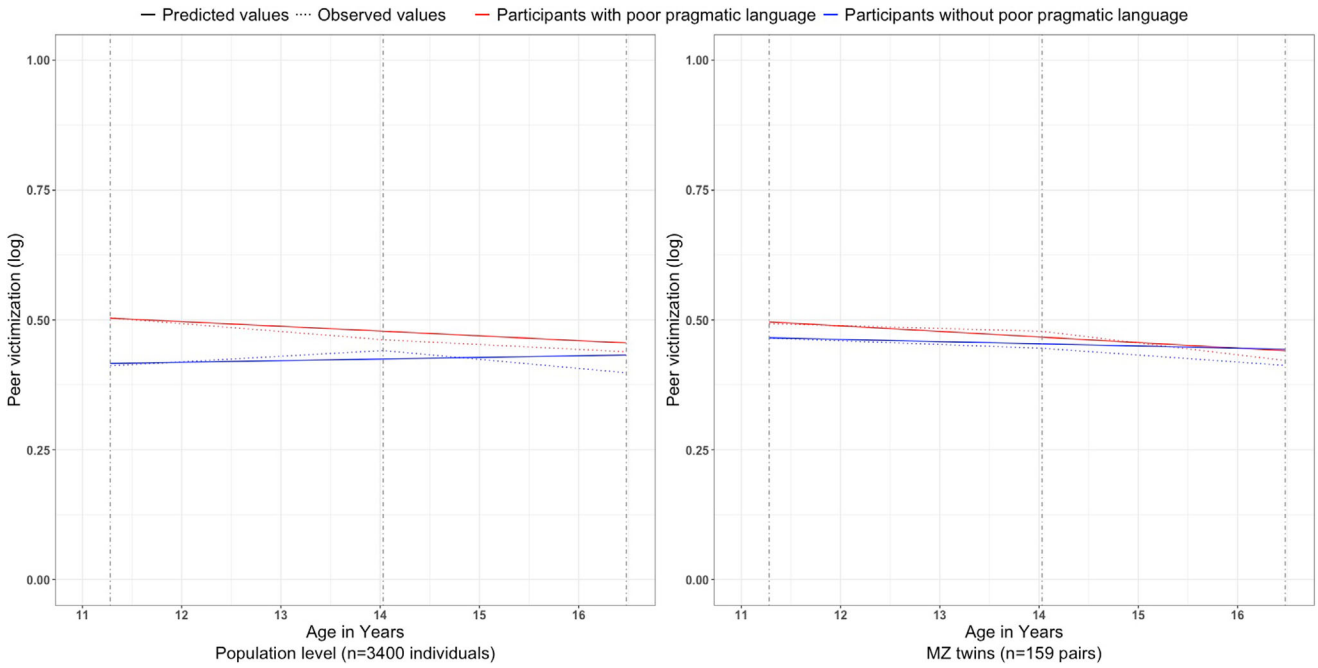

Figure 3 Trajectories of self-reported peer victimization from ages 11 to 16 for participants with and without poor pragmatic language. Red lines represent participants with poor pragmatic language. Blue lines represent participants without poor pragmatic language. Solid line represent predicted values of peer victimization. Dotted lines represent observed values of peer victimization

language for peer relationships in clinical samples (Conti-Ramsden et al., 2019; Abbot-Smith, Dockrell, Sturrock, Matthews, & Wilson, 2023). However, it is important to note that almost half of individuals with poor pragmatic language in this study had concomitant deficits in structural language.

A novel aspect of our study is the use of a genetically sensitive longitudinal design to investigate the

association of language difficulties with peer victimization. We found that the population-level association between DLD and peer victimization, as well as between poor pragmatic language and peer victimization, could both be explained by genetic and environmental factors shared by twins. Why might this be? One explanation is that genetic, environmental, or indeed the interplay between these factors could be common causes for both DLD and experiencing peer victimization. As shown in our data, adolescents with DLD grew up in families with lower socioeconomic status, had lower nonverbal ability, and higher mental health symptomatology. When adjusted for, some of these factors (e.g. nonverbal cognitive skills and mental health difficulties) were responsible for explaining some of the population-level and within-twin pair effects. Moreover, some of these factors may share common genetic influences with DLD and/or peer victimization. For instance, internalizing problems often co-occur with language difficulties (Botting, Toseeb, Pickles, Durkin, & Conti-Ramsden, 2016), and are risk factors for bullying victimization (Schoeler et al., 2018). The co-occurrence between language difficulties and internalizing problems in childhood and early adolescence seems to be genetically influenced (Toseeb et al., 2022) and in some instances, DLD may amplify mental health difficulties for those with high genetic risk for common psychiatric disorders (Toseeb et al., 2023). Therefore, common genetic factors that underly the association between DLD and poor mental health may also explain the association between DLD and peer victimization.

Alternatively, being the target of peer victimization might not be related to language ability per se, but rather with behaviors associated with DLD such as longer time taken to understand a conversational exchange, difficulties in communicating feelings or solving conflict. Although we aimed to capture this by considering pragmatic language, it is likely that these assessments (with only moderate internal consistency) fail to capture language processing in a communicative context. In a population-based longitudinal study, Knox and Conti-Ramsden (2003) found that 11-year-old adolescents with language difficulties were more likely to be bullied. However, performance on standardized tests of language and literacy did not contribute to the risk of being bullied, but behavioral and socioemotional problems did. Moreover, a randomized controlled trial evaluating the Nuffield Early Language Intervention found that while children receiving the language intervention showed improvements in behavioral adjustment, these were not mediated by improvements in language ability (West et al., 2022). Plausibly, they were instead the result of the intervention emphasizing the need to pay attention and regulate behavior in a communicative context.

A final possibility is that language abilities do matter for peer victimization, but only at the severe end of the spectrum, which we might not have captured in this population sample. Findings from a qualitative study suggest that young children are not aware of the language difficulties of their peers if they are not very severe (Janik Blaskova & Gibson, 2021). Moreover, Goh et al. (2021) documented that language more strongly predicted socioemotional and behavioral problem at low language levels, relative to typical language levels. Therefore, it may be possible that a direct effect of DLD on peer victimization is still present for those with severe DLD. However, it is worth noting that our pattern of results was similar, even when a more stringent cut-off was used to identify cases of DLD (e.g. −1.5 *SD* below the mean of the TEDS sample).

It is important for future studies to identify the mechanisms that underlie the association between language difficulties and peer victimization to aid our understanding of how and when to intervene most effectively. Poor emotion regulation is one proposed mechanism. For example, Goemans, Viding, and McCrory (2021) found that poor emotion regulation was associated with victimization and Griffiths et al. (2021) showed that language skills at school entry were associated with emotion regulation success 5 years later. Furthermore, research also suggests that the relationship between poor emotion regulation and peer problems is stronger among children at risk of language disorders (Forrest et al., 2020). Future studies should also investigate sex differences. Our exploratory findings suggest that in adolescence, the association of DLD (and separately poor pragmatic language) with parent-reported peer victimization differed between males and females in population level and DZSS, but not MZ analyses. That is, boys with DLD reported higher levels of peer victimization, while girls with DLD reported lower levels of peer victimization compared to their peers without DLD. To date, the findings regarding sex moderation for the relationship between language difficulties and peer victimization are inconsistent (Øksendal et al., 2021). Finally, we note that some of the co-twin analyses may have been underpowered (e.g. unstable estimates with large confidence intervals). Therefore, future epidemiological studies on the association of language difficulties with peer victimization require even larger samples.

In closing, we consider the limitations of our study. First, we used a population sample and did not rely on a formal diagnosis or clinical assessment of DLD. Our cut-off is likely indicative of low to moderate language difficulties, which might explain why a higher proportion of participants was classified as having DLD (i.e. 11.85%) compared to previous studies (Norbury et al., 2016). However, it is important to note that results were similar when we used −1.5 *SD* below the TEDS mean as cut-off, and the proportion of participants classified as having DLD was 8.7%, which is similar to previous studies. While a stricter cut-off would have captured more severe cases, it would have also reduced the sample size, and run greater risk of incomplete data

(more severe cases are less likely to complete questionnaires, Griffiths et al., 2021). Relatedly, this also highlights the danger of relying only on self-reports of peer victimization for those with language difficulties. Reassuringly, however, results were similar in sensitivity analyses that used parent-reported peer victimization at age 14. That said, it is important for future studies among adolescents with DLD to have multiple perspectives (e.g. peers, parents) on their peer relationships.

We also note that some of the analyses may have been underpowered. Dichotomizing the exposure results in loss of power (Altman & Royston, 2006). However, the findings were similar when we used language abilities as a continuous variable. Moreover, data attrition within the TEDS sample was not random: participants with language difficulties and higher levels of peer victimization at age 11 years were more likely to be lost at the two subsequent waves. Also, in our sample participants from more educated families were over-represented, when compared with national averages. Bullying perpetration was not measured in TEDS. This is unfortunate as there is some evidence that young people with DLD may also be involved in bullying perpetration (Øksendal et al., 2021). Finally, we note that we analyzed data from twins. The social development of twins may be different from singletons (e.g. twins may have lower levels of peer victimization as they have support from their co-twin and language abilities may reinforced by communication with the co-twin). While twin-singleton comparisons do not support this assumption in general (DiLalla, 2006), this needs to be evaluated in the context of poor language.

In conclusion, we used a stringent co-twin design to strengthen causal inference about the relationship between DLD (and separately, poor pragmatic language) and peer victimization. We found that genetic and shared environmental factors explain the association between language difficulties and elevated levels of peer victimization. Future studies should aim to identify modifiable factors that underpin the association of DLD with peer victimization. This will help to guide interventions to create environments that support children with DLD navigate their peer relationships.

Supporting information

Additional supporting information may be found online in the Supporting Information section at the end of the article:

Table S1. Representativeness of the analytical sample of the current study.

Table S2. Comparison of intercept only model and linear latent growth curve model for peer victimization among the analytical sample (n = 3400 twin pairs).

Table S3. Characteristics of participants and non-participants retained in the analytical sample at ages 14 and 16 years with reference to the analytical sample at age 11 (n = 3400).

Table S4. Characteristics of adolescents with and without pragmatic language difficulties at age 11 years in the Twins Early Development Study.

Table S5. The concurrent and longitudinal association of language abilities with self-reported peer victimization (models unadjusted for individual-specific covariates).

Table S6. The longitudinal association of language difficulties with parent-reported peer victimization (PV) at age 14 years old.

Table S7. Comparison of the concurrent and longitudinal association of DLD with self-reported peer victimization in adolescence (11–16 years old) for boys and girls.

Table S8. Comparison of the concurrent and longitudinal association of pragmatic language difficulties with peer victimization (PV) in adolescence (11–16 years) old for boys and girls.

Table S9. The concurrent and longitudinal association of DLD (cut-off −1.5 *SD*) with self-reported peer victimization in adolescence (11–16 years old).

Table S10. The concurrent and longitudinal association of pragmatic language difficulties (cut-off −1.5 *SD*) with self-reported peer victimization (PV) in adolescence (11–16 years old): adjusted for structural language.

Table S11. Development of peer victimization from ages 11–16 years for adolescents with and without DLD (cut-off −1.5 *SD*).

Figure S1. Pearson correlation between self-reported and parent-reported peer victimization.

Figure S2. Overlap between DLD, poor structural language and poor pragmatic language using the cut-off −1.5SD below.

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Key points

- Children with language difficulties are more likely to experience peer victimization than their peers. However, this association has seldom been studied throughout adolescence and we know little about the factors underlying it.
- Adolescents with developmental language disorder at age 11 years were more likely to experience higher levels of peer victimization from age 11 to 16 compared to their peers without language difficulties.
- Genetic and environmental factors shared within families confounded the observed association between language difficulties and peer victimization in adolescence.
- As language difficulties and peer victimization share common causes, it is important to identify modifiable factors that can reduce and prevent peer victimization for adolescents with language difficulties.

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