
**Abstract**
Many uses of new media entail processing language content, yet little is known about the relationship between language ability and media use in young people. This study compares educational versus interpersonal uses of home computers in adolescents with and without a history of specific language impairment (SLI). Participants were 55 17-year-olds with SLI and 72 typically developing peers. Measures of frequency and ease of computer use were obtained as well as assessments of participants' psycholinguistic skills. Results showed a strong preference for interpersonal computer use in both groups. Virtually all participants engaged with interpersonal new media, finding them relatively easy to use. In contrast, one third of adolescents with SLI did not use educational applications during a typical week. Regression analyses revealed that lower frequency of educational use was associated with poorer language and literacy skills. However, in adolescents with SLI, this association was mediated by perceived ease of use. The findings show that language ability contributes to new media use and that adolescents with SLI are at a greater risk of low levels of engagement with educational technology.

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Very high proportions of young people in industrialized societies use computers at home and school (Bevort & Bréda, 2008; Lenhart, Madden, & Hitlin, 2005; Roberts & Foehr, 2008). Many parents encourage home computer use, regarding it as facilitative of cognitive and educational development (Subrahmanyan, Greenfield, Kraut, & Gross, 2001; Turow, 1999; Valentine, Marsh, Pattie, & BMRB, 2005). In recent decades, computer use has been advocated by governments and educational policymakers as an essential tool, a key route to information and a means of enhancing young people’s learning experiences (Schmidt & Vandewater, 2008; Valentine et al., 2005). Use of computer technologies for non-educational purposes (playing games, communicating with friends, and meeting new people) is also widespread and particularly popular among adolescents (Durkin & Barber, 2002; Livingstone & Bober, 2003; Roberts, Foehr, Rideout, & Brodie, 1999). Interpersonal contact and everyday social arrangements among teenagers are now routinely effected by text-based communication via e-mail, chat rooms, instant message services, and similar media (Boneva, Quinn, Kraut, Kiesler, & Shklovski, 2006; Bryant, Sanders-Jackson, & Smallwood, 2006; Subrahmanyan & Greenfield, 2008).

At the same time, it is clear that not all young people use the potentialities of computers to the same extent (Buckingham, 2002; Livingstone & Bober, 2004; Schmidt & Vandewater, 2008). Furthermore, theoretical accounts of new media use converge on the premise that it is not a uniform phenomenon experienced by all individuals in the same way but an active, constructive and potentially divergent process reflecting the capacities, needs and goals of users (Crock, 1994; Subrahmanyan & Greenfield, 2008; Valkenburg & Peter, 2008). In this paper, we investigate the uses of home computers by a group of adolescents with a developmental disorder - specific language impairment (SLI). We examine the relationship between language ability and the uses of home computers for educational and non-educational purposes, comparing evidence from participants with and without SLI. Understanding the ways in which young people with SLI engage with the media is important for at least two reasons. First, it can tell us about the implications of this disorder for the ways in which young people respond to educational, leisure and interpersonal opportunities. Second, it provides a distinctive comparison by which to enrich our evidence base concerning the role of language in new media use among typically developing (TD) young people.

A wide range of factors bear on individuals’ use of computers, including educational background, socio-economic status (SES), intellectual capacity, accessibility, needs, attitudes towards technology, health, prior experience, perceived usefulness and perceived ease of use (Czaja et al., 2006; Davis, Bagozzi, & Warshaw, 1989; Livingstone & Bober, 2004). Of particular interest in the present study are language ability and perceived ease of use. Language ability has received little attention in relation to new media use, and we outline below why this neglect should be addressed. Perceived ease of use is important in this connection because one influential theory of new technology adoption has identified this as one of the key variables (Davis et al., 1989) and because making tasks easier, for example by reducing their processing demands, has been shown to help individuals with SLI to produce and comprehend language (Gathercole & Alloway, 2006). Davis et al. propose as a general principle that the easier potential users believe it is to use a technology, the greater their readiness to do so. Considerable empirical support has been obtained for this account in studies of adults’ uses of new media, primarily in occupational contexts (Porter & Donthu, 2006; Venkatesh & Davis, 2000). However, inconsistencies of findings across studies have led to speculation that these relationships may be moderated by, inter alia, the characterstics of users (Sun & Zhang, 2006). Sun and Zhang propose that important characteristics include intellectual capabilities. They argue that perceived ease of use should be a more important factor among those who have weaker intellectual capacities.

Although, Sun and Zhang’s (2006) arguments are focused on uses of technologies among adults in occupational contexts, they have implications for our understanding of uses by young people and of the consequences of other individual differences. At present, there is a dearth of evidence concerning the ways in which the individual characteristics of young people bear on their uses of new media. We consider next how these may have implications for computer use by young people with SLI.
SLI and computer use
SLI involves marked difficulties with language in children whose IQs fall in the normal range, in the absence of sensory impairment (e.g. deafness) or neurological damage (Bishop, 1997; Leonard, 1998). Many children experience SLI: at around 5 years of age the key prevalence USA study suggests a population incidence of approximately 7% (Tomblin et al., 1997). There is a significant proportion of young people who have persisting difficulties with language throughout development (Conti-Ramsden, Durkin, Simkin, & Knox, in press; Stothard, Snowling, Bishop, Chipchase, & Kaplan, 1998). While SLI was initially investigated with a focus on developmental psycholinguistic characteristics, it has become increasingly evident that the disorder has broader ramifications for social and educational experiences and attainments.

Much, though not all, computer use entails language: reading texts and instructions, word processing, seeking information, following hyperlinks and sending and receiving messages. There are several reasons to expect that young people with linguistic impairments would be disadvantaged in the face of language-dependent modes of communication, interaction and learning. Children with SLI have difficulties in the production (Dockrell, Lindsay, Connelly, & Mackie, 2007; Mackie & Dockrell, 2004) and comprehension of written text (Bishop & Clarkson, 2003; Snowling, Bishop, & Stothard, 2000). Even in TD children and adults, reading from computer screens is generally slower and less efficient than reading from paper (Dillon, 1992; Kamil, Kim, & Lane, 2004; Kerr & Symons, 2006). TD children write more slowly via a keyboard than with a pen (Crook & Bennett, 2007). Research indicates that the vocabulary demands of search engines can be off-putting to some children (Livingstone & Bovill, 2001) and vocabulary growth tends to be poorer in children with SLI compared to typical peers (Beichtman et al., 2008). These findings suggest that reading and writing with computers would be especially onerous to young people with SLI.

Other processing limitations have been found to be associated with SLI, especially in working memory (Conti-Ramsden & Durkin, 2007; Leonard et al., 2007), speed of information-processing (Kail, 1994), visuospatial performance (Bavin, Wilson, Maruff, & Sleeman, 2005; Spaulding, Plante, & Vance, 2008), auditory processing (Bishop & McArthur, 2004; Rosen, 2003), and fine motor movements (Hill, 2001). Uses of computer technology present a host of additional requirements that draw on these abilities as well as skills in multitasking and integration of material with diverse textual formats, pictorial, graphical, and auditory features (Johnson, 2006; Kim & Kamil, 2004; Livingstone, 2002; Roberts & Foehr, 2008). As these processing demands can be challenging for the TD, there is good reason to expect that they will be even more so for those with SLI.

Young people with SLI also suffer broader educational disadvantages. Their educational achievements tend to lag behind those of their peers through the school years (Conti-Ramsden et al., in press; Dockrell, Lindsay, Palikara, & Cullen, 2007; Durkin, Simkin, Knox, & Conti-Ramsden, in press). Hence, in general, educational work is likely to be more arduous for these children, and this may be particularly the case when working in media, such as the computer, where direct personal support is not always available.

Taken together, these bodies of research indicate that the psycholinguistic and information-processing difficulties experienced by many children with SLI should lead to difficulties with computer activities, especially for educational, learning purposes. In this study, we investigate whether young people with SLI find computers less easy to
use than do TD peers. We also address the possibility that this difficulty will be reflected in lower use of the technology for these purposes by adolescents with SLI.

This is not to say that use of computers is impossible by young people with SLI. Indeed, there may well be features of computers that are more favourable to people with SLI than are other media and modes of communication. For example, not all linguistic requirements of the new media are necessarily stringent. In peer-oriented uses of text-based media, the rules of spelling and grammar are considerably relaxed, internet interaction is often casual, and expressive mistakes are tolerated (Livingstone & Bovill, 2001; Plester, Wood, & Joshi, pp. 145–161). In addition, some electronic media allow for asynchronous, editable forms of interaction which can offer young people with SLI more time to think, write, and rewrite (edit) language. However, in the main, these advantages are most salient in informal uses of computer mediated communication (CMC) rather than in educational uses.

With respect to interpersonal uses of the computer, theoretical and empirical bases for predictions concerning young people with SLI are somewhat mixed. On the one hand, social relations are another area of difficulty. Children with SLI tend to be less socially accepted and have fewer friends than do other children (Brinton & Fujiki, 2002; Rice, 1993); by mid-adolescence, they are less likely than TD peers to have close friends and, on average, they report poorer friendship quality (Durkin & Conti-Ramsden, 2007). These considerations, together with the processing demands of CMC, suggest that adolescents with SLI will be less likely to use computers for interpersonal purposes than will be TD adolescents. On the other hand, difficulties with peer relations do not mean that adolescents with SLI have no desire to interact with peers. Although young people with SLI tend to be shyer, more reticent and less skilled in interpersonal contact, they do seek to relate to other youth, they are motivated by sociability, and many achieve satisfactory levels of friendship (Durkin & Conti-Ramsden, 2007; Wadman, Durkin, & Conti-Ramsden, 2008). CMC can be an attractive medium for shyer and more socially anxious individuals because it reduces the pressures of face-to-face interaction and the threat of negative evaluation (Stritzke, Nguyen, & Durkin, 2004; Valkenburg & Peter, 2008). On this basis, then, adolescents with SLI could be expected to be motivated to use home computers for interpersonal purposes.

The present study
In this study, we aimed to compare the uses of home computers by adolescents with and without SLI. Participants completed questionnaires and diaries about their uses of new media. In addition to language/literacy abilities and performance IQ (PIQ), we measured frequency of use and perceived ease of use with respect to both educational and interpersonal purposes. We focused on home use because previous research has shown that children are considerably more likely to use computers at home than at school, whether for educational or entertainment purposes, and that they prefer home use (Downes, 1996; Mumtaz, 2001). Although much remains to be investigated concerning the relationship between computer use and educational performance (Schmidt & Vandewater, 2008; Underwood, 2007), the evidence available to date indicates that home use is associated with more positive attitudes towards computers (Mumtaz, 2001; Selwyn, 1998), with better performance on information technology (IT) tasks (Underwood, Billingham, & Underwood, 1994) and with at least moderately higher scores on standardized achievement tests (Jackson et al., 2006; Subrahmanyam et al., 2001; Valentine et al., 2005).
We expected that adolescents with SLI would find computers less easy to use than their peers. However, home computers are now ubiquitous. Some uses are very attractive to most young people, especially non-educational and interpersonal uses. Given the importance of peer relations to adolescents and consistent evidence of a preference in this age group for interpersonal uses of new technologies (Livingstone & Bober, 2004; Subrahmanyan & Greenfield, 2008), we expected that both groups would report more frequent uses of computers for non-educational than educational purposes. Because educational uses of new media are more demanding than non-educational uses, we expected that, compared to TD peers, participants with SLI would report less extensive uses of computers for educational purposes.

In light of evidence from the adult literature that ease of use affects uptake of new media (Davis et al., 1989), we expected that ease of use should contribute to the prediction of frequency of use in adolescents. Given theoretical arguments that the relationship between ease of use and frequency of use is moderated by group ability (Sun & Zhang, 2006), we expected this relationship to be more marked in the participants with SLI. However, SLI is a heterogeneous disorder and individuals vary in severity of impairment (Conti-Ramsden, 2008); hence, we expected that those with greater language and literacy impairments would be the least frequent users. Finally, we expected that, within the SLI group, the relationship between language and literacy ability and frequency of use for educational purposes would be mediated by perceived ease of use.

Method

Participants

Adolescents with SLI

The adolescents with SLI in this investigation were originally part of a wider longitudinal study: the Conti-Ramsden Manchester Language Study (Conti-Ramsden & Botting, 1999a,b; Conti-Ramsden, Crutchley, & Botting, 1997). This initial cohort was recruited from 118 language units attended to English mainstream schools. These language units provided a list of year two children (7-year-olds) attending for at least 50% of the week. Across England approximately 500 children fitted this criterion. All language units were asked to participate and two declined this invitation. Subsequently, approximately half of the eligible children in each unit were randomly sampled. This resulted in an initial study cohort of 242 children. The age range was 7.5–8.9 years and consisted of 186 males and 56 females (females forming 23.1% of the cohort). These children were reassessed as part of the original study at 8, 11, 14 and 16 years of age.

From the original cohort of 242 individuals described above, 111 (45.9% of the original cohort) were approached to participate in the present study. Longitudinal data showed that all of these adolescents met criteria for SLI at least at one time point (7, 8, 11, 14 or 16 years) prior to the data collection for the present study. These criteria comprised:

1. PIQ of 80 or more and at least one concurrent standardized language test score >1SD below the population mean at one of the longitudinal assessment stages.
3. English as a first language.
4. No record of a medical condition likely to affect language.
Of the 111 adolescents invited to take part, 90 agreed to participate. However, given the comparative nature of the present study, only data from those participants who completed both the Educational Computer Use Interview (ECUI) and the New Media Interview (NMI) were included. An additional criterion was that these young people with a history of SLI had access to a computer at home. This resulted in a final sample of 55 adolescents with a history of SLI (69.1% male/30.9% female) aged between 16 years 2 months and 18 years 2 months (mean age 17; 10 years).

**Typically developing adolescents**

A comparison group of adolescents from a broad background participated in the study. They had no history of special educational needs or speech and language therapy provision had participated in the Manchester Language Study (MLS) at the 16 year phase and had access to a computer at home. The MLS used Census data from the 2001-2002 General Household Survey (Office of National Statistics, n.d.) to target adolescents who would be representative of the range and distribution of households in England in terms of household income and maternal education. Ninety-one TD adolescents agreed to participate. Of these 72 TD adolescents (56.9% male/43.1% female) participated in the present study. They were aged between 16 years 2 months and 17 years 10 months (mean age 16; 10 years) and had completed both the ECUI and NMI.

**Participants’ SES background**

TD adolescents were matched in terms of age and SES to the adolescents with SLI. As part of a previous assessment at 16 years of age, data were collected from participants’ parents in order to ascertain levels of maternal education (minimal to degree level) and household income (≤£5,200—£52,000 per annum), as measures of SES. No significant differences were found between the adolescents with SLI and TD adolescents in maternal education level, \( \chi^2(2, N = 122) = 1.78, p = .410 \), or household income band, \( \chi^2(3, N = 123) = 4.64, p = .200 \). Importantly, therefore, the adolescents with SLI were similar to the TD adolescents in terms of SES indicators. Further, the household income of both groups ranged from the lowest bracket found in the 2001-2002 General Household Survey (Office of National Statistics, 2001-2002) to the highest bracket and thus was representative of the range of household income distribution found in England as a whole.

**Participant PIQ and language profiles**

All 127 adolescents had psycholinguistic data available from the present stage of the study (see Table 1). As expected, \( t \) tests revealed that TD adolescents performed significantly better than adolescents with SLI on tests of PIQ, receptive language, expressive language, reading and spelling (all \( p \) values < .001).

Adolescents with SLI were classed as currently impaired if, at the time of the study, they met the following criteria for SLI: PIQ [Wechsler Abbreviated Scale of Intelligence (WASI); Wechsler, 1999] of 80 or more and concurrent expressive or receptive language index score (CELF-4 Semel, Wiig & Secord, 2003) less than 85.

Exactly 60% of the adolescents with SLI (33/55) were classified as meeting criteria for SLI at the time of the study. The remaining 40% had all met the established SLI criteria at some point in the last ten years. Of this group, 11 (20% of the total) demonstrated concurrent normal PIQ and language ability and 11 (20% of the total) showed PIQ and
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<th>Adolescents with SLI</th>
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<td>WASI PIQ</td>
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<td>72</td>
<td>108.0</td>
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<td>CELF4 receptive language</td>
<td>55</td>
<td>73.5</td>
<td>18.7</td>
<td>72</td>
<td>99.8</td>
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<tr>
<td>CELF4 expressive language</td>
<td>55</td>
<td>67.6</td>
<td>16.6</td>
<td>72</td>
<td>101.3</td>
<td>12.1</td>
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<tr>
<td>CELF4 core language</td>
<td>54</td>
<td>70.1</td>
<td>19.4</td>
<td>72</td>
<td>104.4</td>
<td>12.2</td>
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<td>TOWRE word reading</td>
<td>55</td>
<td>73.5</td>
<td>17.2</td>
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<td>95.9</td>
<td>12.7</td>
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<tr>
<td>WRAT3 reading</td>
<td>54</td>
<td>83.2</td>
<td>15.1</td>
<td>71</td>
<td>102.7</td>
<td>10.3</td>
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<td>WRAT3 spelling</td>
<td>55</td>
<td>83.9</td>
<td>16.2</td>
<td>72</td>
<td>104.1</td>
<td>9.3</td>
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All p-values < .001

language ability in the impaired range. None of the adolescents had impaired non-verbal abilities but normal language scores. Therefore, at the time of the study, a total of 44/55 of the adolescents (80%) had concurrent language difficulties.

Of the TD adolescents, 62/72 (86.1%) had normal PIQ and language scores (as defined above). Of the 72 TD Adolescents, 9 (12.5%) had normal PIQ but low expressive or receptive language and 1 (1.4%) had normal language but low PIQ. None of the TD adolescents had both low non-verbal and language skills. Thus, regardless of PIQ, 63/72 (87.5%) of the TD adolescents had normal language functioning. It is to be expected that a representative sample of TD adolescents without a history of special education or language problems drawn from the full range of the socio-economic spectrum would include some adolescents who obtain poor scores on language or other psycholinguistic measures (Durkin & Conti-Ramsden, 2007).

Participants’ information and communication technology experience

Of the adolescents with SLI, 66% took information and communication technology (ICT) at school in years 10 and 11. This figure was 53% for the TD adolescents. The groups did not differ significantly in this respect, \( \chi^2(1, N = 127) = 2.06, p = .151 \).

Tests and materials

**Psycholinguistic test battery**

Adolescents participated in a wide battery of standardized assessments as described below.

1. PIQ was assessed using the full form of the WASI (Wechsler, 1999). The WASI is a battery of four subtests (Vocabulary, Block Design, Similarities, and Matrix Reasoning) and is used to provide a measure of a person’s intellectual ability. It can be used with people aged 6-89 years. The Block Design and Matrix Reasoning subtests were used to derive PIQ.

2. Expressive language, receptive language, and overall core language score were assessed using selected subtests of the *Clinical Evaluation of Language Fundamentals—Fourth edition* (CELF-4; Semel et al., 2003). The CELF-4 is an individually administered language test designed for 5 to 21-year-olds. Receptive language was assessed using the following subtests: understanding spoken
paragraphs, semantic relationships, and the receptive part of Word Classes 2. Expressive language was assessed using the following subtests: Recalling Sentences, Formulated Sentences, and the expressive part of Word Classes 2. The core language score was derived using the following subtests: Recalling Sentences, Formulated Sentences, Word Classes 2 (both receptive and expressive parts), and Word Definitions.

(3) Reading efficiency was assessed using the full form of the Test of Word Reading Efficiency (TOWRE; Torgesen, Wagner, & Rashotte, 1999). The TOWRE consists of two timed subtests: sight word efficiency and phonemic decoding efficiency. These are suitable for use with individuals aged 6-24 years.

(4) Reading and spelling accuracy were assessed using the reading and spelling subtests of the Wide Range Achievement Test - Third edition (WRAT-3; Wilkinson, 1993). This test can be used with people aged 5-75 years.

**Educational computer use interview**

The ECUI comprised three parts, collecting information on: (a) frequency of home computer use contrasting educational versus non-educational uses, (b) engagement in on-line educational uses, and (c) ease of educational uses.

Part (a) contained two questions on frequency of use that asked participants how often they used their home computers. One question referred to educational uses whilst the other referred to non-educational uses. Responses were coded on a four-point scale (less than once a week, once a week, two to three times a week, every day).

Part (b) comprised questions concerning on-line educational uses, i.e. different uses of the internet for educational purposes and offline educational uses. Online uses comprised revising for exams/tests, using on-line libraries, downloading educational material, searching for information, using on-line discussion groups/bulletin boards, tracking information, and any other on-line uses. Offline uses comprised using spreadsheets/databases, using presentation software, using word processing and any other offline software use. Eleven questions asked whether or not the participant used each of the applications above (e.g. 'Do you download educational material for school/college work?'). Responses were coded as 'yes' or 'no'.

In part (c) of the interview, 11 questions queried the ease of use of each of the applications (e.g. 'Do you find downloading educational material hard/easy to use?'). Response options were coded on a four-point scale (very hard, hard, easy, and very easy).

In addition, there were open-ended questions relating to ease of use (querying why participants found a particular application hard) and to the specific types of software used (querying what other types of applications they used).

**Educational Computer Use Diary**

The Educational Computer Use Diary was devised to record the time (in minutes) that the adolescent spent using different educational applications during a typical week. This diary contained separate pages for each day of the week, a separate row on each page for time of day (morning, afternoon, and evening), and a separate column on each page for each application (internet use, spreadsheets and databases, presentation software, word processing, and any other educational use). There was a box at the bottom of each page for the participant to tick if he or she did not use the home computer that day.
Participants were required to write down how long they spent on the computer for each application at each time of the day (e.g. 15 min/30 min/1 h, etc.).

**Non-educational computer use measures: Interview and diary**
The non-ECUI comprised two parts. Part (a) queried the adolescents on the types of non-educational computer uses they engaged with. These included on-line uses (e.g. e-mail, MSN, browsing/surfing, and downloading music) as well as offline uses (e.g. offline game playing). Participants were asked whether or not they engaged in each of these activities.

In part (b), for comparison purposes, participants were interviewed further about three specific non-educational uses of computers involving computer-mediated communication (herein referred to as interpersonal uses, given their interactive nature): e-mail, MSN and chat rooms. Three questions concerned the ease of use of these applications. The coding scales used were identical to those employed for educational applications. Participants also filled in a diary and recorded the time (in minutes) spent using different interpersonal applications during a typical week. This booklet was identical to the educational diary except for the type of applications which, in this case, were send/receive an e-mail, use MSN, talk in a chat room, and any other interpersonal use.

**Procedure**
Participants were assessed and interviewed either at home or at school on the above measures, as part of a wider battery. Portions of the battery (i.e. some of the interviews) were carried out over the telephone for those adolescents for whom a further personal visit was not practical. Both diaries were either left with, or posted out to participants for them to complete and post back. Ethical approval for the study was gained from The University of Manchester. Informed written consent was gained from all participants.

**Results**

**Frequency of home computer use**
Responses to the two questions in part (a) of the educational uses interview yielded data on frequency of use. This was reported on a 1–4 scale, from ‘less than once a week’ to ‘everyday’ for both educational uses and non-educational uses. A mixed-design two (group: SLI vs. TD) by two (context: educational vs. non-educational) ANOVA, with the latter as a repeated measure, was applied to these data. This analysis yielded a main effect of context, $F(1, 125) = 15.98, p < .001, d = 0.44$. As expected, non-educational use ($M = 3.12, SD = 0.97$) was more frequent than educational use ($M = 2.69, SD = 1.00$). The main effect of group and the interaction were not significant.

**Types of educational use**
Different types of use of home computers for educational purposes (both on-line and offline) were investigated using the questions in part (b) of the educational uses interview (see Table 2). Associations between group (SLI vs. TD) and use were examined using Fisher's Exact tests. Adolescents with SLI were less likely to use their home computer to download educational material, to use on-line libraries, and to use
Table 2. Adolescents’ engagement with different types of computer use for educational purposes

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<tr>
<td><strong>Online</strong></td>
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<tr>
<td>Use internet to revise for exams</td>
<td>30</td>
<td>62.5</td>
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<tr>
<td>Use online library</td>
<td>3</td>
<td>6.3</td>
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<tr>
<td>Download educational material</td>
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<td>18.8</td>
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<tr>
<td>Search for information</td>
<td>45</td>
<td>93.7</td>
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<tr>
<td>Discussion groups/bulletin boards</td>
<td>3</td>
<td>6.3</td>
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<td>Track information</td>
<td>10</td>
<td>20.8</td>
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<tr>
<td>Other waysa</td>
<td>7</td>
<td>14.6</td>
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<tr>
<td><strong>Offline</strong></td>
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<tr>
<td>Spreadsheets/databases</td>
<td>21</td>
<td>42.9</td>
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<td>Presentation software</td>
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<td>Other softwareb</td>
<td>5</td>
<td>10.2</td>
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*a p < .05.

Examples include College Blackboard (online teaching aid allowing interaction with teachers and peers), Google Images.

Examples include Xara (design technology), Picture It, Encyclopaedia Britannica.

the Internet to revise for exams (all p values < .05). For offline uses, the groups revealed similar levels of use of word processing but use of spreadsheets/databases was significantly less common among adolescents with SLI. Presentational software and other software tended also to be less commonly used by adolescents with SLI.

Data on the weekly educational diaries were also examined. The diaries yielded quantitative data (in minutes) of the time the adolescents spent using different applications. Analyses revealed no significant differences between groups in computer time spent on educational applications. However, nearly one-third of adolescents with SLI reported that they did not use their computer for on-line educational applications in a typical week (30% as compared to 8% for TD adolescents, p = .025). A similar but less pronounced trend was found for offline educational uses (17 vs. 6%, p = .15).

**Types of non-educational use**

Table 3 presents the numbers of adolescents reporting different types of non-educational uses of home computers based on the questions in part (a) of the non-educational uses interview. These data revealed some interesting differences between groups. First, adolescents with SLI were less likely to use interactive facilities, such as e-mail and MSN (Fisher’s Exact, p < .001). Use of chat rooms was similar for both groups but only a small proportion engaged in this activity. Blogging, which is communicative but largely unidirectional, was also a low-frequency pursuit, though participants with SLI were strikingly less likely to use this option. Second, adolescents with SLI were less likely to use functional opportunities such as making purchases and downloading music. Third, the one use in which adolescents with SLI exceeded TD adolescents was playing games offline.
Data on the weekly interpersonal diaries revealed that virtually all adolescents from both groups engaged in interpersonal use during the week of the diary (SLI = 96% and TD = 98%). Examination of the time data in minutes revealed no significant difference between groups for computer time spent in interpersonal applications.

**Ease of computer use**

Responses to the ease of use questions for educational use [part (c) of the educational interview] and interpersonal use [part (b) of the non-educational interview] form the basis for analyses. Ease of use was scored 1 to 4 with increased ease of use. An [2 (group: SLI vs. TD) × 2 (context: educational vs. interpersonal)] ANOVA yielded two main effects. The main effect of group, $F(1, 96) = 6.13, p = .02$, Cohen’s $d = 0.5$, revealed that adolescents with SLI found applications generally less easy to use ($M = 3.17, SD = 0.38$) than did TD peers ($M = 3.35, SD = 0.32$). The main effect of context, $F(1, 96) = 28.98, p < .001$, Cohen’s $d = 0.63$, reflected the fact that participants found it less easy to use educational applications ($M = 3.14, SD = 0.45$) than interpersonal applications, ($M = 3.42, SD = 0.44$). However, the interaction was not significant, $F(1, 96) = 2.07, p = .15$.

In response to the open-ended questions, some adolescents with SLI gave reasons why they found it hard to use the various educational applications. There were two main types of explanation given, which were not mutually exclusive. First, there were issues related to the accessibility of the application. Adolescents with SLI found that the information provided was too technical, involved the use of too much text, and was difficult to understand. They also found it hard to identify relevant information and to navigate through different educational applications independently. In addition, they
expressed a need to be shown explicitly how to use them. Ten adolescents with SLI (18%) gave accessibility as a reason for finding educational applications difficult. Second, there were issues related to their psycholinguistic difficulties. Adolescents with SLI indicated that they found it hard to read, write and spell when using the applications. They also had difficulties remembering information, including how to use an application from one time to the next. Thirty adolescents with SLI (55%) cited psycholinguistic difficulties in explaining why they found education applications difficult to use.

What predicts frequency of computer use for educational purposes?
A hierarchical regression was conducted involving all participants. The outcome variable, frequency of educational use, was derived from interview data complemented by diary data which identified a proportion of non-users. This yielded a five-point scale ranging from no use (coded as zero) to everyday use (coded as four). In this analysis, PIQ was entered first. We expected that language/literacy abilities would impact on frequency of use. The four language and literacy measures were highly intercorrelated and so we created a composite variable which was the mean of all four measures ($\alpha = .94$). This language/literacy composite was entered at step two. At step three, perceived ease of use was entered. The regression model is presented in Table 4. The model was significant at step two and step three, $F(2, 109) = 7.19, p = .001$ and $F(3, 108) = 8.98, p < .001$, respectively. At step two, after controlling for the effect of PIQ, language/literacy contributed significantly to the frequency of computer use for educational applications, explaining 10% of the variance. At step three, ease of use contributed a further 8% of the variance over and above language/literacy. Thus, this model explained a total of 18% of the variance of frequency of educational use.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Unadjusted $R^2$</th>
<th>$\Delta R^2$</th>
<th>Adjusted $R^2$</th>
<th>$\hat{R}^2$</th>
<th>B</th>
<th>SE B</th>
<th>$\beta$</th>
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<tr>
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<td></td>
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<td>.008</td>
<td>0.346**</td>
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<tr>
<td>Step 3</td>
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<tr>
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<td>.009</td>
<td>-0.052</td>
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<tr>
<td>Language/literacy</td>
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<td></td>
<td></td>
<td></td>
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<td>.008</td>
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<tr>
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<td></td>
<td>0.836</td>
<td>.250</td>
<td>0.316**</td>
</tr>
</tbody>
</table>

* $p < .05$; ** $p = .001$.

The regression was then repeated adding group status (SLI vs. TD) as a last step. This model was significant, $F(4, 107) = 7.29, p < .001$, and contributed 1% of unique variance suggesting that the effects of the variables identified in the regression analyses (i.e. ease and language/literacy) may be different across groups. The potential moderating effect of group was examined in relation to the effect of ease on computer use uptake. Moderation analysis was carried out by following the procedure recommended by Baron and Kenny (1986) for a categorical moderator and a continuous independent variable. Separate regression analyses for each group, with frequency of
use as the dependent variable and ease of use as the independent variable, revealed a significant difference between the unstandardized regression coefficients, $z = 2.16$, $p < .05$ (Paternoster, Brame, Mazerolle, & Piquero, 1998). This suggests that group is a significant moderator in the relationship between ease of use and frequency of educational use. Analyses of simple slopes were conducted using the ModGraph programme (Jose, 2003). These revealed that ease of use was significantly associated with frequency of educational use for the adolescents with SLI, slope = 1.16, $t(108) = 4.11$, $p < .001$, but not for the TD adolescents, slope = .09, $t(108) = .20$, $p = .84$ (see Figure 1). Regression analyses for each of the groups separately confirmed this pattern of findings. Ease was the only significant predictor for adolescents with SLI, accounting for 19% of the variance. For TD adolescents, ease played no role; language/literacy was the only significant predictor accounting for 6% of the variance in frequency of educational use.

The next set of analyses examined the potential mediating role of ease in the relationship between language/literacy and frequency of educational use. For the TD group, ease of use was not significantly correlated with either frequency of use ($r = .03$) or language/literacy ($r = .11$). This meant that two of the conditions for examining mediation effects were not met. However, for the adolescents with SLI, mediation analysis was possible (MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002). Ease of use was significantly correlated with both frequency of use ($r = .47$) and language/literacy ($r = .30$). Analysis revealed a non-significant total effect of language/literacy on frequency of educational use, $\beta = 0.09$, $p > .05$. This was followed by a series of regression analyses (see Figure 2). A second regression revealed a significant relationship between language/literacy and ease of use (path a), $\beta = 0.30$, $p = .040$. A further regression model, with frequency of use as the dependent variable and both language/literacy and ease of use as predictors, revealed a significant relationship between ease of use and frequency of educational use (path b), $\beta = 0.49$, $p = .001$. In addition, the direct effect of language/literacy on frequency of use (path c, controlling for ease) was found to be non-significant, $\beta = -0.06$, $p > .05$. This direct effect (path c') was also found to be smaller than the total effect reported above, suggesting a partial mediation effect.

![Figure 1. Moderation of frequency of educational computer use.](image-url)
The indirect effect of language/literacy on frequency of educational use through ease of use was found to be 0.15 ($a \times b = 0.30 \times 0.49$). A Sobel test indicated that the mediation effect was marginally significant, $z = 1.74, p = .08$. However, it has been argued that the Sobel test is conservative and that bootstrap analysis (Shrout & Bolger, 2002) is more appropriate with smaller sample (Preacher & Hayes, 2004). AMOS 7.0 was used to test results based on 2000 bootstrap samples. This analysis indicated that the indirect effect of language/literacy on frequency of use was significant, $p = .015$; 95% confidence intervals ranged from .03 to .32. Therefore, the mediation analysis suggests that the relationship between language/literacy and frequency of educational use was partially and significantly mediated by ease of use for the adolescents with SLI only.

Discussion

To the authors’ knowledge, this is the first study to investigate uses of the home computer by adolescents with SLI. The findings indicate that there are some similarities but also some important differences between the ways in which these young people experience and exploit the computer medium and the ways in which it is used by TD peers.

Note first that access to home computers was essentially identical between groups. We expected to find that both groups of participants would demonstrate a preference for non-educational uses of home computers (Subrahmanyan et al., 2001). This was confirmed. On average, adolescents used their home computers once a week for educational purposes but two to three times per week for interpersonal activities. Both adolescents with SLI and their TD peers not only used home computers more frequently for interpersonal than educational purposes but they found interpersonal applications easier to engage with. Virtually all participants used their computer to engage in interpersonal activities. These findings were consistent across the interview and diary methods used.

We expected to find that participants with SLI would show a greater discrepancy than would TD participants between educational and non-educational uses. While an
overall main effect for context of use was obtained, the absence of an interaction effect
does not confirm the expectation of a more marked difference within the SLI group in
this respect. However, a significantly larger proportion of adolescents with SLI did not
use educational applications in a typical week (nearly one-third for SLI vs. only 8% for
TD). Furthermore, comparing frequency of use of different types of computer
applications across groups revealed some interesting consistent differences.
Adolescents with SLI used several applications less often. This was the case for a
number of on-line and offline educational applications (downloading educational
materials, using on-line libraries, using the Internet to revise for exams, using
spreadsheets/databases and using presentational software). In terms of non-educational
applications the observed pattern was similar but also more mixed. Adolescents with
SLI used some facilities less often, ranging from computer-mediated communication
e.g. MSN) to functional activities (e.g. downloading music). These data indicate that a
considerable proportion of adolescents with SLI have little engagement with
educational applications at home.

Given the language and other information-processing difficulties associated with SLI,
we expected that these participants would find it less easy to use computers. This was
supported and provides further evidence of the broader ramifications of SLI in
adolescence (Conti-Ramsden & Durkin, 2008; Durkin & Conti-Ramsden, 2007), this time
in the area of new media use. The implications of how easy participants find a particular
type of use are different between adolescents with SLI and TD adolescents. Regression
analyses showed that ease of use contributed to the prediction of frequency of
educational use. However, as predicted, this was moderated by group. Follow up
analyses showed that perceived ease of use was associated with frequency of use only
for the adolescents with SLI and that, in this group, the effect of language/literacy on
frequency of use was partially mediated by perceived ease of use. These findings suggest
that, in an area of home computer use which young people in general tend to find
harder, adolescents with SLI were likely to elect to engage less frequently as a function
of perceived ease of use. The participants' open-ended comments on what they
found difficult are consistent with this interpretation. They reported that
they found information too technical, too text-bound, and difficult to comprehend.
They mentioned difficulties with reading, writing and spelling; they found navigation
through different applications problematic in addition to remembering information
across different times of use. Several expressed a need to be shown explicitly how to use
features. Previous research indicates that not all young users of home computers receive
guidance on how to do so, and often instruction is limited to illustration of how to get
started (Downes, 1996; Livingstone & Bober, 2003).

One use of home computers in which we found some evidence that adolescents
with SLI exceeded TD adolescents was playing offline games. As might be expected, this
was a popular activity with both groups but, while 74% of the TD adolescents reported
this use, 88% of adolescents with SLI did. Because game play was not a central focus of
this study, we did not collect more detailed data on the frequency of use or types
of games played. However, the findings suggest questions for future research.
The relationship between game play and adolescent development is complex, and much
depends on the types of games played and the frequency (Durkin, 2006; Shaffer & Gee,
2007). Note that there was no difference in the proportion of individuals in each group
who played on-line games (approximately 66%). The greater interest in offline games
among adolescents with SLI might reflect preferences for less challenging and less time-
pressed formats, or it may reflect 'default' uses of the home computer given less
interest in use for educational purposes. A positive implication, however, is that the majority of adolescents with SLI do report playing games on their computers and thus are prepared to use the medium if the purposes are sufficiently attractive.

We want to emphasize, the influence of language and literacy in adolescent outcomes in SLI. Evidence is beginning to emerge to suggest that those young people with SLI who have difficulties with literacy are more at risk of poor outcomes than those who do not. Tomblin, Zhang, Buckwalter and Catts (2000), for example, found that risk for behavioural difficulties was greater in those children with SLI who also had developed reading difficulties by second grade. In the same vein, it is now being suggested that the combination of language and literacy difficulties observed in approximately half the children with SLI can result in increasingly detrimental effects in development (Bishop & Snowling 2004; Catts, Fey, Tomblin, & Zhang, 2002; Conti-Ramsden & Durkin, 2008) and that reading difficulties, i.e. dyslexia, may be a less severe form of SLI (Snowling, Bishop, & Stothard, 2000). In this study, we found that language and literacy skills appear to be associated with frequency of educational use. We suggest that language difficulties in childhood and the development of associated literacy difficulties in adolescence contribute at least partly to the poorer level of educational technological engagement achieved in adolescence by young people with a history of SLI.

In contrast, interpersonal computer use in adolescents with SLI was very similar to those of their TD peers. Virtually, all adolescents with SLI regularly engaged in interpersonal uses of new media. The informal nature of interpersonal computer use may have provided a more accommodating medium for these young people in the face of the social and information-processing limitations often exhibited in SLI. Nonetheless, use was somewhat restricted for adolescents with SLI. They were less likely to engage with the full range of interpersonal activities examined in this study. They also found applications less easy to use generally when compared to their TD peers. What remains to be investigated in more detail are potential explanatory factors, including psychosocial factors, that may influence interpersonal computer uses as well as specific characteristics of certain facilities, e.g. e-mail, and how these may present particular challenges or opportunities to young people with a history of SLI.

The findings have practical implications for developmental and educational interventions with young people with SLI. It is important to underline that nearly one third of adolescents with SLI were non-users of educational applications and thus may be missing out on the potential benefits of educational technology in enhancing their learning. The challenge therefore is not only to make educational applications more accessible and easier to use for young people with language impairments but also to support those young people who are yet to become users of educational computer applications at home. Continual improvements in the design of new media are likely to contribute towards tackling issues associated with ease of use (Hasselbring & Glasser, 2000), though the rapid nature of developments within these media, together with the competing pressures to develop applications that challenge users, mean that young people with SLI, and other special needs, will be at risk of lagging behind in the adoption of innovations unless careful attention is paid to the relationship between their abilities and their patterns of use.

Investigating difficulties associated with atypical development also serves to illuminate competencies that underlie the uses of media by TD young people. Language ability is somewhat ‘transparent’ in typical adolescents. It can be assumed to be advanced and available, and hence its contributions to everyday tasks are easily overlooked. The present findings indicate that those who have language within the
typical range are more likely to take up educational applications of home computers and this underscores the fact that language is one of the intellectual abilities drawn upon on in media use. Indeed, among the TD participants themselves, language/literacy ability contributed 6% of the variance in frequency of use, suggesting that within the typical range individual differences bear on the ways in which people engage with new media. Importantly, the new media are not simply experiences which ‘happen to’ young consumers; processing is dependent on the motivations, choices and abilities of the user.

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