

The impact of aphasia on Internet and technology use

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Declaration of Interest

The authors report no conflicts of interest.

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Abstract

Purpose: This study compared Internet use post-stroke in people with aphasia (n = 25) and without aphasia (n = 17). The purpose was to understand how people with aphasia were using the Internet and to investigate the impact of aphasia on their use.

Materials and methods: A face-to-face supported questionnaire explored use of technologies, types of Internet use, traditional and Internet communication, perception of abilities, and possible barriers to acquiring or improving Internet skills. Descriptive and inferential statistics were used to analyse the data.

Results: Internet use ranged from fully independent to by proxy across both groups. Most participants perceived their aphasia as a barrier, but for the majority it was not the sole reason for failing to acquire or improve skills. Aphasia was related to difficulties with technology-based written communication. Educational attainment was related to participant's feelings about their own skills. Whilst aphasia was important, analysis revealed that age was a stronger predictor of Internet use per se.

Conclusions: It is clear that aphasia often negatively affects Internet use and proficiency.

However, this research clearly demonstrates that it is important to consider the influence of factors such as age, proxy use, education, and previous technology use and experience.

Keywords: digital exclusion, aphasia, stroke, accessibility, Internet

Introduction

The Internet and other technologies have become part of people's everyday lives, and many digital devices are now used within communication. However, people with aphasia (acquired language and communication impairment after stroke or brain injury) may find aspects of Internet use linguistically and cognitively demanding¹⁻⁴. Access to information is a priority area of need post-stroke⁵. The Internet is a valuable resource for meeting information needs on health as well as many other areas. Those who are not able to tap into the benefits of such a wealth of information are more likely to experience disadvantage⁶. Studies on supporting people with aphasia to use the Internet are positive about the benefits of improving Internet-related skills for social engagement and inclusion^{7,8}. The wider view is that using digital technologies and the Internet are of benefit to individuals and society⁹⁻¹³. Whilst the benefits of interventions to support aspects of Internet use for people with aphasia can be seen in several studies, e.g., 7,8,14,15, there is limited knowledge on how people with aphasia currently use the Internet, including which aspects they find difficult, or the impact of factors external to aphasia. This knowledge is needed to guide the design and evaluation of interventions as part of an holistic approach to rehabilitation and to inform long-term support services for people with aphasia.

Previous studies investigating computer and Internet use amongst people with aphasia have provided insight into aspects such as the popularity of various activities, dependence on support, and types of devices and software used^{16,17}. Mobile computing technologies (e.g., smartphones, tablets) have been mooted as having advantages for people with aphasia¹⁸ and provision of language therapy via computers or using telepractice is an area with a growing evidence base¹⁹⁻²². However, in aphasia research there has been a focus on patterns of computer rather than

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Internet use and a limited range of Internet activities investigated. Despite communication being the single most common use of the Internet²³, there is currently limited insight into the impact of aphasia on a person's ability to participate in everyday communication or activities online. As aphasia is a disorder of communication, it is of great importance to explore its impact on online interactions as well as those carried out face-to-face.

Older adults without aphasia and adults with other disabilities may also have poor knowledge or skills of the Internet, and may also be at increased risk of inadequacy of skills or knowledge to enable equality of access to the Internet or Internet-based services. This type of disadvantage is frequently defined in social science research as '*digital exclusion*'²⁴. Many older adults have access to a proxy who uses the Internet on their behalf²⁵. Therefore, independence may not always be the ultimate or realistic goal for people with aphasia, and many may be satisfied with achieving success while supported by others²⁶. For these reasons, it is important to consider the impact of aphasia alongside a range of other factors which may influence engagement with the Internet and technology.

In 2010, Elman and Larsen¹⁶ described how they examined computer ownership and use and the frequency of a selection of computer/Internet activities using a supported questionnaire with 33 people with aphasia. They concluded that although Internet activities had decreased post-stroke for people with aphasia, this was not due to lack of interest but related to the inaccessibility of support with using computers. They recommended that tailored training programmes should be available to prevent exclusion of people with aphasia from using computers and the Internet. Finch and Hill¹⁷ conducted a postal survey with 34 people with aphasia, about computer and Internet use. They predominantly focused on participants' views on using computers for

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rehabilitation of speech and language skills. Their study also examined what people with aphasia thought about computers as part of their daily lives. Most of the respondents did use computers (84%) but most also reported they would require assistance with setting up a computer and with using specific language therapy software. Use of computers was common for a variety of tasks pre-aphasia, with work and emailing the most popular activities. Following aphasia onset, computer use for daily activities became less frequent and patterns of use changed with more of a focus on therapy and entertainment purposes. Gustavsson et al.²⁷ consulted 18 Swedish and Danish people following stroke in focus groups about their information and communication technology (ICT) use and found enthusiasm for the use of ICT as a tool to increase participation and independence. Participants in the study reported they felt technology continued to be a necessity for them to maintain reassuring social connections with others. They also reported other stroke related barriers, describing difficulties with fine motor skills, memory, perception, and speech.

The above studies demonstrate that people with and without aphasia post-stroke continue to use computers, both within therapy and for everyday social participation. Elman and Larsen's¹⁶ results are unlikely to reflect the detail of current types of Internet use, given the phenomenal developments in digital technology, mobile devices, and social media over the past decade^{25,28,29}. Finch and Hill's survey was adapted to provide some support for people with reading difficulties to access their written postal questionnaire and participants could complete the survey with the support of a family member or friend. In the latter case, the influence of proxy respondents should be considered^{30,31}. There may also have been individuals without access to support who were unable to complete the questionnaire, potentially excluding a group of respondents who

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lived alone or had reading and writing difficulties. Finally, Gustavsson et al.'s qualitative study provides useful insight into the role of ICT post-stroke and to the impact of stroke on previous ICT use. Participants self-rated their communication skills on the Stroke Impact Scale³² and the majority indicated at least slight difficulties with communication. However, the study did not give any specific information as to the nature or severity of any communication difficulties, which could have included dysarthria or apraxia of speech. They also did not ask participants to specify whether any difficulties with ICT were due to their communication difficulties.

Whilst the literature to date provided some insights into specific aspects of engagement with computers and the Internet post-stroke and aphasia, there is a need to investigate in detail the impact of aphasia as a discrete factor on Internet use. Barriers to Internet use are considered multifactorial and are evident in healthy older adults^{25,28,33,34}. Therefore, it is important to investigate possible demographic influences as well as self-perceived barriers to acquiring or improving Internet skills. In addition, there are other possible influential factors related to a major health event^{35,36}, e.g., stroke-related disabilities. Finally, it is important that this is considered with people with a range of aphasia severities since the ability to access and use the many benefits of the Internet is now deemed a universal human right³⁷.

Aiming to examine these issues, this study investigated the technology use and Internet skills of two groups of individuals. All had experienced a stroke, but some presented with aphasia and others did not. This allowed aphasia to be considered specifically, but alongside other variables shared across the two groups, including age and level of education. Critically, all members of the sample had experienced a stroke and with it the possibility of long-term disability with potential

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impact on their daily lives. As stroke is more prevalent in older adults³⁸, the sample was likely to be older. A demographically older sample increased the likelihood that some participants would have age-related difficulties with Internet use^{33,39}. Drawing on detailed comparison of these two groups, the study set out to answer the following research questions:

- 1) How do people with aphasia use the Internet?
- 2) What types of difficulties with Internet use can be attributed to aphasia?
- 3) What other factors might contribute to ability to use the Internet with aphasia?

Methods

Participants

Forty-five people were referred to the project via stroke review clinics, Speech and Language Therapists, and stroke support groups in the North East of England. Inclusion criteria stipulated that all should be more than six months post-stroke, native speakers of English, able to give informed consent, and not have any other neurological or psychological conditions. Three were excluded on initial contact due to being unable to consent, not meeting the inclusion criteria on time post-onset, and undiagnosed aphasia presentation in a participant consented into the 'no aphasia' group. Twenty-five people presented with chronic post-stroke aphasia of a range of severities and 17 had had a stroke but did not have aphasia. Participants with aphasia had been either diagnosed by the referring SLT or were attending aphasia support groups. Severity of aphasia was measured using the severity scale from the Boston Diagnostic Aphasia Examination⁴⁰ (based on examiner [i.e., first author] observations during interaction with each participant). To facilitate recruitment of a diverse sample, information leaflets about the research

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were designed to convey that the study was interested in all people post-stroke, regardless of whether they were familiar with or used the Internet.

Data collection

All participants were seen in person (one-to-one session with the first author) and were asked a range of questions about their Internet and technology use. The questionnaire was designed and presented to be as easy to understand as possible, informed by research and guidelines on written information materials for aphasia⁴¹⁻⁴³. An initial version of the questionnaire was also trialed with a member of the Newcastle Aphasia Research User Group⁴⁴, who provided feedback on the clarity of supportive materials. Consequently, the questionnaire comprised clearly written versions of questions with key words highlighted and simple pictures illustrating each question. They were each read aloud by the researcher and repeated or explained further as needed. Possible responses were provided in pictorial and written form, and the researcher again read each one aloud. This was to ensure that verbal responses were not necessary to provide a response. When questions required either a yes/no answer or response on a Likert scale, participants were given clear visual representations of choices. To ensure consistency, these resources were presented to all participants regardless of whether they had aphasia or not. If relatives or friends were present, they were asked not to contribute. The wording of items and options provided within the questionnaire is provided in the supplementary material. When detail within the text below refers to an aspect of the questionnaire, this is denoted by a subscript alphanumerical code referring to the corresponding section of the questionnaire provided in the supplementary material.

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Initially, each participant provided demographic information on their age, gender, and highest level of education. Subsequent questions were informed by the Oxford Internet Institute's surveys of the UK population^{23,25,28}, thereby capturing areas relevant to current Internet use. They were selected to cover a broad range of Internet and technology use. As this study recruited participants who could be Internet users or not, to ensure relevance of questions, all participants were asked an initial question about whether they used the Internet. There were then two versions of the questionnaire (available in supplementary material). Subscript alphanumerical codes within this part and the results section refer to specific questions within each questionnaire.

Those who responded they used the Internet (Internet users) were given questionnaire A (14 questions) and those who said they did not use the Internet (Internet non-users) were given questionnaire B (ten questions). This initial division of participants enabled: (1) direct comparisons of the demographics of sub-groups (those with and without aphasia and those who were users/non-users); and (2) analysis of possible predictors for Internet use. All participants were asked about their means of communication with others to facilitate comparison between online and more traditional means (e.g., use of email and social networking compared with writing or visiting). All participants were also asked to rate their frequency of contact with others on a five-point visual scale from less than monthly to several times a day. Questionnaire B (for non-users) asked three specific questions for that sub-group on whether the person had used the Internet in the past, if they wanted to use it in the future_{B1}, and whether anyone used the Internet on their behalf_{B4-5}. Questionnaire A (for Internet users) contained seven questions relating to the specifics of participants' computer use and Internet activities_{SA1-4, A10-18}. These questions related to where the Internet was used (at home or elsewhere), how it was accessed,

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how participants rated their own skills, whether they used any accessibility tools, what type of information they sought online, the types of websites they accessed, and whether they needed support to do so. One question aimed at identifying barriers to Internet use was worded slightly differently in questionnaire A (which referred to barriers to improving skills) and questionnaire B (which referred to barriers to acquiring skills). Dutton et al.^{23,28} reported a list of barriers to internet use and these were included as possible responses. One of these possible barriers was a broad category of health/physical problems. As this questionnaire was particularly focused on the role of aphasia on Internet use, participants with aphasia were given an additional option of ‘aphasia’ amongst the list of barriers. For those without aphasia, ‘aphasia’ was not one of the possible choices but was replaced with ‘stroke’ to cover other possible consequences of their stroke.

Data Analyses

Descriptive statistics were used to compare Internet users regarding the location and means of their Internet access, their Internet skills and activities, and their use of accessibility tools. Cross-tabulated comparisons and t-tests were conducted to identify any significant differences between sub-groups on responses to the majority of questions. For questions using rating scales, comparisons were carried out using non-parametric Mann-Whitney U or Kruskal Wallis tests. Spearman’s rank correlation was used to compare popularity of types of Internet activity. As the questionnaire also provided some data on variables that might predict whether a person used the internet, a post-hoc binomial regression was carried out to examine which factors were most likely to predict Internet use/non-use. The variables age, gender, educational level, and presence or absence of aphasia were entered into the model informed by existing literature on digital exclusion and Internet use^{25,34,45,46}. Due to the small sample sizes, all independent

variables were entered into the regression simultaneously. This allowed each independent variable to be considered in terms of its unique contribution to the dependent variable⁴⁷. Because of the exploratory nature of the study, the alpha level for all statistical calculations is the conventional .05.

Results

Demographic information about age, gender and educational level (school, 16+, or university) is shown in table 1. [table 1 near here]. Within the people with aphasia group, there was a range of severities with representation of people with mild to severe difficulties. Distribution of aphasia severity can be seen in table 2. [table 2 near here]. There were no significant differences between the ages of participants with and without aphasia ($t[40] = -0.247, p = 0.806$). There were also no significant differences between gender ($\chi^2[1] = 0.494, p = 0.482$) and levels of education ($\chi^2[2] = 0.601, p = 0.741$). The numbers of people with and without aphasia who said they did and did not use the Internet are presented in table 3. [table 3 here]. There were no significant demographic differences between people with and without aphasia who used the Internet (age: $t[12.397] = -1.221, p = 0.245$), gender: $\chi^2[1] = 0.027, p = 0.87$), and educational level: $\chi^2[2] = 0.169, p = 0.681$). The same was true when comparing people with and without aphasia who did not use the Internet (age: $t[18] = -0.08, p = 0.937$, gender: $\chi^2[1] = 1.056, p = 0.304$), and educational level: $\chi^2[1] = 0.204, p = 0.651$). Participants without aphasia who did and did not use the Internet did not have significant differences in terms of: age, $t[15] = -1.54, p = 0.144$, gender: $\chi^2[1] = 0.284, p = 0.594$, and educational level: $\chi^2[2] = 0.70, p = 0.403$. Amongst the participants with aphasia, Internet users were similar in age ($t[23] = -2.05, p = 0.052$) and gender ($\chi^2[1] = 0.667, p = 0.414$) to those who did not use the Internet. Internet users with aphasia had a higher levels of education than non-users with aphasia ($\chi^2[1] = 4.056, p = 0.044$).

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Use of everyday technologies (all participants) A5, B2

Table 4 presents the participants' use of everyday technologies with percentage comparisons between people with and without aphasia. The two groups used similar technologies, with a preference for older style devices like digital televisions or cameras over smartphones and tablets. People with aphasia had significantly less use of both e-readers (Fisher's exact, $p = 0.029$) and digital cameras (Fisher's exact, $p = 0.029$). [table 4 here]

The Internet for communication (all participants) A19 - 20, B9 - 10

Table 4 also presents the responses from the questions on means of communication with others alongside percentage comparisons. There were significant differences regarding the use of email ($\chi^2 [1] = 3.990$, $p = 0.047$) and text messaging ($\chi^2 [1] = 6.959$, $p = 0.010$) with people with aphasia using these methods less than those without aphasia. There were no significant differences in other forms of communication between the two groups. To consider whether presence of aphasia might influence use of the Internet for everyday interaction with others, participants were also asked to rate the amount of contact they had with others on a five-point scale. An independent samples Mann-Whitney U test on this data from the entire sample demonstrated that people with aphasia reported significantly less contact with others than those without aphasia ($p = 0.022$). There was no significant difference in amount of reported contact with others between Internet users and non-users ($p = 0.865$).

Barriers to acquiring or improving Internet skills (all participants) A4, B3

Figure 1 illustrates the most commonly perceived barriers to acquiring Internet skills selected by those who said they did not use the Internet or had used it in the past. Responses from Internet users on barriers to improving skills are presented in figure 2. This information is presented in

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separate graphs for clarity as the two groups differed in number. [figures 1 and 2 here]. Four participants did not answer this question because they did not feel their existing skills needed improvement ($n = 3$), or they did not choose to respond ($n = 1$). The mean number of barriers chosen by people with aphasia was higher than the mean number of barriers chosen by people without aphasia (2.2 vs. 1.6); however, this difference was not statistically significant ($t[40] = 1.74, p = 0.089$). There was a significant difference between the mean number of barriers chosen by those who said they were Internet users (1.5) and those who said they were not (2.5) ($t[40] = -2.1, p = 0.006$). Sixteen of the 25 participants with aphasia (9/15 non-users and 7/10 users) said their aphasia was a barrier to improving or acquiring skills. A Mann-Whitney U test showed those who said aphasia was a barrier were significantly more impaired on the Boston scale than those who did not select aphasia as a barrier ($p = 0.003$). The mean age of those who felt age was a barrier was 78, while the mean age of those who did not was 68. This represented a significant difference ($t[35] = 2.912, p = 0.015$). None of the participants without aphasia selected the 'stroke' option as a barrier to acquiring or improving Internet skills. Amongst the non-users, five people with aphasia chose the category of health/physical problems as a barrier whilst none of the people without aphasia reported health or physical problems to be a barrier. Amongst the Internet users, four people with aphasia and three people without aphasia selected health/physical problems as a barrier to improving skills.

Supported use (all participants) A17-18, B4-5

Internet users with and without aphasia reported many activities were carried out independently. However, participants in both groups also reported needing some form of help. Figure 3 illustrates the breakdown of independent and supported Internet use by people with and without aphasia for activities where at least one participant reported requiring support. Statistical

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comparisons were carried out to determine between-group differences in terms of receiving help with each activity; there were no significant differences. This included linguistically demanding tasks like sending emails (Fisher's exact, $p = 0.633$), shopping online (Fisher's exact, $p = 1$), and online banking (Fisher's exact, $p = 1$). [figure 3 here] Of the 20 non-users, one participant's responses to the question on proxy use were excluded because the participant became upset and frustrated while attempting to produce a response. Seven out of 14 people with aphasia (50%) and four out of five without aphasia (80%) said that someone did help them with the Internet or carried out activities on their behalf.

Seeking information (all participants) A7-9, A10-16, B6-8

Table 5 presents the results of questions on how participants' sought information on the areas of travel and health with no response denoted as NR. [table 5 here]. There was a preference in both groups for asking others as a first source of information rather than using the Internet or the phone. No participants reported looking for information in books. One person who did not respond for the health category stated they had worked in a health profession and felt they already had adequate information. Those who did not respond to the travel/holiday question reported their health no longer permitted them to go on holiday. For both groups, the Internet was used more as a source of information for travel/holidays than for health. The most commonly sought types information (of the eight areas covered) were news and travel, followed by local events, health, sports, funnies, jobs, and volunteering.

Location and means of Internet access (Internet users only) A1-2

There were 22 Internet users, representing 52% of the entire group. This comprised 10 people with aphasia and 12 without aphasia. As the numbers here were not sufficient for pairwise

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comparisons, only descriptive statistics are presented within this section. Table 6 shows the locations where participants reported they used the Internet and the types of devices used. [table 6 here] All those without aphasia and all but one of the participants with aphasia had the Internet at home. There was a small amount of use in other locations, the greatest being in the home of family members or friends. Three people with aphasia reported going online at a library and two at an aphasia support group. Many participants used more than one device to go online, including home-based and mobile devices.

Internet skills and activities (Internet users only) A3, A17-18

Mean self-ratings of Internet skills for all Internet users broken down by group are presented in table 7. There were no significant difference between self-rated skills for people with and without aphasia (Mann-Whitney U, $p = 0.872$). There were also no differences between the self-rated skills of men and women (Mann-Whitney U, $p = 0.837$) or between those under and over 65 (Mann-Whitney U, $p = 0.164$). There were significant differences between the mean self-rating of Internet skills between people who had different levels of education, with people with higher levels of education feeling more positive about their own Internet abilities (Kruskal-Wallis, $p = 0.027$). [table 7 here]

The most popular activities for people with aphasia (in order of frequency) were: watching TV/films, sending emails, comparing products/prices, buying something online, and Facebook. Most popular for people without aphasia were: sending emails, playing games, Facebook, watching TV/films, and comparing products/prices. Least popular activities for people with aphasia were: discussion groups/forums, religious websites, Twitter, betting or gambling, and blogging. For people without aphasia the least popular activities were: information on the government, betting or gambling, Twitter, discussion groups/forums, and blogging. Comparing

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the two lists of 20 activities between people with and without aphasia using Spearman's rank correlation ordered by mean popularity indicated a very strong similarity of types of Internet use ($\rho_s [18] = 0.835, p = 0.0001$).

Accessibility tools (Internet users only) A6

Four Internet users with aphasia and three Internet users without aphasia reported using adaptations or strategies to access computers. For the people with aphasia, this consisted of two persons using touchscreens, and one accessing communication aid software which integrated with email on a tablet device. A fourth participant had learned how to adapt settings to avoid two-handed use of 'ctrl-alt-delete' function on their keyboard. The three participants without aphasia who reported using adaptations or support were using word prediction to speed up typing, a stylus to compensate for sensory problems in hands, and adjustment of brightness settings to compensate for post-stroke visual sensitivity.

Predictors of Internet use

The binomial regression model was statistically significant, $\chi^2 [5] = 13.771, p = 0.017$. The model attained 76.2% group classification accuracy. The Nagelkerke R square coefficient of .373 suggested that this model explained 37% of the variance in the data. In terms of individual variables that made significant contributions to the model, age was a significant variable regarding whether a person used the Internet or not ($p = 0.045$), presence of aphasia was not significant ($p = 0.055$), and gender was not significant ($p = 0.798$). Educational level was also not a significant predictor for Internet use ($p = 0.204$).

Discussion

This study examined the extent to which aphasia, as a discrete factor, impacts on Internet use in the presence of other potential barriers. The results indicated that the expected risk of digital exclusion for most people with aphasia appeared to stem not only from their aphasia, but from a combination of factors. Although aphasia may have a considerable influence, other factors are likely to contribute. This makes people with aphasia a complex population with whom to achieve digital inclusion.

Recruitment of a sample of participants who were very similar except for the presence or absence of aphasia enabled direct consideration of the role of aphasia. The comparison revealed many similarities between the two groups. There were no differences regarding location and means of access to the Internet. There were also people who defined themselves as Internet users and as non-users both with and without aphasia. While both people with and without aphasia were using the Internet independently, some required support from others and some reported having no access to support. There was no clear distinction between ‘users’ and ‘non-users’ with some participants (both with and without aphasia) who said they did not use the Internet doing so via a proxy.

Digital exclusion of people with aphasia

There were several differences between people with and without aphasia that point to people with aphasia being at increased risk of digital exclusion. People with aphasia were less likely to communicate using email and text messaging. These differences could reflect the difficulties people with aphasia may experience in reading and/or writing. The majority of participants (both with and without aphasia) reported visiting others or using the telephone over online means of communication. This finding is of interest given research that warns of social isolation of people

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with aphasia⁴⁸ and could be interpreted as a lack of need to use online communication in favour of more traditional forms of interaction. However, there was also significant difference in the amount of contact people with aphasia had with others in comparison with their non-aphasic peers. Therefore, the findings can be interpreted as an example of greater social exclusion of people with aphasia⁴⁹ post-stroke, with exclusion even in digital environments.

The regression analysis showed that age had a greater influence than aphasia on whether someone used the Internet after a stroke. However, the regression model explained only 37% of the variance. This suggests that other factors beyond those considered were likely to contribute to Internet use/non-use. Age UK¹² considered Internet use by older adults and found that factors contributing to digital exclusion in order of their influence were: age, income, household composition, self-perceived health status, sex, mobility, Asian ethnicity, and memory or self-rated ability to concentrate. Level of education was not predictive of digital exclusion. However, there were signs of the influence of education in the finding that non-users with aphasia had lower levels of education than those with aphasia who did use the Internet. Another finding was that in the entire sample, lower levels of education were associated with lower self-rating of Internet skills. The influence of educational level for the population of people with aphasia should, therefore, not be discounted. The above findings warrant further investigation and should raise awareness of the potential exclusion of those with aphasia who have lower levels of education.

The finding that aphasia is likely to be one of several contributory factors raises the need to identify ways to support people with Internet use which take into account both their aphasia and factors external to their aphasia. Motivation and circumstances vary amongst older adults and

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researchers have suggested that it is inadvisable to consider older people as a homogenous population³⁴. The present study confirms the heterogeneity of the post-stroke population regarding Internet use and skills. These insights demonstrate the need to be sensitive to differences, recognising that some may experience barriers in a different way than others. Aphasia diminishes language and communication skills required for access to computers and technology (e.g., understanding spoken audio content, taking part in video calls, reading or creating online content). However, there are also implications for aspects of computer use external to direct interaction with technology, e.g., choosing and buying equipment, understanding written instructions, or reporting problems when they occur⁴. The majority of participants with aphasia reported that their language difficulties were a barrier to either improving or acquiring Internet skills. This was in stark comparison to the finding that none of the participants without aphasia selected stroke as a barrier and fewer participants in the no aphasia group reported barriers related to the broader category of health or physical difficulty. However, there were also relatively few people who selected aphasia as the sole barrier to acquiring or improving Internet skills. This suggests that although aphasia may exist as the sole barrier for some, for the majority, there are multiple factors at work. An interesting finding was that those with more severe aphasia were more likely to list aphasia as a barrier to their Internet use. Despite this, there were people with severe aphasia in the study who were independent for many aspects of Internet use. Self-perception of disability may not always go hand in hand with ability or potential^{50,51}, and the characteristics of those with severe aphasia who experience success with digital technologies warrants further investigation. There is a need to explore the interaction of aphasia alongside other possible barriers. Further research should, therefore,

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involve greater collaboration between aphasia researchers and those working to lessen digital exclusion.

Age

Age emerged as a barrier, in both the regression analysis and in participants' perceptions of age as a barrier to improving or acquiring Internet skills. Age and its relationship to Internet use is discussed in detail in several other studies, including both barriers to Internet use and the experiences of older people when using technologies.^{33,34,52-54} Those who responded 'I'm too old' may hold the belief that ability to learn new skills are age related, and that once someone is older, it is not possible for them to learn how to use technologies. However, these beliefs are not necessarily justified. For example, Wandke et al.⁵⁵ discuss a number of commonly held myths surrounding older people's use of computers, e.g., that older people are not interested or that they believe computers to be useless or unnecessary. They highlight that there is growing evidence to suggest that 'myths' about older people and technology are overgeneralized, leading to a risk of a perpetuation of the belief that there is little that can be done to engage older people with technology. The results from this study also showed that those who defined themselves as Internet users reported fewer barriers to improving skills than those who did not perceive themselves as Internet users. This demonstrates that it is important to demonstrate to older adults (including those with aphasia) that engagement with technologies is possible. Some may assume that difficulties with Internet use for some sections of the population will disappear over time as the younger, more technologically able, generation become older. However, although technology is more integral for younger people, many aspects of ageing (e.g., declining sensory and cognitive skills) may still pose barriers for future generations⁵⁶.

Health and physical problems

Several participants selected the broader category of ‘health/physical problems’ when asked to identify barriers to improving Internet skills. The options provided did not clearly delineate between the categories of ‘stroke/aphasia’ and ‘health/physical problems’. This meant that it was difficult to make distinctions between stroke-related vs. other health issues or for subtlety of interpretation of the type of difficulty (e.g., hemiplegia, vision, memory, mental health). The exact nature of other health difficulties may clearly play a role. The more frequent choice of health and physical problems as a barrier chosen by people with aphasia may reflect that people experiencing aphasia post-stroke are likely to have more comorbid conditions³⁸. The need for more detailed explanation is vital in providing appropriate support, as there are a range of possible adaptations for different physical and cognitive difficulties⁵⁷. There was relatively little use of accessibility tools within both the groups, suggesting that knowledge of any adaptations to use technologies may have been poor for people with and without aphasia. Lack of knowledge in this area may mean that the post-stroke population is not being made aware of possible adaptations to support their use of computer. There are many options in this area for people with different physical and cognitive difficulties⁵⁷ and several adaptive technologies have also shown benefits for people with aphasia^{14,58-60}.

Confidence

Confidence in individuals’ own Internet skills was a common barrier chosen by people both with and without aphasia. Dutton et al.²⁵ also report lower levels of confidence in Internet skills amongst retired adults. The source of any lack of confidence is unclear, but perhaps likely to stem from different experiences and beliefs. Confidence may also relate to trust in technology. Blank and Dutton⁶¹ suggest that over time experience with computers and the Internet has made

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older people more trusting. This suggests that exposure to technology (e.g., as part of introductory training programmes) is likely to be of benefit for those lacking in confidence and experience. Dickinson et al.³⁹ reported on a group for older novice users of technology and found that building confidence took a considerable amount of time. In addition, mistakes could cause a decline in confidence and upset the progress learners had already made. These insights suggest that supporting people with aphasia who have poor confidence in their own Internet skills is likely to bring additional challenges. Kelly et al.⁸ report on the benefits of bespoke computer and Internet training for aphasia, as those taking part often needed individualised support. One finding from our study was that people with aphasia were less likely to use e-readers. This difference between the two groups is most likely linked to aphasia related difficulties with reading. The finding is a good example to illustrate possible issues with confidence and fear and a need for supported exposure to new technologies. E-readers offer features that could increase access to books for some people with aphasia⁶² yet fear of failure may influence individuals' willingness to try tech-based adaptations and support. However, confidence building over time within a supportive environment may be the key to facilitating more long-term adoption of supportive technologies.

The environment

Support with the Internet by a proxy was common within this sample and is reflected in wider research with older adults and people with disabilities²⁵. The majority of participants also relied on other people for information about their health, preferring this to seeking information online. Some may be happy with others carrying out activities and seeking information on their behalf, as demonstrated in work on traditional literacy skills of people with aphasia²⁶. However, others

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may wish for more independence but be unaware of how to attain that. It is important to bear in mind in the interpretation of the study results that this distinction was by no means clear.

Elman¹ suggests people with aphasia are likely to be in need of specialist support with the Internet, and Kelly et al.⁸ found that 1:1 or 1:2 support was needed for people with aphasia to achieve success in training. Menger et al.⁴ discuss potential environmental barriers, including the skills of those supporting a person with aphasia. The nature of support needed is worthy of further exploration, particularly regarding how people with aphasia experience being supported, and how those providing help feel about their role. Wider initiatives to support people at risk of exclusion with their Internet use are potentially inaccessible for people with aphasia and there are reports of successful Internet training programmes with tailored support for language difficulties^{7,8}. However, such training programmes are not universally available and still lack a comprehensive evidence base. Geographical factors were not considered in this study but may be important, particularly with regard to areas of social deprivation and urban vs. rural divides⁶³.

Limitations

This study was exploratory. Its main limitation is the small sample size. It was not possible to recruit the number of participants required to achieve greater power, in particular for the logistic regression. These findings should, therefore, be interpreted conservatively. Another limitation is that the study was carried out in the North East of England, an area with high levels of digital exclusion⁶⁴. This might have led to results presenting a skewed picture of Internet use and skills than might be seen elsewhere in the UK.

Conclusions

Whilst the study demonstrates that people with aphasia are likely to have many characteristics in common with other older or disabled users when it comes to using the Internet, aphasia acts as an isolated barrier for some people and as an additional factor amongst other influences for the majority of others. People with aphasia experience difficulties with technology-based communications such as email and messaging services, further increasing their risk of isolation. The study has several implications for aphasia rehabilitation. It demonstrates that needs of individuals with aphasia are likely to differ a great deal. Supporting people with aphasia to successfully engage with the Internet (in the way they want, if and when they want to) is an ongoing challenge for rehabilitation. To support people in this area, cross-disciplinary and agency collaboration may be needed, drawing on different expertise, including that of people with aphasia. The subject also raises issues for those working or volunteering in the third sector. Aphasia support organisations are, perhaps, more likely to provide help with computer and Internet skills to people living with aphasia as a long-term condition. It is important to consider whether people with aphasia are receiving the type of support with Internet and computer skills they need or want and whether third sector organisations feel they have the skills and resources to provide that support. At present, the evidence on how to best provide support for people with aphasia to use the Internet is lacking. Further research is needed to guide clinicians and third sector organisations in decision-making and service provision. The findings of this research provide useful information and, in future, could be supplemented by further qualitative investigations. Acknowledgement of the role of the Internet in people's lives is vital for the long-term rehabilitation of people with aphasia and particularly in enabling people with aphasia to live successfully with the condition, engaging in an ever more digital world.

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Tables

Table 1: Participant demographics

Group	Gender		Age			Education		
	Male	Female	Mean	Min	Max	School	16+	University
With aphasia (n=25)	15	10	68.9	38	90	16	5	4
Without aphasia (n=17)	12	5	69.8	56	82	9	5	3

Table 2: Distribution of aphasia severity

	severe		↔	mild	
Aphasia severity rating	1	2	3	4	5
Number of participants	9	6	3	4	3

Table 3: Number of participants in each sub-group

	Internet users	Internet non-users
With aphasia (n=25)	10	15
Without aphasia (n=17)	12	5
Totals	22	20

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*Table 4: Comparison of use of technologies and means of communication with others. * = significant difference.*

<i>Type of technology</i>	With aphasia (n = 25)		Without aphasia (n = 17)	
	No.	%	No.	%
Digital TV	24	96	15	88
Basic mobile	11	44	12	71
Laptop	10	40	9	53
Digital camera*	7	28	11	65
Smartphone	6	24	7	41
Tablet	6	24	8	47
Other technology	4	16	5	29
E-reader*	3	12	8	47
Games console	2	8	3	18
MP3 player	2	8	2	12
Webcam	2	8	4	24
<i>Means of communication</i>				
Phone	20	80	16	94
Visiting	19	76	9	53
Writing/sending cards	9	36	10	59
Email*	7	28	10	59
Text messaging*	6	25	11	65
Social Networks	4	16	6	35
Video calling	4	16	4	24
Other	1	4	4	24

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Table 5: Comparison of first source of information for health and travel/holidays. (NR = no response)

	Health				Travel/Holidays			
	Internet	Phone	Ask	NR	Internet	Phone	Ask	NR
With aphasia (n=25)	3	4	18	0	6	1	13	5
Without aphasia (n=17)	5	0	11	1	8	0	8	1

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Table 6: Location of Internet use and devices used to go online.

<i>Location</i>	With aphasia		Without aphasia	
	n (10)	%	n (12)	%
Home	9	90	12	100
Home of family or friend	4	40	5	42
Library	3	30	0	0
Support group	2	20	0	0
Work	2	20	1	8
Internet café	2	20	1	8
Other	2	20	2	17
<i>Device</i>				
desktop computer	7	70	6	50
mobile	7	70	4	33
laptop	7	70	9	75
tablet	6	60	7	58
e-reader	2	20	2	17
other	2	20	1	8

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Table 7: Mean self-rating of Internet skills by category (Internet users)

	All (n=22)		with aphasia (n=10)		without aphasia (n=12)	
	Mean	SD	Mean	SD	Mean	SD
Males	3.10	1.14	2.86	0.69	3.31	1.44
Females	3.14	1.21	3.67	1.15	2.75	1.26
School education	2.90	0.74	3	0	2.83	0.98
16+ education	2.50	1.38	2.33	0.58	2.67	2.08
University education	4.08	0.92	4	1	4.17	1.04
All	3.11	1.13	3.10	0.88	3.13	1.35

Figures

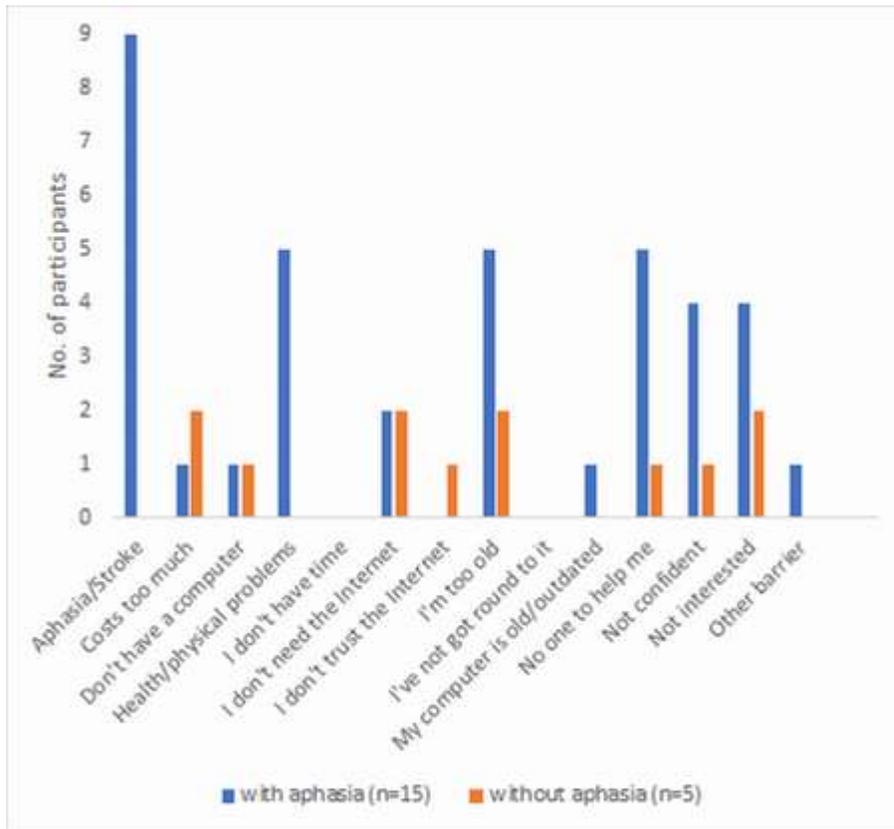


Figure 1: Barriers to acquiring or regaining Internet skills (Internet non-users only)

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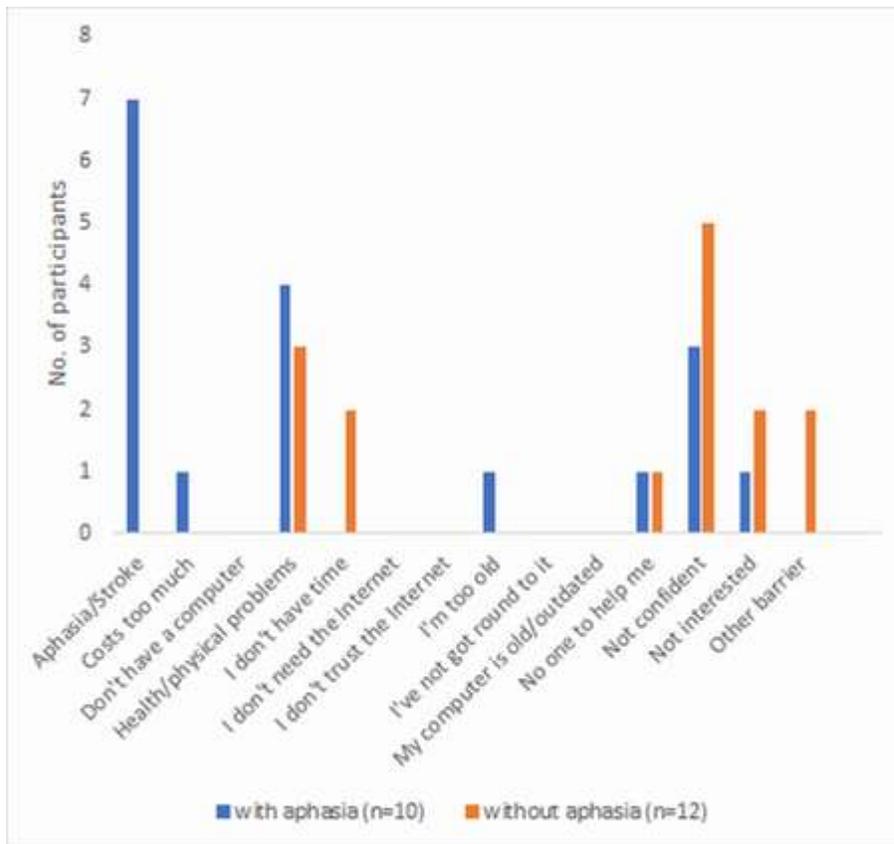


Figure 2: Barriers to acquiring or regaining Internet skills (Internet users only)

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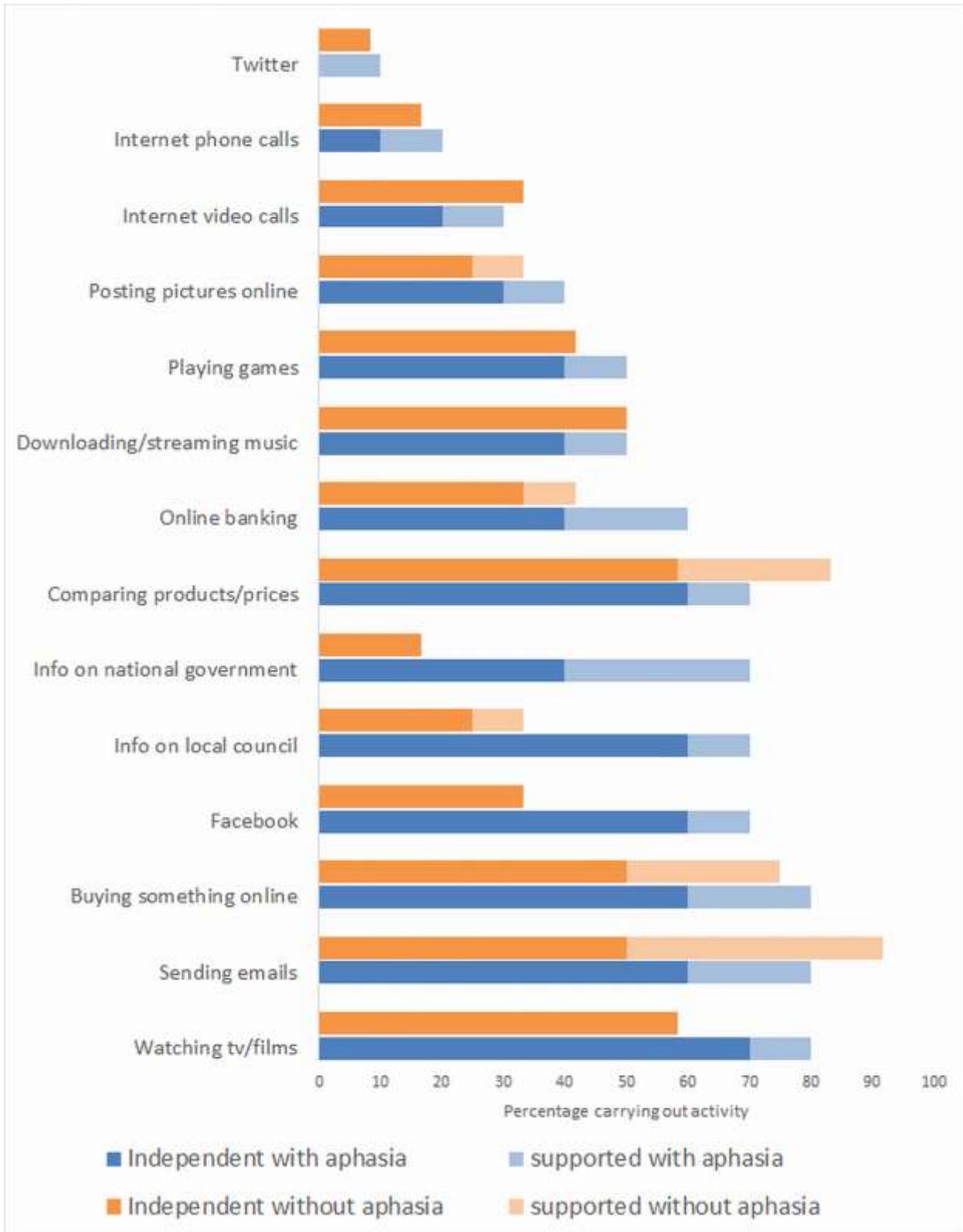


Figure 3: Independent and supported Internet use