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Effectiveness of intervention focused on vocational course vocabulary in post-16 students with (developmental) language disorder

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Abstract

Background: People with language disorders (including developmental language disorder—DLD) often struggle to learn new words and, for young adults, this could affect their success in future work. Therefore, it is crucial to support their learning of career-specific vocabulary. However, little published evidence exists regarding the effectiveness of speech and language intervention for older adolescents and young adults with (developmental) language disorder (D)LD within a post-16 provision.

Aims: To investigate whether for students with (D)LD in a post-16 environment, the addition of direct individual intervention from a speech and language therapist (SLT) teaching course-specific vocabulary leads to more progress than just in-course teaching on bespoke vocabulary measures.

Methods & Procedures: A total of 28 college-aged students (11 female and 17 male) with (D)LD (aged 16.0–19.9) participated in a within-participant study comparing progress with explicit vocabulary intervention plus in-course teaching versus in-course teaching alone. The participants were assessed at four time points (3 months pre-intervention, immediately pre- and post-intervention, 3.5 months after intervention) using bespoke vocabulary assessments with an equal number of nouns, verbs and adjectives. All participants received one-to-one vocabulary intervention from their usual SLT for 30 min per week for 9 weeks. The intervention had four main components: (1) to identify intervention focus, (2) to recap previously taught terms (using an online flashcard program), (3) to explicitly teach new words using word maps to help with: creating definition and pictorial representation, identification of word class and investigation of phonological and morphological properties, and (4) to add new words, with their definition and pictorial representation to online flashcard program.

Outcomes & Results: The results showed a stable baseline, then during the intervention term significant progress on words targeted only in lessons and significantly greater progress on words targeted both in lessons and SLT sessions. Progress was maintained for 14 weeks. Individuals with initially lower scores showed smaller intervention effects. In general, performance was higher on verbs and on the definition recognition task and lower on the production tasks, but all tasks improved with intervention.

Conclusions & Implications: Direct one-to-one vocabulary intervention with an SLT can lead to significant gains in knowledge of course-specific terminology for college-aged students with (D)LD. The effectiveness of speech and language therapy services for this age group in a wider range of areas of language and social communication should also be investigated.

What this paper adds

What is already known on this subject

- Very few services exist for young adults with DLD, despite their persisting language difficulties and the detrimental impact of these on their academic attainment and employment prospects. Most careers involve specific vocabulary which is crucial to executing a role successfully and these need to be learned by those looking to move into these careers. However, children, adolescents and adults with DLD struggle to learn new words and may need help in this area.

What this study adds to existing knowledge

- The young adults with (D)LD received 9 weeks of intervention targeting individualized course-specific vocabulary (nouns, verbs and adjectives), using word maps to focus on word forms, definitions, morphologically related words and syntactic information such as word class and how to use the word in a sentence. An online learning tool provided regular spaced retrieval practice of previously taught words and their definitions. The participants showed significant progress with learning course-specific vocabulary from attending lessons. However, they made significantly greater progress on those words which were also targeted in individual SLT sessions, regardless of word class. Progress was maintained over 14 weeks.

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

- Direct one-to-one vocabulary intervention with an SLT can lead to significantly greater gains in the acquisition of targeted course-specific terminology for young adults with (D)LD than the vocabulary teaching available in lessons. Individual intervention delivered by SLTs should therefore be offered to this age group of students with (D)LD to maximize their ability to access the academic curriculum and their future careers. Indeed, the broader role of SLTs in

helping these young adults to access the world of work and independent living should be further investigated and supported.

INTRODUCTION

Language difficulties are typically identified during early childhood with 7% of school starters meeting the diagnostic criteria for developmental language disorder (DLD) and 10% for wider language disorder (Norbury et al., 2016). Individuals with DLD are faced with a variety of challenges, including difficulties with vocabulary (McGregor et al., 2013, 2017), word finding (German, 1992) and syntax (Leonard, 2014; Nippold et al., 2009). DLD persists into adolescence and young adulthood (Conti-Ramsden et al., 2012; Stothard et al., 1998) and, due to the increasing language demands of the curriculum and socialization, the long-term ramifications of DLD go beyond the comprehension and use of language, significantly impacting on social interactions, daily activities, academic progress and attaining skilled employment (Clegg et al., 2005; Conti-Ramsden et al., 2018; Howlin et al., 2000; Law et al., 2009; Snowling et al., 2001).

An essential component of being an effective communicator involves the understanding and use of vocabulary, and a crucial component of accessing education, training and the world of work, is having sufficient knowledge of the specific terminology linked to one's chosen career. It is well documented that children with DLD have difficulties learning, retaining and using vocabulary (Gray, 2005; Kan & Windsor, 2010; McGregor et al., 2020), learn fewer words compared with typically developing (TD) peers of the same age (Ellis Weismer & Hesketh, 1996; McGregor et al., 2017; Nash & Donaldson, 2005; Rice et al., 1992) and have a shallower understanding of those words they do know (e.g., McGregor et al., 2002). These difficulties learning and using vocabulary also extend beyond childhood to adolescence and indeed adulthood (McGregor et al., 2020). Indeed, the gap between children with DLD and their TD peers with respect to vocabulary, widens with age (Rice & Hoffman, 2015).

People with DLD are less able to derive meaning from context (Cain et al., 2004; McKeown et al., 1985), perhaps due to difficulties identifying and storing new phonological and semantic representations in long-term memory (Chiat, 2000) and/or syntactic difficulties leading to challenges using the sentence structure in which new words appear to help infer their meaning (van der Lely, 1994). Thus, people with DLD are likely to require explicit teaching of vocabulary, with multiple presentations, focusing on word forms and meanings and the links between them. Recent studies (summarized in Gordon, 2020; Leonard et al., 2021) also highlight the value of retrieval practice (saying the word in response to a stimulus), with feedback regarding correctness, distributed over several days or weeks to support the retention of new vocabulary. Indeed, studies have shown that the above approaches lead to learning and retention of new vocabulary by children with DLD (e.g., Gray, 2005; Haebig et al., 2019; Leonard et al., 2019; Riches et al., 2005; Storkel et al., 2017, 2019; Zens et al., 2009).

Intervention studies with adolescents

The vast majority of intervention studies for people with DLD are with pre-school or primary-aged children. However, it is recognized that adolescents and young adults with DLD continue to require support with language development and social and emotional well-being (Spencer, 2018) and a growing number of studies have considered the effectiveness of intervention for adolescents. This includes interventions aiming to improve a range of language areas (Ebbels et al., 2017), receptive and expressive syntax (Balthazar & Scott, 2018; Ebbels, 2007; Ebbels & van der Lely, 2001; Ebbels et al., 2007, 2014) word finding (Campbell et al., 2019; Ebbels et al., 2012; Hyde-Wright et al., 1993) and vocabulary (Joffe et al., 2019; Lowe & Joffe, 2017; Lowe et al., 2019; Murphy et al., 2017; Spencer et al., 2017; Wright et al., 2017). However, despite the lifelong nature of DLD and its wide-ranging impacts there is a prominent gap in the literature regarding the effectiveness of intervention in any area of language for students of post-16 age (or indeed adults) with DLD. A few notable exceptions have targeted preparedness for job interviews (Mathrick et al., 2017), word finding (Campbell et al., 2019) and vocabulary (McGregor et al., 2020). The lack of intervention research with this age group is reflective of the lack of intervention typically provided to this group of young people, but in a vicious circle, the lack of evidence also contributes to the limited provision of services for secondary and post-16 students (and adults) with DLD.

Vocabulary intervention is likely to be particularly important for post-16 students as they access specific courses related to future careers. Such courses may involve the introduction of many new items of vocabulary which

are likely to be key to their future performance in their chosen career. They will need to be able to recognize, understand and use these vocabulary items accurately. Promisingly, vocabulary intervention has been shown to be effective with students with language disorders of various ages (for reviews, see Lowe et al., 2018; Steele & Mills, 2011), including some with adolescents (Joffe et al., 2019; Lowe & Joffe, 2017; Lowe et al., 2019; Murphy et al., 2017; Spencer et al., 2017; Wright et al., 2018) and young adults (Campbell et al., 2019; McGregor et al., 2020). We will consider the two studies with young adults in greater detail below as they are of most relevance to the current study.

McGregor et al. (2020) is part of a series of studies considering word learning in adults with DLD. This study did not aim to test a clinical intervention per se, but rather aimed to test the hypothesis that the word learning problems in young adults with DLD (aged 18–25 years) involve challenges with encoding rather than retention. They trained di-syllabic novel nouns paired with pictures of unusual objects until mastery via retrieval practice and feedback. The participants with DLD were recruited from post-secondary college settings in the United States and while their scores fell below those of the TD group, they scored mainly within the average range of the standardized tests administered. On average, the students with DLD required 39% more exposures to commit new words to long-term memory than the TD students, and the number of exposures required was correlated with vocabulary levels (i.e., those with poorer vocabulary needed more cycles). Indeed, a quarter of those with DLD (with the more severe levels of DLD) failed to reach mastery. Retention tests showed that reviewing words after 1 week led to greater retention at 1 month than reviewing them after one day, which was better than not reviewing them at all.

Campbell et al. (2019) evaluated an intervention for word-retrieval difficulties with post-16 students (aged 16–19 years) with severe levels of DLD attending a specialist college for students with language disorders. The participants received eight weekly 30-min intervention sessions targeting real nouns from specific semantic categories. The intervention focused on semantics, using categorization and discussing specific semantic attributes of pictures. The results showed greater change in raw score on a standardized test of word finding with intervention than during the preceding baseline period. The authors hypothesized that increasing participants' awareness of the semantic detail of words may have helped them to retrieve other words which were not targeted, perhaps by self-generating semantic cues which increased the details of the lexical concepts, thus leading to access to the phonological representations.

Measuring vocabulary knowledge and progress

Measuring outcomes following vocabulary intervention is complex and depends on the aims of the study. Standardized vocabulary tests are unlikely to show progress following a short-term intervention. Indeed, a meta-analysis of vocabulary studies with a range of children showed no effect on standardized vocabulary tests, but large effects on targeted vocabulary (and no relation between the two; Rogde et al., 2021). In most studies, it is important to measure whether the participants have made progress in both their breadth and depth of understanding of the targeted vocabulary (Duff, 2019). This often requires bespoke tests. The nature of the tasks will depend partly on the nature of the words (e.g., their word class and where they lie on the concrete to abstract continuum), but usually it will be important to capture varying degrees of the participants' semantic knowledge of the words and their ability to use them in sentences. Thus, a range of tasks is often required, both to assess a range of skills and also to capture any incremental improvements in word knowledge.

Effect of word class

Previous studies have identified that the degree of word learning challenges faced by children with DLD varies with word class, with several studies finding they have particular difficulty learning and retaining verbs (e.g., Oetting et al., 1995; Rice et al., 1994; Riches et al., 2005). There are also indications that adjectives may be harder than nouns for young children with DLD to learn (Oetting et al., 1995), but a study specifically of adjective learning (Leonard et al., 2019) found no significant difference in adjective learning or retention between children with DLD and TD children, when provided with multiple presentations. However, the children with DLD benefitted more than TD children from repeated spaced retrieval of targeted adjectives.

The evidence above suggests that intervention for children with DLD probably needs to focus on all word classes, but nouns may be the easiest to learn. However, observation of standard intervention sessions with 5–7 year olds (Justice et al., 2014) found most focus on nouns, with very little focus on verbs, or adjectives. One intervention study with adolescents (Spencer et al., 2017) focused only on verbs, while another (Wright et al., 2018), specifically compared progress on nouns versus verbs and found intervention was effective for both nouns and verbs, but targeted nouns appeared to improve more than targeted verbs. There were, however, indications of more generalization to untreated verbs than to untreated nouns.

We found no studies specifically considering the effectiveness of teaching adjectives to adolescents with DLD. Nonetheless, adjectives may well have featured in some interventions, as identifying word class is part of the intervention used in Murphy et al. (2017) and Joffe et al. (2019).

Explicit identification of word class may help adolescents with some aspects of word learning. Knowing the word class indicates likely semantic features (e.g., verbs are often actions and adjectives attributes) and may also help with producing definitions (which are likely to have a different form for different word classes). In order to use words accurately in sentences, it is important to know their morphosyntactic properties, including word class. However, whether this knowledge needs to be explicit is an open question. In our study, we measured any change in explicit identification of word class, but analysed this separately from the main results. This was because this is a different construct from measures of word knowledge in terms of definitions or ability to use the target word in a sentence, both of which can be done well without explicit knowledge of word class. However, we did investigate the relationship between the change in explicit word class knowledge and the other measures.

Summary, aims and predictions

DLD is common and persists into adulthood, affecting employment prospects. Good knowledge of career-specific vocabulary is crucial, and this includes nouns, verbs and adjectives. Improving the ability to understand and use career-specific vocabulary in young adults with DLD, could support them in entering their chosen career. However, very little evidence exists regarding the effectiveness of intervention with this age group. Some studies focus on improving vocabulary in younger adolescents with DLD, but only Wright et al. (2018) specifically considered their ability to learn words of different word classes, and that did not include adjectives.

In this study, we aimed to investigate the effectiveness of an intervention for young adults with language disorders aged 16–19 years, targeting individualized course-specific vocabulary, including nouns, verbs and adjectives, using word maps to focus on the word form, definition, morphologically related words and syntactic information such as word class and how to use the word in a sentence. An online learning tool was used to aid learning and to provide regular spaced retrieval practice of previously taught word forms and definitions. We considered progress on the recognition and production of word definitions, identification of word class and sentence production for words included only in lessons, compared with words targeted in

one-to-one SLT sessions in addition to in lessons during a baseline period (with no intervention), during the intervention period (in which half the words were targeted in one-to-one SLT sessions) and the term after intervention. We also asked the participants to rate their understanding of their test words (controls and targets combined) directly before and after intervention.

We predicted:

1. During the baseline period, the participants would make little progress.
2. During the intervention period, they would make some progress on the words targeted only in lessons, but would make more progress on the words targeted in both lessons and SLT sessions, given that the SLT intervention includes many features shown to be effective in previous studies.
3. During the maintenance period, given that the participants were still following the same course and thus the words should continue to appear in lessons, we predicted that most progress should be maintained. However, we predicted a possible decline in performance, particularly where detailed knowledge of the words is required (e.g., definition or sentence production). We predicted less decline where less detailed knowledge can still lead to success (e.g., definition recognition in a multiple-choice task).
4. Using the words in sentences and producing definitions would be more difficult than recognizing definitions and pairing them to word forms in a multiple-choice task. This is because (a) guessing can help in multiple-choice tasks, (b) production tasks require more detailed knowledge of the word than word form to definition pairing tasks and (c) the participants' wider language disorder will affect their ability to form accurate sentences in definition and sentence production tasks.
5. Previous literature with young children would predict lower performance on verbs than nouns, with performance on adjectives intermediate. We predicted greater difficulties with verbs and adjectives particularly on tasks involving sentence production, as the semantics of verbs and adjectives are closely related to the sentence structures that they can appear in. We had no particular predictions as regards differential intervention effects for word classes. Perhaps nouns would improve more, as in Wright et al. (2018), or perhaps those word classes with the lower scores initially would improve more.
6. We predicted improved explicit knowledge of word class would improve definition production and sentence production, but not necessarily recognition of definitions in a multiple-choice task.

METHOD

Context

This study was carried out at a specialist college for adolescents with language disorders (the majority of whom meet the criteria for DLD) in the UK. The college has direct links with three local further education colleges where the students pursue a chosen vocational qualification with direct support from specially trained staff. Students receive a speech and language therapy intervention package which includes per week: one 30-min individual session, one 60-min social skills group and one 60-min language group. In addition, the SLTs support offsite lessons and provide direct support during collaboratively planned onsite lessons of English, Maths and PSHCE (Personal, Social, Health and Citizenship Education).

Ethical consent

This project was approved by the Moor House Ethics Committee and was provided in accordance with school and college policies. All participants and their parents provided consent before partaking in the project.

Participants

A total of 28 college age students (11 female and 17 male; aged 16.0–19.9) participated. All participants met the criteria for language disorder as defined by Bishop et al. (2017). All were being educated in a specialist setting for children with language disorders. Accessing the specialist setting involves a rigorous multidisciplinary assessment of each student's needs, taking into account both standardized scores and also the impact of their language difficulties on access to the curriculum and social participation. A total of 24 of the students met the criteria for DLD, while the other four had an associated diagnosis of autism spectrum disorder (ASD) and thus met the criteria for language disorder associated with ASD. All these students were included in the study as they all had language difficulties including in the area of vocabulary and the clinical judgement of their SLT was that focused work on their college course vocabulary would improve their access to the curriculum content of their chosen course.

All participants were assessed 3 months prior to intervention commencing using the Test of Adolescent Language (TOAL-4; Hammill et al., 2007). Their mean general language score was 65.0 (SD = 10.1). The TOAL-4 includes three subtests related to vocabulary (Word Opposites,

TABLE 1 Number of students accessing the different course levels

Level of further education course	Equivalent qualification	Number of participants
Entry Level 1	GCSE at G/1 or below	5
Level 1	GCSE at D–G/ 3-1	9
Level 2	GCSE at A*–C/ 9-4	13
Level 3	A-level	1

Note: General Certificate of Secondary Education (GCSE) exams are usually taken at 16 years (highest scores are A* or 9 and lowest G or 1) and Advanced levels (A-levels) at 18 years in the UK.

Word Derivations and Word Similarities), each of which has a scaled score (mean = 10, SD = 3). Averaging the scores across these three subtests gave a mean scaled score for the group of 5.1 (SD = 1.5), indicating vocabulary difficulties.

Study design and procedure

This study used a within-participants design comparing progress on targeted versus control items over three different periods: baseline (summer holiday, no words targeted), intervention (autumn term, all words may well have occurred in lessons, but only half were targeted in SLT sessions) and maintenance (spring term, all words may have occurred in lessons, but none was targeted in SLT sessions). An even balance of nouns, verbs and adjectives in both the targeted and control groups meant we could investigate any effects of word class. The vocabulary items were directly linked to the 17 different further education courses participants were studying. These were at different levels; Table 1 contains a summary, with the full list provided in additional Supporting information S1.

We designed a bespoke assessment for each course and level, with vocabulary taken from course-specifications and glossaries. Each bespoke assessment contained 42 words (14 nouns, verbs and adjectives). The word lists for two level 1 and two level 2 courses are provided in additional Supporting information S2 as examples. The words were randomly assigned within word classes to groups A and B. Each participant was then randomly assigned to receive one-to-one SLT intervention on either group A or B items, with the other group acting as controls. Thus, we compared progress on words likely to occur in lessons (without SLT involvement, the control words) with progress on words occurring in lessons and explicitly targeted in direct one-to-one SLT sessions (the targeted words).

Participants were assessed on their bespoke assessment by their usual SLT (who also delivered the intervention)

in their allocated SLT session within their school day at four time points; 3 months before intervention (baseline), 1 week before intervention (pre-intervention), 1 week after intervention (post-intervention) and one term (approximately 14 weeks) after (maintenance). Unfortunately, blinding of assessors was not possible due to resource limitations. However, the four SLTs involved each double-marked 10 tests at each time point ($40/112$ tests $= 36\%$) and when double-marking were unaware of which words were targets or control words for each participant. Agreement was greater than 90%. Any disagreements were resolved through discussion.

Assessment

In order to gain a fuller picture of the participants' knowledge of vocabulary items and to provide increased sensitivity to change, we administered four different assessment tasks with varying demands (described in detail below) and delivered them in the following order for each word: Word Class identification, Definition Production, Definition Recognition and Sentence Production. These were administered either in one long session, or two shorter sessions, dependent on timetable constraints. The participants completed the four assessment tasks for each of the 42 words in the set in turn. All responses were transcribed live.

Task 1: Word class identification

Before the assessment began, the students were reminded of the broad semantics of nouns as people or things, verbs as actions and adjectives as descriptions, and had access to visual prompts, in the form of the SHAPE CODING™ system (Ebbels, 2007, with updated colours described by Balthazar et al., 2020), which includes shapes for different roles in the sentence and colours for different word classes: red ($=$ noun) belongs in WHO or WHAT oval; blue ($=$ verb) belongs in WHAT DOING hexagon; and green ($=$ adjective) belongs in WHAT LIKE/HOW FEEL cloud). Most of the participants had been exposed to the SHAPE CODING system previously as it is used across the establishment. First, the SLT presented each word verbally and orthographically. The participants were then asked to underline the word in the correct colour. This subtest was considered separately from the others in the results due to the fact that this explicit grammatical knowledge is not required to be able to perform well on the other tasks and may or may not be related to the participants' ability to recognize, use and define words.

Task 2: Definition production

Participants were then asked to produce a definition of the word. This test was done before the Definition Recognition multiple-choice task as that included the correct definition. Glossaries of college course vocabulary provided by course tutors and found in course handbooks were used to create the target definitions. The participants' responses were compared with the target definition and full or partially correct responses assigned 1 or 0.5 respectively (for examples of target definitions and scoring, see Appendix A).

Task 3: Definition recognition (multiple-choice task)

Next, participants were asked to choose the correct definition from a choice of three which were shown and read out: the correct definition, a definition of another word from the same course, and a definition of a word from a different course. All definitions came from words of the same word class. A list of words, their ideal definition and the alternatives presented in the Definition Recognition task are given for one course (Horticulture Level 1) in additional Supporting information S3 as an example.

Task 4: Sentence production

The final task required using the word in a sentence. Full or partially correct responses were assigned 1 or 0.5 respectively (for scoring examples, see Appendix B).

Participants' self-rating

After the completion of the assessments at pre- and post-intervention only, the participants were asked to rate their understanding of all the vocabulary items assessed (target and control words) on a 5-point visual rating scale (0–4), with 0 representing 'I don't understand any of the words, this is really hard, I can't do any of it', 1 representing 'I am really struggling but I do know a few of the words', 2 representing 'I know some of the words, I need some help but I can do it', 3 representing 'I know most of the words and just need a little reminder', and 4 representing 'I know all of the words and I don't need any help'.

Intervention

The intervention was delivered by each participant's usual SLT following an intervention plan, shown in additional

Supporting information S4. The participants received nine weekly sessions of 30 min (4.5 h in total) and were taught two to three words from different word classes per session. For further information, see Appendix C.

Each session involved four main components within a 30-min session:

1. **Discussion of the intervention focus.** The SLT asked the participant what they were working on and why it was important and the participant wrote down the focus of the intervention.

2. **Recap of all previously taught words (5 min)** using Quizlet.com, an online flash card app and vocabulary learning tool. All previously taught vocabulary was recapped to improve retention and the number of times the participant was exposed to each word. Quizlet is a vocabulary app where you can create personalized vocabulary sets and add words with a definition and an image. The app then generates games requiring (a) matching the words to their definition, (b) seeing the definition and choosing the correct word out of a choice of four, (c) seeing the word and retrieving the definition, and (d) seeing the definition and retrieving the word. Each participant had their own individualized study set, containing all words targeted to date. When using the games to monitor recall of word meaning Quizlet provided immediate feedback to the participants as to whether their response was right or wrong. If they made an error with (a) matching words to definitions, they kept trying until they got a correct result, (b) selecting the correct word to match the definition, Quizlet would provide the correct answer, (c) and (d) saying the definition on seeing the word or vice versa, the SLT and participant would revisit the word and its definition. Screenshots from Quizlet are shown in additional Supporting information S5.

3. **Explicit teaching of two or three new words using word maps (20 min).** For examples of a blank and completed word map, see Supporting information S6 and Appendix D. For each word, the participants were asked the following:
   - To write and say the word.
   - To link the words to questions coded with the SHAPE CODING™ system shapes, for example, 'what?', 'what doing?' and 'what like?', and colour code the word according to its word class (noun = red, linked with 'what?/who?'; verb = blue, linked with 'what doing?'; adjective = green, linked with 'what like?').
   - To research and discuss the meaning of the word with their SLT and write a definition. This entailed looking up a definition either in the course glossary or a dictionary, where the participant would read out the definition, if able. This was then paraphrased by the SLT, giving examples.
   - To draw or find a picture representing the word.
   - To use the word in a sentence.
   - To manipulate the word to different word classes using derivational morphology (where applicable, for example, verb: *to sauté*, adjective: sautéed potatoes).
   - To discuss the phonological properties of the word: first letter, vowel sounds and number of syllables.
   - Where applicable, participants were shown a short YouTube video to represent each word to support understanding of the concept.

   The same procedure was then used for the next word.

4. **Adding words to Quizlet app (5 min).** To support consolidation, participants added the words taught in that session to Quizlet along with the definition they had learnt using the word maps and a suitable picture from the selection within the app itself. Participants were asked to play games on the Quizlet app on their phones between sessions to consolidate word learning.

Attendance and fidelity

All SLTs kept detailed records for each participant of the sessions attended, the total amount of intervention time received, and activities and words targeted in each session, but unfortunately data on use of Quizlet app between sessions or the percentage definitions correct was not collected. Fidelity was checked through two peer observations of session delivery per SLT and by checking each SLT's notes. All SLTs followed the plan detailed above, and therefore the only difference between participants was the specific vocabulary items targeted (and tested) which depended on their further education course. However, due to participant absences, four participants received only eight out of the nine planned intervention sessions.

RESULTS

General effectiveness of intervention

An overall summary of the results by time and type of word (targeted versus control), regardless of word class or task is shown in Figure 1. This shows little progress in either control or targeted words during the baseline period and then progress during the intervention period (particularly on targeted words). Progress appears to be broadly maintained during the maintenance period.
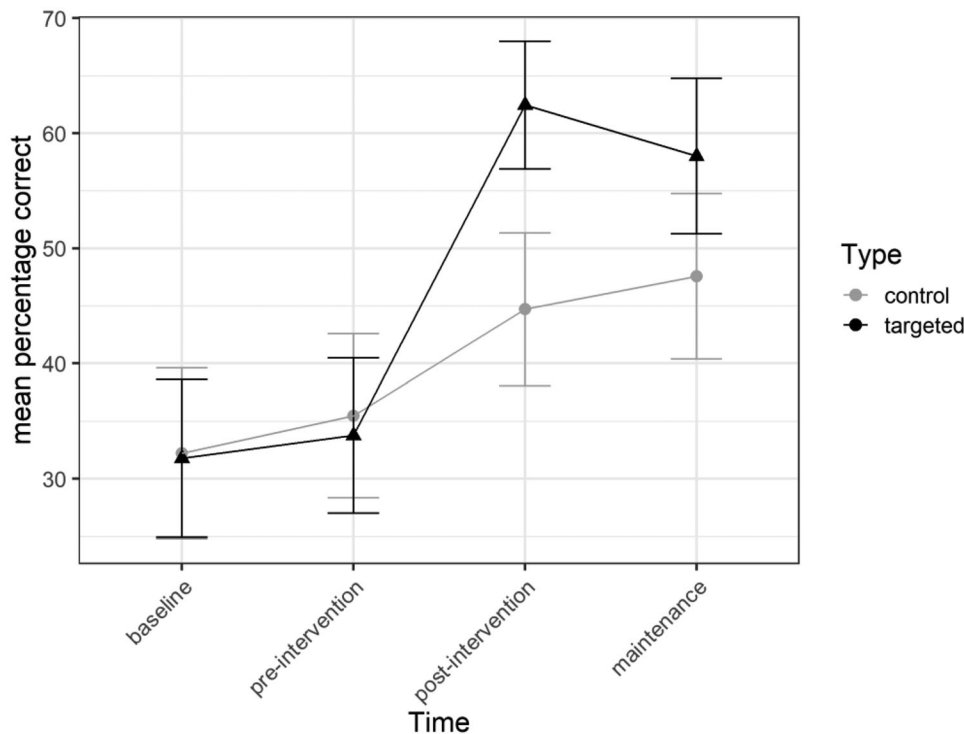
FIGURE 1 Percentage of control and targeted words correct over time: 21 control and 21 targeted words were tested

We were also interested in whether the word class (noun, verb, adjective) and task (Definition Recognition, Definition Production, Sentence Production) interacted with the other factors. Figure 2 splits the above results by task and word class. This shows higher scores for the Definition Recognition task. However, overall, the pattern of intervention effects shown in Figure 1 appears to apply to all word classes and tasks.

In order to analyse these results, we used linear mixed modelling. This type of general linear model (Howell, 2010) allows us to mathematically adjust for the variability associated with the individual participants (i.e., multiple responses from the same person are more similar than responses from other people). All analyses were carried out in R version 4.0 using the *lme4* package (version 1.1-23).

We considered the fixed effects of time (baseline, pre-intervention, post-intervention, maintenance, with pre-intervention as the reference) and type (targeted versus control, with control as the reference), word class (noun, adjective, verb, using sum coding), task (Definition Recognition, Definition Production, Sentence Production, using sum coding) and their interactions. Sum coding compares the mean of a given level (e.g., adjectives) to the grand mean (e.g., of word class). Only those effects that significantly improved the model's predictive ability were included in the final model. The final model included time, type, task and their interactions plus fixed effects only for word class. Adding the interactions of word class

with other factors did not improve the model fit. For random effects, we considered participant and course, but the model including course did not converge, so only participant was included in the final model.

The full final model is shown in Appendix E and discussed below, but for simplicity and clarity we first present a simple model in Table 2 which considers only the fixed effects and interaction of time and type (omitting task and word class) and thus corresponds to Figure 1. Both the full and simple models showed a main effect of time, where both post-intervention and maintenance scores (of control items) were significantly higher than their pre-intervention scores ($p < 0.001$), but baseline scores did not differ significantly from pre-intervention scores (indicating a stable baseline). Targeted items did not differ from controls at pre-intervention, but the interaction between type and time at both post-intervention and maintenance ($p < 0.001$) showed that targeted items had significantly greater gains than control items from pre-intervention to both post-intervention and maintenance.

To check whether the slight drop on targeted items in the maintenance period visible in Figure 1 was significant, we re-ran the models with post-intervention and targeted items as the reference levels; this showed that the apparent decrease in targeted items between post-intervention and maintenance was not significant ($p = 0.14$). Thus, both controls and targeted items showed significant progress during the intervention period, which was maintained
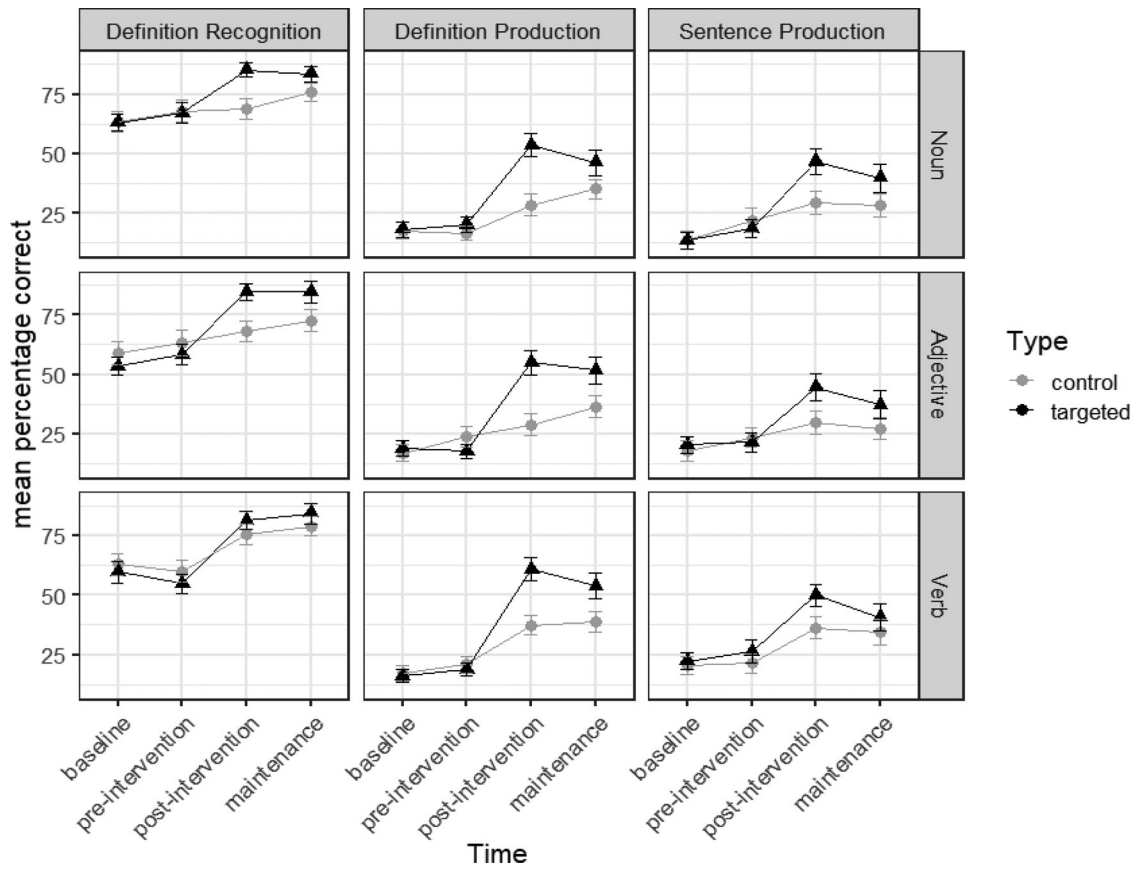
FIGURE 2 Percentage correct of control and targeted words over time split by task and word class (seven nouns, seven verbs, seven adjectives)

TABLE 2 Linear mixed model results for the simple model

Predictors	Score		
	Estimates	CI	p
(Intercept)	35.61	29.61–41.62	< 0.001
Time [baseline]	−3.41	−8.01 to 1.20	0.147
Time [post-intervention]	9.09	4.48–13.69	< 0.001
Time [maintenance]	12.88	8.22–17.53	< 0.001
Type [targeted]	−1.85	−6.46 to 2.75	0.431
Time [baseline] * Type [targeted]	1.41	−5.10 to 7.92	0.672
Time [post-intervention] * Type [targeted]	19.60	13.09–26.11	< 0.001
Time [maintenance] * Type [targeted]	12.29	5.72–18.86	< 0.001
Random effects			
σ^2	694.44		
$\tau_{00\ ID}$	185.46		
ICC	0.21		
N_{ID}	28		
Observations	1997		
Marginal R^2/conditional R^2	0.129/0.313		

Note: Predictors were coded using treatment contrasts. The intercept represents mean scores for control items at pre-intervention: all other values are relative to this reference level.

during the maintenance period, but significantly greater progress was seen on the targeted than control items.

The full model (see Appendix E) included a few additional significant effects (and one significant three-way interaction). Within the full model, the score for control items at baseline was marginally significantly lower ($p = 0.04$) than at pre-intervention. There was also a highly significant effect of Task at pre-intervention for control items, where Definition Production was significantly below ($p < 0.001$), and Definition Recognition significantly above ($p < 0.001$) the grand mean for all tasks. A significant effect ($p = 0.011$) of verbs (but with no significant interactions, as the model with word class interactions included did not improve the fit) showed that these generally had higher scores than the grand mean across all word classes for control items at pre-intervention, but this effect was small. The significant three-way interaction (Definition Production × targeted items × post-intervention) was due to the gap between targeted and control items being larger at post-intervention for this task than for other tasks (Figure 2).

Thus, it appears that the overall intervention effect (where both control and targeted items improved during the intervention period, but the targeted items improved significantly more) was similar regardless of word class or task, although the short-term intervention effect on targeted items as compared with control items was larger for Definition Production than for the other tasks. However, verbs were slightly easier than the grand mean for the three word classes and Definition Recognition was easier and Definition Production harder than the grand mean for the three tasks.

Individual results

Figure 3 presents the results for the 28 individual participants. To simplify, we averaged the baseline and pre-intervention scores into a 'before' intervention score, and the post-intervention and maintenance scores into an 'after' intervention score. All participants showed positive change on targeted words. All but two participants (IDs 20 and 16) showed more progress on targeted words than controls. These two participants were among those with the lowest starting scores, and indeed before intervention scores (targets and controls combined) correlated significantly with the difference in progress between the targets and controls, $r = 0.50$, $p = 0.010$, showing the value of including random intercepts in the models above. The participants with an ASD diagnosis (IDs 9, 11, 22, 25), appear to show a similar pattern to the others.

Explicit identification of word class of vocabulary items

Next, we considered the effect of intervention on the ability to identify the word class of items. This was not included in the main model as this may not be related to the ability to use or define words, or recognize their correct definition. Figure 4 shows the participants were particularly poor at identifying the word class for adjectives pre-intervention, but appeared to show general progress with intervention in identifying all word classes.

We again used linear mixed modelling and added the fixed effects of time (with pre-intervention as the reference time), type (with controls as reference), word class (using sum coding) and their interactions individually and evaluated their effect on the model fit using model comparisons. Only those effects that significantly improved the model's predictive ability were included in the final model which included time, type of item (targeted versus control) and their interactions, plus word class as a fixed effect only. However, the results of this model showed only one significant effect which was a main effect of word class, where adjectives scored 13.4 percentage points lower than the grand mean across all word classes, and verbs scored 7.0 higher (both $p < 0.001$). No other effects or interactions reached significance. This shows that the participants were significantly less able to identify the word class of adjectives and more able to identify verbs.

In our final analysis we investigated whether the change in the ability to explicitly identify the word class correlated with progress on any of the other three tasks. In order to do this, we calculated for each participant, their mean change in score from pre-intervention (mean of the baseline and pre-intervention scores) to post intervention (mean of post-intervention and maintenance scores) for each of the four tasks (targeted and control items combined). Pearson correlations are shown in Table 3. This shows that progress in identifying the word class was significantly correlated only with progress in Definition Production, not with progress in the Sentence Production or the Definition Recognition tasks. Progress scores on the other tasks were all strongly correlated with each other.

Participants' self-rating

Participants self-rated their performance on a scale of 0–4 on the immediate pre- and post-intervention tests (that included both targets and controls). A Wilcoxon signed-rank test showed their self-ratings immediately pre-intervention (mean = 1.9, SD = 0.7) differed significantly, $Z = 4.2$, $p < 0.001$, $r = 0.79$, from immediately post-intervention (mean = 2.7, SD = 0.5).
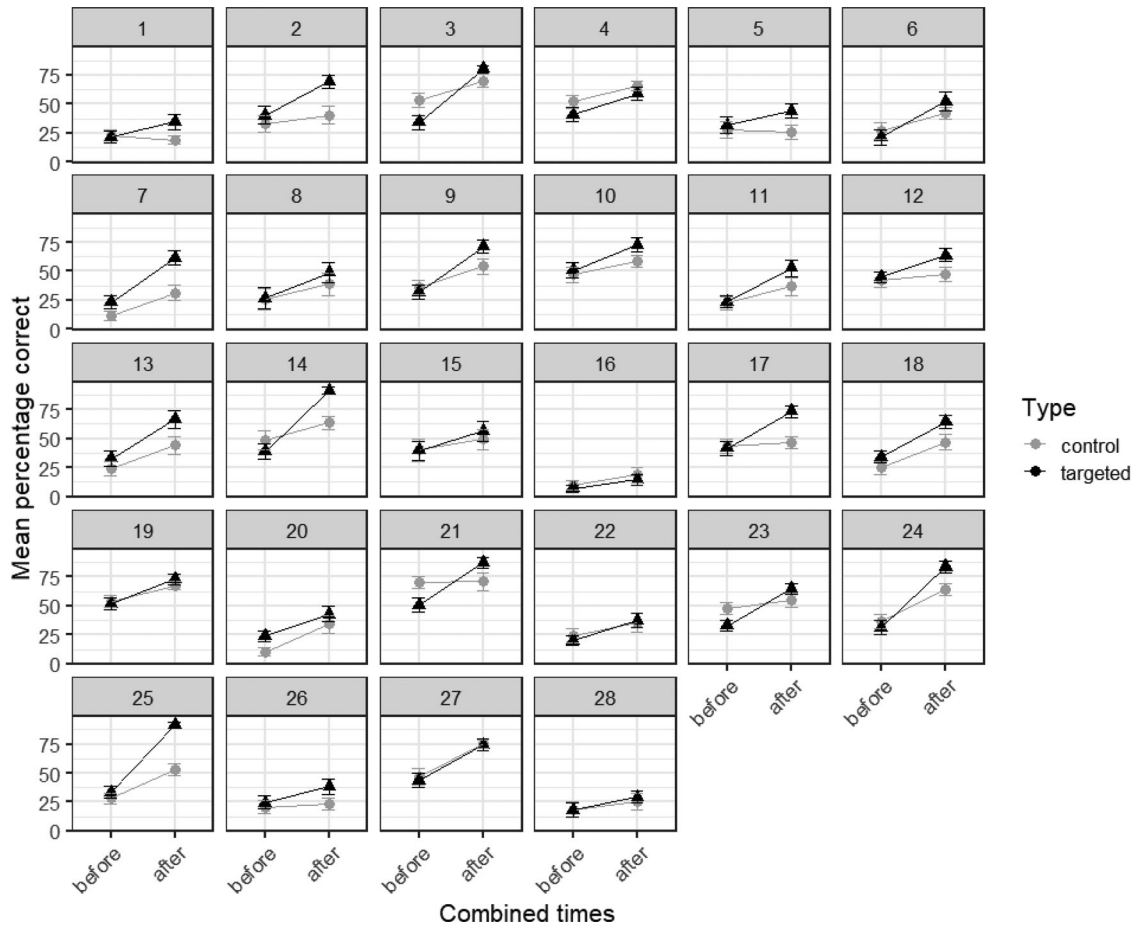
FIGURE 3 Scores for each individual participant before intervention (baseline and pre-intervention scores combined) and after intervention (post-intervention and maintenance scores combined)

DISCUSSION

Since 2014, in the UK, Education Health and Care Plans have given students with special educational needs the right to be in education or training until the age of 25. This has given more opportunities for these students, including those with DLD and wider language disorders, to remain in education and learn the skills necessary for employment. However, further education courses aimed at future careers involve many new (and often complex and abstract) vocabulary items. People with DLD have difficulties learning vocabulary, therefore it is vital that we find effective ways of supporting their learning of course-specific vocabulary items which will be important throughout their career.

The participants within this study were in the first, second or third year of college provision (aged 16–19 years) and were being exposed to many new words as they were taught a new curriculum. As a relatively new provision for this age group, we wanted to investigate the effectiveness of our approaches to supporting their course-specific vocabulary learning.

Our study used a within-participant design and measured progress on the participants' ability to identify, define and use individually selected vocabulary items (with equal numbers of nouns, verbs and adjectives) from their individual further education courses. During the baseline period no items were targeted, during the intervention period half the items (within each word class) occurred in lessons only and the other half in both lessons and nine 30-min one-to-one SLT sessions (4.5 h in total). The results showed a stable baseline, then during the intervention term significant progress on words occurring in lessons but significantly greater progress in words also targeted in one-to-one SLT sessions (thus confirming predictions 1 and 2). This progress was maintained for 14 weeks. This confirms our third prediction, although we did not find strong evidence of a decline on production tasks. All individuals showed similar patterns (including those with an ASD diagnosis), but those with lower scores before
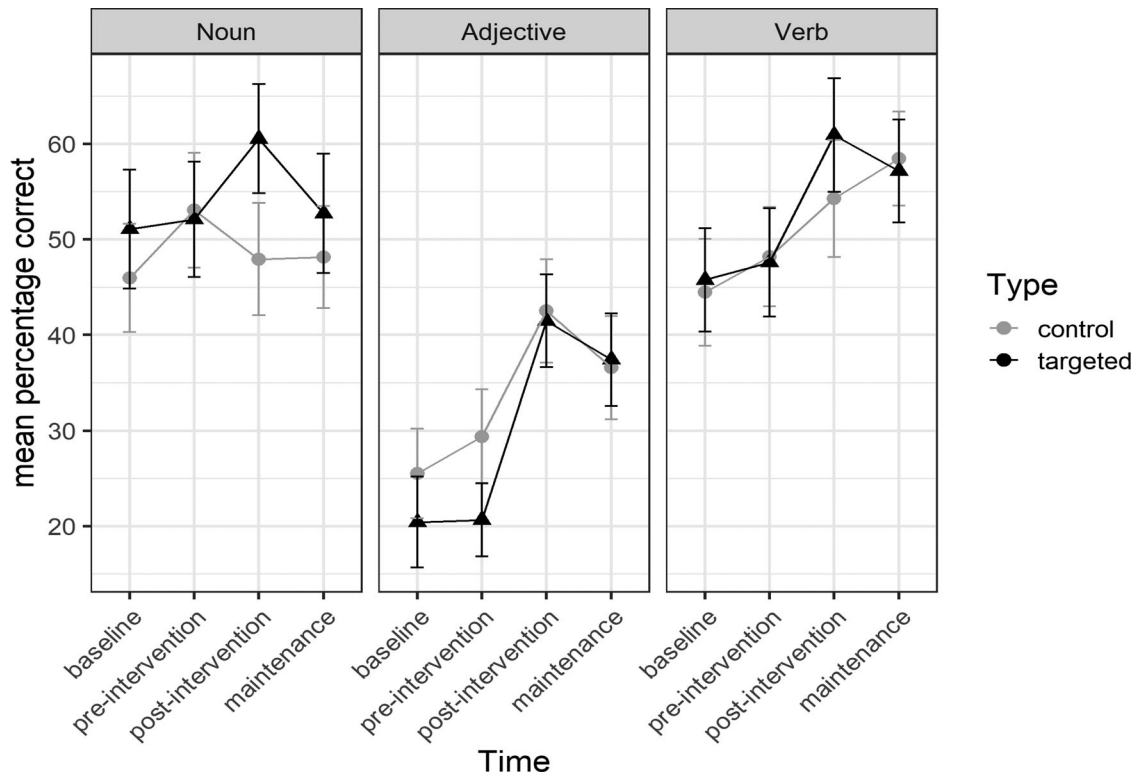
FIGURE 4 Percentage correct for identifying the word class of targeted versus control words over time

TABLE 3 Pearson *r* (*p*-values) of correlations between progress on the four tasks

	Identifying word class	Definition recognition	Definition production
Definition recognition	0.06 *(0.45)*		
Definition production	**0.22** *(< 0.001)*	**0.34** *(< 0.001)*	
Sentence production	0.09 *(0.25)*	**0.26** *(< 0.001)*	**0.55** *(< 0.001)*

intervention showed smaller intervention effects. Participants' self-ratings after intervention were higher than before intervention.

In general, performance was higher on the Definition Recognition task, lower on Definition Production and higher on verbs (but with no significant interactions with other factors). When asked to identify the word class of items, their performance on verbs was higher, and that on adjectives lower than the mean for all word classes. The participants' better performance with verbs chimes with their better performance with verbs on the other tasks, but their worse performance on adjectives differs from the other tasks where there was no difference in the ability to identify, define and produce accurate sentences containing

adjectives compared with the mean for all word classes. However, progress in explicitly identifying word classes correlated with progress in Definition Production. These findings are discussed further below.

To date, only a few studies have investigated the effectiveness of speech and language therapy with the post-16 population (Campbell et al., 2019; Mathrick et al., 2017) and very few services provide direct SLT to the population of language disordered young adults. However, the results of this study reveal the significant additional benefit that SLTs can make to the learning of new vocabulary by improving students' knowledge of course-specific vocabulary items, improvements which were maintained for at least 14 weeks. This maintenance of new skills is especially important, as these are vocabulary items from vocational courses that lead to careers and thus should be useful to these participants throughout their working lives. The repeated revision of previously taught words in weekly sessions probably helped with their maintenance as McGregor et al. (2020) showed that revision one week after learning a new word improved maintenance one month later. Participants were also asked to revise between sessions using the Quizlet app on their phones.

The SLTs reported that the participants engaged well with the sessions, perhaps because they realized that the sessions were making their lessons easier to understand because the vocabulary items were directly linked to their

academic course. Their higher self-ratings after intervention than before indicate that they could see the benefit of the intervention. However, the self-ratings applied to all tested items (both targets and controls) and it is possible that higher self-ratings post-intervention might have been obtained if only knowledge of targeted items had been rated. This was not possible as the assessments involved both targets and controls presented in a random order.

The smaller intervention effect in participants with lower scores prior to intervention also aligns with the findings of McGregor et al. (2020). In their study, those participants with poorer vocabulary needed more exposures to items in order to reach mastery. It is therefore possible that in our study, those with lower scores would have benefited from focusing on fewer words in total with more exposure to those few words. Of course, this means carefully selecting from a curriculum only a few words which are the most important for accessing the course and also future work, never an easy task.

It is important to note that the participants also made progress with the control words during the intervention period. Because these were part of their course, these words are likely to have occurred within lessons, although the amount of explicit teaching of these words to the whole class is unknown. Thus, this study shows that the lessons themselves led to progress in the course-specific vocabulary. However, significantly greater progress was made on the words that were also specifically targeted during SLT sessions.

Effect of task

In general, the Definition Recognition task was easier and Definition Production harder than the grand mean for all three tasks (supporting prediction 4). This is likely to be due to the complexity of the tasks and the level of knowledge required. The Definition Recognition task required choosing between three definitions (where one distractor was from the same course and one from a different course). So, to be successful, the participant only needed to recognize which two definitions were from their course and then to have sufficient knowledge of the meaning of the presented word to choose between the two course-related definitions. This requires much more limited knowledge of the word meaning than the Definition Production task. To be able to use a given word in the production tasks requires general abilities to produce grammatical sentences, as well as detailed semantic and syntactic knowledge of the word thus, given the wider language difficulties of the participants, particular difficulties with these tasks are unsurprising.

Progress with intervention on the three main tasks was highly significantly correlated and performance on all tasks appeared to improve with intervention, particularly for the targeted items. The only significant interaction indicated a short-term effect (at post-intervention, but not maintenance) for Definition Production, where the difference in progress between targeted and control items was greater than for other tasks.

Effect of word class

When comparing the ability to recognize and produce definitions and use the vocabulary items in sentences, we found a general advantage of verbs, but no interactions with other factors. We had predicted greater difficulties with verbs and adjectives, particularly on the tasks involving sentence production pre-intervention (prediction 5). Our findings of slightly higher overall scores for verbs and similar progress with intervention across word classes did not support our hypothesis and contrasts with previous studies with younger children with DLD (Oetting et al., 1995; Rice et al., 1994; Riches et al., 2005) which state that nouns are easier to acquire because of their concrete nature, and contrasts with an intervention study with younger adolescents with DLD (Wright et al., 2018) where nouns improved more than verbs. However, at this stage of education, curricular nouns may actually be more abstract (e.g., *risk*, *disability*, *software*, *virus*, *atrophy*, *privacy*) and thus more difficult than curricular verbs (e.g., *prepare*, *consume*, *absorb*, *model*)—see additional Supporting information 2 for more examples. SLTs supporting the post-16 curriculum should therefore target words from all word classes.

When asked to explicitly identify the word class, the participants showed lower scores on adjectives and higher scores on verbs. The higher scores on verbs may be because the verbs were just better known (as shown by higher scores on the other tasks). Lower scores on adjectives might be due to less explicit focus on adjectives in previous interventions and teaching, as the lower scores did not seem to affect participants' ability to recognize, define or use them in sentences. We did find however, that progress on the ability to identify correctly the word class of all words, was related to progress in Definition Production (but not Sentence Production) with intervention, thus partially supporting prediction 6.

Limitations and future directions

This study was carried out in a busy post-16 college setting for students with DLD as part of usual clinical practice with no additional funding. While this reflects our real-world clinical setting, it led to some limitations in the research process. The assessments were carried out by the SLTs who were providing the intervention and thus testing was

not blind, leading to potential bias. Some attempts were made at ensuring interrater reliability and fidelity with blind double-marking of 36% of assessments. It was not possible to record and analyse assessment and intervention sessions to record exactly what was said, including detailed dosage. Instead, we relied on the SLTs' notes, written within 24 h of each session as a record of what happened in the sessions. This was therefore fairly broad in nature. Thus, while we could conclude that each SLT introduced the vocabulary items in the specified order and carried out the activities in the plan, we do not know in detail exactly what was said or how many times each word was said by SLTs or participants. Future studies should record assessment and intervention sessions, although analysing this would require additional time and therefore specific funding.

Our self-rating scale was limited in scope as it only measured the participants' rating of their knowledge of the tested words (which included both targeted and control words). Future studies could include questionnaires about their perceptions of the impact of intervention on their understanding of and participation in their course, their use and views of independent strategies for learning vocabulary and whether/how this might affect their future career goals.

Avenues for future research might include intervention studies with adults with DLD, linked with their (hoped for or current) employment. We are also keen to investigate the effectiveness of other interventions we provide to the young adults in our setting, replicating some of our earlier studies with younger adolescents and also investigating the effectiveness of our group intervention for this older age group (Holland et al., in preparation).

Clinical implications

This intervention was functional and supported academic attainment, as it was directly linked to participants' college courses and potentially their career goals. The intervention was multifaceted and it is not possible to draw conclusions about the relative effectiveness of different aspects of the intervention. Some aspects of the intervention required specialist knowledge and skills (e.g., use of aspects of the SHAPE CODING system), but other aspects aimed to develop skills and strategies the young people could use independently (e.g., use of Quizlet), that could be transferrable (with support and encouragement) into adulthood and their career. The intervention was of relatively short duration and intensity (nine weekly 30 min sessions) and therefore potentially achievable in other non-specialist settings.

CONCLUSIONS

This research demonstrates that direct individual SLT intervention targeting vocabulary acquisition with post-16 students with (D)LD is effective, where 4.5 h of direct one-to-one intervention targeting course-specific vocabulary acquisition led to significantly greater progress than the vocabulary teaching available in lessons. Individual intervention delivered by speech and language therapists should therefore be offered to this age group of students with (D)LD to maximize their ability to access the academic curriculum and their future careers.

CONFLICT OF INTERESTS

The authors were all employed in the setting where this study was carried out. The authors are responsible for the content and writing of the paper and report no other conflicts of interest.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

Appendix A: Examples of scoring of Definition Production task

- All key concepts present: 1 point
- Partial knowledge of word, where the student had some understanding of the word, for example got the broad category, for example 'PPE' means 'safety': 0.5 of a point
- Incorrect or no response: 0 points.

Course	Word	Target definition	Response	Score
Caring sectors Level 1	disability	Something that makes a person unable to do certain activities	You are not able to do something like some people	1
Sports Level 2	synovial joint	The most common joint type where 2 bones meet to create a capsule that is filled with synovial fluid	A joint with a capsule filled with synovial fluid	1
Animal Management Level 1	reptile	A cold-blooded animal that breathes through gills and lungs	Cold blooded	0.5
Hair and Beauty Level 1	effleurage	Massaging with a circular stroking motion	massage	0.5
Hair and Beauty level 1	scabies	A skin disease that is caused by mites living under the skin	Creatures in your hair	0.5
Media Level 2	interact	When you can engage with media products and with other people through media	Touching electronic devices	0.5
Caring sectors Level 1	chronic	Happening for a long period of time without stopping	Don't know	0
Land Based Studies	deciduous	Having leaves that drop off each year	A flower	0

Appendix B: Examples of scoring of sentence production examples

- Semantically and syntactically correct sentence: 1 point.
- Partially syntactically correct, but semantically correct, or vice versa: 0.5 of a point.
- Completely incorrect or no response: 0 points.

Course	Word	Use in a sentence	Score
Caring sectors Level 1	disability	The girl had a walking disability	1
Sports Level 2	synovial joint	You have a type of joint called a synovial joint	1
Catering Level 1/	mince	When you get a cut of beef, you put it in the mincer	0.5
Caring sectors Level 1	comforting	I felt comforting when the girl came over	0.5
Hair and Beauty Level 2	peroxide	Peroxide is when the hair develops and might turn the colour you want	0.5
Art	cross-hatching	I cross-hatching my work	0.5
ICT Level 1/2	multimedia	I have made a multimedia before	0
Land Based Studies	Deciduous	Deciduous are trees that makes cones	0

Appendix C: Type and number of words taught each session

Session	Number of words	Word Classes
1	2	Noun, Verb
2	2	Adjective, Noun
3	2	Verb, Adjective
4	2	Noun, Verb
5	2	Adjective, Noun
6	2	Verb, Adjective
7	3	Noun, Verb, Adjective
8	3	Noun, Verb, Adjective
9	3	Noun, Verb, Adjective

Appendix D: Example word map

Appendix E: Full Linear Mixed Model

Predictors	Score		
	Estimates	CI	p
(Intercept)	**35.55**	**29.97–41.14**	**<0.001**
Time [baseline]	**−3.35**	**−6.50 to −0.19**	**0.038**
Time [post-intervention]	**9.15**	**5.99–12.30**	**<0.001**
Time [maintenance]	**12.97**	**9.78–16.16**	**<0.001**
Type [targeted]	−1.79	−4.95 to 1.36	0.266
Task [Definition Production]	**−14.90**	**−18.07 to −11.74**	**<0.001**
Task [Definition Recognition]	**28.17**	**25.01–31.33**	**<0.001**
Word Class [Adjectives]	−0.91	−2.03 to 0.21	0.113
Word Class [Verbs]	**1.45**	**0.33 – 2.57**	**0.011**
Time [baseline] * Type [targeted]	1.35	−3.11 to 5.81	0.554
Time [post-intervention] * Type [targeted]	**19.54**	**15.07–24.00**	**<0.001**
Time [maintenance] * Type [targeted]	**12.23**	**7.73–16.73**	**<0.001**
Time [baseline] * Task [Definition Production]	0.01	−4.46 to 4.48	0.997
Time [post-intervention] * Task [Definition Production]	1.81	−2.66 to 6.27	0.428
Time [maintenance] * Task [Definition Production]	4.13	−0.38 to 8.64	0.073
Time [baseline] * Task [Definition Recognition]	1.41	−3.05 to 5.87	0.535
Time [post-intervention] * Task [Definition Recognition]	−2.13	−6.59 to 2.33	0.350
Time [maintenance] * Task [Definition Recognition]	0.06	−4.44 to 4.56	0.980
Type [targeted] * Task [Definition Production]	0.09	−4.37 to 4.56	0.967
Type [targeted] * Task [Definition Recognition]	−1.74	−6.20 to 2.72	0.445
Time [baseline] * Type [targeted] * Task [Definition Production]	0.80	−5.52 to 7.11	0.805
Time [post-intervention] * Type [targeted] * Task [Definition Production]	**7.03**	**0.72–13.34**	**0.029**
Time [maintenance] * Type [targeted] * Task [Definition Production]	3.31	−3.06 to 9.68	0.308
Time [baseline] * Type [targeted] * Task [Definition Recognition]	−0.88	−7.19 to 5.43	0.784
Time [post-intervention] * Type [targeted] * Task [Definition Recognition]	−3.01	−9.32 to 3.30	0.350
Time [maintenance] * Type [targeted] * Task [Definition Recognition]	−0.38	−6.75 to 5.98	0.906
Random effects			
σ^2	326.05		
$\tau_{00\ ID}$	190.69		
ICC	0.37		
N_{ID}	28		
Observations	1997		
Marginal R^2/Conditional R^2	0.489/0.678		

Note: 'Time' and 'Type' were treatment coded; 'Task' and 'Word Class' were sum coded. For factors with three levels (as in the case of word class and task), slopes correspond to the difference between the second level of the factor and the grand mean, and the third level of the factor and the grand mean (SCHAD et al., 2020). The intercept represents means scores for control items at pre-intervention, averaged across task and part of speech.