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DISABILITY AND REHABILITATION: ASSISTIVE TECHNOLOGY
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RESEARCH ARTICLE

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Sustained use of compensatory technology following brain injury: experiences from Neumind users

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ABSTRACT

Assistive technology for cognition (ATC), particularly smartphone-based apps, can significantly enhance rehabilitation outcomes for individuals with acquired brain injury (ABI). Despite demonstrated efficacy, challenges persist in initial uptake and long-term engagement with such technologies. This study employed a mixed-methods approach to examine factors influencing sustained engagement with the Neumind app over 13–14 months among individuals with ABI. Twelve adult participants were interviewed, and their app usage data was quantitatively analysed over nine months post-interview. Eleven participants used the app when interviewed 4–5 months after download (3 highly active, 3 moderately active and 5 occasional users). The six active users maintained their use nine months later. Qualitative thematic analysis identified six major themes impacting sustained ATC engagement: Introduction and Initial Use (recommendation by others, ease of setup), Perceived Benefits (increased confidence, independence), Technical and Functional Challenges (technical issues, reliability, simplicity), User Customisation Preferences (reminder features, calendar scheduling), Community and Social Support (sense of belonging, helping others), and Integration into Rehabilitation and Daily Life (integration with rehabilitation, habit formation, established strategies, timing of introduction). Participants who maintained consistent use reported tangible benefits, effective habit formation, emotional engagement through community participation, and successful integration into rehabilitation routines. Non-users faced technical difficulties, perceived irrelevance of content, and preferred existing strategies. This study underscores the critical role of early introduction, ease of use, community integration, and habit formation in sustaining ATC engagement. Addressing usability barriers, enhancing customisation, and incorporating structured social support may significantly improve long-term use and effectiveness of ATC interventions in neuro-rehabilitation.

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Assistive technology for cognition; neuropsychological rehabilitation; acquired brain injury; compensatory technology; cognitive rehabilitation

➤ IMPLICATIONS FOR REHABILITATION

This study was able to track the use of the Neumind app across 12 early adopters and investigate in depth about use and user experience. This real-world observational follow up in this study is longer than in many studies that have investigated the use of assistive technology in brain injury rehabilitation and recovery. This allows valuable insights to be gathered that indicates directions for future work.

- Timing and Early Introduction Could Support Engagement

Participants who became active users described being introduced to the Neumind app at critical points in their rehabilitation (e.g. when other support was limited), suggesting that early introduction might facilitate longer-term engagement.

- Established Strategies May Limit Adoption of New Technologies

Several participants who did not sustain long-term use reported already relying on established tools such as built-in smartphone apps or paper-based planners, making them less inclined to adopt Neumind. Quantitative usage data reinforced this, showing these users engaged minimally or discontinued app use early. This is consistent with previous research and indicates that it can benefit rehabilitation professionals to assess clients' existing strategies before introducing new assistive technologies.

- Community Features Can Enhance Long-term Engagement

Qualitative findings indicated that participants who frequently used community features, valued the emotional and social support provided, potentially enhancing their sustained engagement. Quantitative results also showed these users maintained consistent app activity over the follow-up period. Incorporating community or peer-support elements within cognitive technologies could be explored further to potentially support ongoing user engagement.

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Introduction

Assistive technology for cognition (ATC) has the potential to play a vital role in neuropsychological rehabilitation, particularly for individuals with acquired brain injury (ABI) who experience persistent impairments in memory, attention, and executive function. Compensatory technologies that provide timely prompts and/or structured cognitive support have been shown to be effective in improving prospective memory performance [1] and reducing burden on caregivers [2]. For example, pagers and smartphone apps can deliver reminders to support people with prospective memory difficulty [3,4]. Technologies delivering auditory or step-by-step instructions can support people with executive difficulties to do everyday tasks with several sub-steps [5]. The INCOG 2.0 guidelines [6] advocate for the use of smartphone-based external memory aids over traditional non-technological compensatory strategies for individuals with memory impairments.

Despite their proven efficacy, long-term adoption of assistive technologies (AT) remains a significant challenge [7]. A recent study highlighted that older adults with cognitive impairments often encounter barriers such as limited technological literacy, socioeconomic factors, and the digital divide – all of which impede sustained use of technologies designed to support cognitive functions [8]. While socioeconomic factors refer to financial constraints and limited access to resources, the digital divide encompasses broader disparities in both access to technology and the internet, as well as differences in digital skills and opportunities for use. Furthermore, a systematic review on electronic AT for memory support in traumatic brain injury (TBI) emphasised the need for more controlled studies to determine their effectiveness and to examine factors influencing their uptake and use [9]. Research with stroke rehabilitation professionals similarly identified priority areas to address for uptake such as device design, access to information, and provision of AT services [10]. An earlier publication on traumatic brain injury rehabilitation underscored the limited adoption of assistive technology despite its potential benefits, calling for further exploration of the challenges and strategies to promote sustained use [11].

This research suggests that despite advancements in ATC, challenges related to usability, accessibility, and sustained engagement persist, highlighting the need for ongoing research and development to enhance long-term adoption. It is crucial to examine the factors influencing the long-term use of ATC to improve design, implementation, and inform clinical recommendations for these interventions.

Technology adoption & behaviour change theories in ATC use

Understanding the initial adoption and sustained use of ATC requires a framework that considers both individual cognitive factors and environmental influences. The Unified Theory of Acceptance and Use of Technology (UTAUT) [12] provides a useful lens for examining how individuals decide whether to engage with technology. It highlights performance expectancy (perceived usefulness of the technology), effort expectancy (ease of use), social influence (external encouragement from caregivers and clinicians), and facilitating conditions (availability of training and support). ABI survivors often struggle with initiation, executive function deficits, and habit formation, making low cognitive load interfaces and social reinforcement critical to sustained engagement.

Beyond initial adoption, the COM-B model of behaviour change [13] suggests that sustained use is driven by capability (can the person effectively use the AT given their cognitive limitations?), opportunity (are there external supports and cues encouraging use?), and motivation (does the user perceive long-term value in the technology?). For ATC to be successfully embedded in daily life, it must align with existing routines, rehabilitation strategies, and social environments.

Once ATC has been adopted and learned, habit formation is crucial to long-term engagement. The habit loop model [14] outlines three key elements: Cue – a reminder, notification, or environmental trigger; Routine – the action of using the ATC (e.g. setting reminders, marking tasks complete); and Reward – positive reinforcement (e.g. app feedback, progress tracking, increased confidence).

Technology use does not occur in isolation. Neurorehabilitation is an inherently social process, and ATC must fit within broader rehabilitation frameworks. Normalisation Process Theory (NPT) [15] explains how new technologies become embedded in practice by considering: Coherence (Does the user understand how the ATC fits their rehabilitation needs?); Cognitive participation (Are clinicians, caregivers, and

peers engaged in reinforcing its use?); Collective action (Is there an infrastructure (training, policies, support networks) supporting use?); and Reflexive monitoring (Can users see tangible benefits over time?).

Long-term engagement with ATC in neurorehabilitation

Long-term engagement with ATC in brain injury rehabilitation remains an underexplored area, despite its potential to significantly enhance cognitive functioning, daily independence, and quality of life. Existing studies often focus on short-term outcomes, with most evaluating usability and initial adoption of ATC within three to six months of implementation [3,9]. More generally, for health apps downloaded from the App or Google Play stores, active use over the long term is very low. It has been reported that the 30 day retention rate was 3.4% for "Health and Fitness" apps in the fourth quarter of 2024 [16] and this was found to be 3.3% for mental health apps in a 2019 study [17].

There is little data in neuropsychological research studies available about retention in the longer term and, whether the small percentage who do still use it after a month keep using it longer term, and what influences this. This longer term use is a particularly important topic to understand when considering technologies to compensate for cognitive abilities. The aim of these technology is to become a long-term compensatory strategy, rather than to engage people for a short time, or provide restorative therapy.

It is likely that barriers outlined in qualitative research and short-term intervention studies overlap with those that impact long term use. For example, common barriers to ATC use include technical difficulties, lack of follow-up training, and the inability of users to integrate technology into existing routines, especially if they already rely on alternative strategies such as paper-based tools [7,18]. Social and emotional factors, such as stigma, limited caregiver support, and difficulties in adapting the technology to individual needs, may further hinder sustained engagement [19,20]. However, further research is required to understand how early use relates to continued use of these technologies. This research is important because the intended use of ATC is to compensate for impaired cognitive abilities in the long-term. There is good evidence for ATC as compensatory aids but less evidence that these technologies can provide consistent and long lasting remediative effects [6].

The current study

Despite the widespread availability of smartphone-based assistive technology for cognition (ATC), little research has systematically examined the factors influencing long-term use. Relatively few studies have systematically explored how ATC becomes embedded in daily life, how it evolves over time, or why some individuals sustain usage while others abandon it. This study aims to evaluate sustained engagement with the Neumind app over a year (13–14 months) by gathering detailed interview data and app usage data from 12 individuals, all of whom had downloaded the Neumind app for at least four months before enrolment. The Neumind app is a shared platform for people with brain injury and their caregivers to create and use personalised strategies including reminders, routines, planning tools, and linked neuro-educational content that help with everyday challenges and improve independence. This study provides a step towards understanding critical insights into the factors influencing the successful integration of ATC into the daily lives of individuals with acquired brain injury.

Methods

The Neumind app

Participants in this study had already purchased the Neumind app (2 week free trial followed by a £2.99 monthly subscription) and were using it on their own phone. The app was available on the Google play and iOS Apple stores and the subscription was for "early access" use. Neumind launched in Spring 2023, around 5 months prior to study recruitment starting. The app was being improved incrementally during the study. The main changes were fixing any bugs identified by testers or users, updating neuro-education course content (Figure 1, screenshot 4 – minor changes), and adding journals and tracker features (Figure 1, screenshot 3 – in early 2024). Prior to the development of Neumind the same company, Neumind plc.,

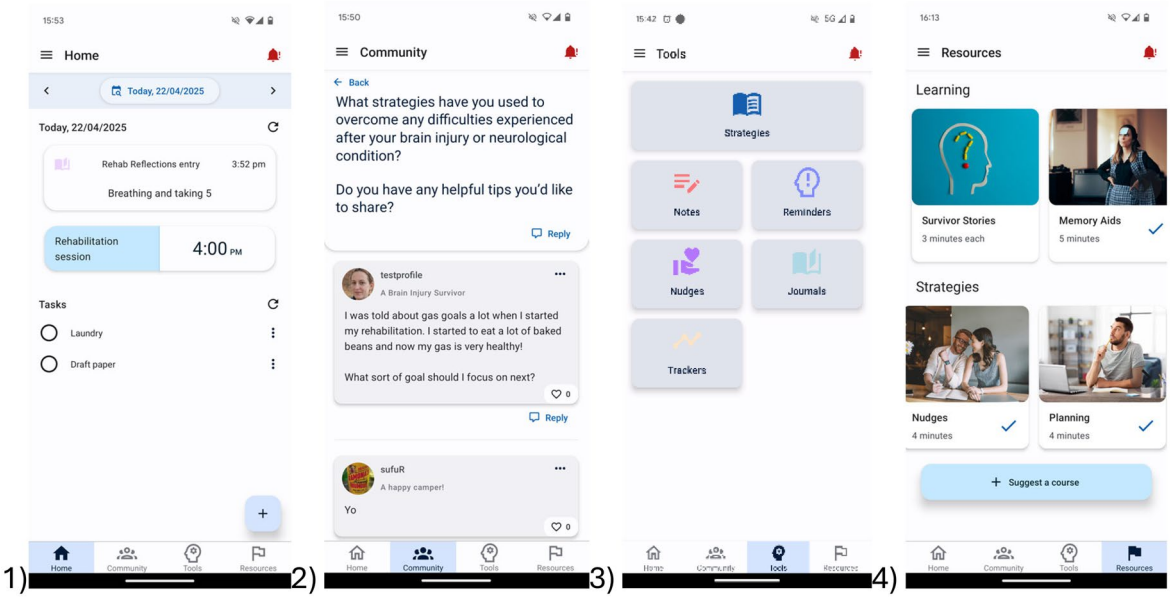


Figure 1. Screen shots of some of the key pages in the Neumind app.

had developed another app, Alfred. Three of the previous users of Alfred started using Neumind including some of the participants in this study (those referred to by the pseudonyms Laura, Sarah and Thomas).

The Neumind app provides a platform for people with brain injury and caregivers to collaboratively create strategies. These include reminders, plans, routines, fatigue management strategies and prompts to help people stop and think about what they need to do. The app also has neuro-educational courses about the consequences of a brain injury for people with ABI and informal caregivers. These link to strategies that help with the common difficulties that occur after a brain injury.

The Neumind app has:

1. Home screen showing the user's daily schedule.
2. A community where people using the app can chat, share their stories and rehabilitation tips.
3. A tools page where the user can browse and use different strategies to help with memory, attention and other cognitive difficulties. Tools included reminders, notes, community, nudges, tasks and journals and trackers. Users, and all those they link with via the app can set, view and edit these tools.
4. Reminders: Users can set one off or repeating reminders that alert and are shown on the home "schedule" screen.
5. Notes: Notes can be written, saved and linked to reminders so they can be read when the reminder goes off.
6. Nudges: Nudges are alerts that go off each day but are not linked to a regular time. They can be things to keep in mind or motivational messages.
7. Tasks: Tasks are to do lists for that day that can be checked off from the home screen. If they are not checked off they carry forward to the next day.
8. Trackers: Trackers allow quantitative information about something (e.g. sleep or fatigue) to be tracked over time and charted.
9. Journals: Journals allow written or photo diaries to be kept. Both trackers and journals can be linked to reminders to prompt regular input.
10. A "courses" page with neuro-educational content about brain injury and helpful strategies. These courses start with information about difficulties and then present a step-by-step guide to setting Neumind tools that may help with these difficulties. For example, after the fatigue course with information about fatigue after brain injury, the user is guided to set up a repeated reminder to fill out a fatigue diary.

Research questions

Primary research question

What factors impact long-term engagement with software developed to support people with cognitive difficulties following an acquired brain injury or other neurological condition?

Secondary research questions

What issues influence the uptake of software developed to support people with cognitive difficulties following an acquired brain injury or neurological condition?

What were the key differences in themes, and usage patterns of people who used the Neumind app long term compared to those who did not use it or stopped using it?

Participants

Participants were adults using the Neumind app who had stated they were happy to be approached about research when they signed up to use the app. During the recruitment window there were 26 users who gave permission for this (who record of this consent could be accessed during the recruitment window between October 2023 and October 2024). Participants were approached *via* email and 12 people replied. They all had self-identified as having a neurological condition or injury when setting up the app, no medical or other confirmation was required to participate. Eight of these participants had previously signed up to the Neumind's online community of app users and testers, indicating their willingness to be early adopters of the app and to be contacted by email about taking part in user feedback interviews. The app was advertised to the public *via* social media, Google adverts, and some users found out about the app following a news article about Neumind. At the time there were 67 unique Neumind users in total (includes app and clinician dashboard) when study recruitment started in September/October 2023. There were 77 users when it finished in September/October 2024.

Taking part in the study involved one recorded video interview with the researcher which all participants took part in. Participants gave recorded consent to take part during the call. All participants also consented to have their recorded feedback from that session, and to allow researchers to access their app use data and transcripts or recordings from previous user feedback exercises conducted by Neumind plc. The study was approved by the University of Glasgow College of Medical, Veterinary and Life Sciences research ethics committee on 13th September 2023 (reference: 200230005).

Inclusion criteria

- Aged 18 or over
- Self-reported acquired brain injury or other neurological condition
- Self-reported cognitive difficulties resulting from their condition.
- They must have signed up for the Neumind app and have downloaded it onto their own phone or tablet.

Exclusion criteria

- Inability to provide informed consent for research participation (as judged by MJ).
- Inability to verbally communicate adequately in a call.

Procedure

Demographic data was obtained from an onboarding questionnaire completed by anyone who uses the Neumind app.

Qualitative interviews

Interviews were conducted over Zoom. Interviews were audio and video recorded. The interview topics were developed by researchers at Glasgow University (MJ, JF, JE) who have experience in researching assistive technology for cognition. One of the researchers (MJ) also works with Neumind. The questions were designed to assess people's experience of Neumind in a balanced way and driven by the aim to understand what influenced long term use. This was the motivating aim for the research team and for the Neumind team who also regularly undertake user testing to understand how the software is used and how it might be improved to better meet user's needs.

The semi-structured interviews took between 30 min to 1 h. The following questions were asked by the interviewer, with follow-up questions asked where appropriate:

1. What made you download the Neumind app?
2. What do you like about it? What do you dislike?
3. Is there anything that surprised you initially?
4. Have you found it helpful in your rehabilitation?
5. Has your use of the app changed over time?
6. Is there anything you would like to see in the future in the app?

The user interview was completed between 4 and 5 months after use and was intended to ask people about issues, likes and dislikes relating to use in that time. The aim was to pick out the themes that influenced use at that time and then follow up use months later to see how the feedback differed for people who did or did not keep using it long term. We therefore asked people how they came to use Neumind, what they liked and disliked about it (focusing on specific features and their interaction with the technology). We also gave people the opportunity to say what they might like to change or add to the app. These questions were designed to get an idea of people's motivations and current feelings about the app in order to then understand which themes dominated for long term users compared to people who never used or stopped using the app. The analysis of factors influencing long-term use of the app is established through a comparison of the themes established at around 5 months for people who did and did not keep using the app long term (established at 9 month follow up).

Usage data

App engagement was calculated over time, with users categorised into active user (highly, moderately, or occasionally active user) or non-use. This was also assessed 9 months after the interview. Highly active users were those who used the app at least once every two days. Moderately active users were those who used it at least once a week (but less than daily) and occasionally active users used it at least once during the month analysed (but less than once a week). Non-users did not use the app during the analysis month.

The total number of app events was also calculated across different features for each user to understand which features were being used most commonly. Feature "flags" for specific events were captured for reminders, notes, community engagement, nudges, tasks and journals/trackers (combined). Feature flags for courses were not available, though reminders, nudges, notes and journals/trackers set *via* the courses were.

Previous user feedback interviews

Neumind carried out regular user feedback sessions on app prototypes prior to launch *via* recorded Zoom sessions. This was to receive feedback about the user experience and to judge how different app features and design decisions were received by the intended end-users. The format of these sessions ranged from brief discussions about app use in general to lengthy sessions testing out new prototypes and giving feedback. Eight of the participants in this study had previously completed these sessions. Neumind shared user feedback recordings with researchers for participants who consented to take part in the study and consented to having these previous recordings shared as part of the study.

Data analysis

We wished to evaluate the factors that influenced participants' use of the app over time. One-to-one interviews with app users were judged to be the most appropriate method for gathering in-depth information about individuals' experiences. With the participants' consent we also transcribed and analysed any interviews participants previously completed with the Neumind team. These were recorded prior to the research study as part of a user feedback process that informed the design and development of the app. It was also judged that feedback given in these recordings would be helpful in attempting to answer our research question as participants were asked what they liked and did not like about app prototypes, and discussed what features would be valuable to them.

The purpose of the research was exploratory, examining the events, experiences and beliefs that influence continued use of assistive technology for cognition. Thematic analysis was completed on the interview transcripts. This involved the researcher who carried out the main participant interviews (MJ) initially coding all responses as relevant, potentially relevant, or irrelevant to the research question. The relevant or potentially relevant responses were grouped into themes and sub-themes that answered the research question, "what impacted or impacts uptake and long term use of the Neumind app?" A second researcher (JE) then checked a randomly selected portion (20%) of the coded feedback using the same method as the main coder. Any disparity in the theme under which the feedback should be coded was resolved during a discussion.

In the thematic analysis, the data were coded with close reference to the verbatim transcript of the interview to give due consideration to the intended meanings of the words used (e.g. where there might be double meanings or local expressions) and the intensity of the comments made (e.g. emotional weight of comments or positive and negative terms used). The frequency and level of depth of the individuals' comments were noted and their internal consistency was kept in mind. Themes were named by the researchers to define and summarise the ideas expressed by participants as accurately as possible. Theme and sub-theme names were based on common terms in the Human Computer Interaction (e.g. "accessibility" & "acceptability") and neuropsychological rehabilitation (e.g. "insight" & "executive attention") literatures.

Results

The participants' ($n = 12$) average age was 44.72 years (SD = 11.52) and six were female. Three described their brain injury as a traumatic brain injury, one reported having a stroke, one reported an infection or disease and the rest described their injury as an unspecified acquired brain injury. Six reported that their brain injury occurred between 2 and 5 years ago and the rest choose the more than 5 years option. No participant reported sustaining their brain injury in the last 2 years.

App use

All participants had signed up to use the Neumind app at least 4 months prior to analysis of their app use (mean months of use = 5.25 (SD = 0.87)). Eight participants signed up as early adopters either following previous email contact from the Neumind team, word of mouth, a Facebook group or from reading a newspaper article about the app. The other four downloaded the app following recommendations from other users or people who had heard about the app. App use is summarised in Table 1. Three participants (two with an age range of 30–40, one with an age range of 40–50 years, two with TBI 2–5 years ago, one with ABI more than 5 years ago) were rated as highly active users when they were interviewed. Three were moderately active users (with age range 30–40, 40–50 and 50–60 years, all ABI; two more than 5 years prior and one 2–5 years ago). Five were rated as occasional users (two with age range 30–40, two with an age range of 40–50 and one between 50 and 60 years, 3 had an ABI more than 5 years prior to the downloading the app, one had an ABI in that 2–5 years and one had a TBI between 2 and 5 years ago). One participant was a non-user during the month they were interviewed (60–70 years old who had an ABI between 2 and 5 years ago). The retention rate for the first 30 days following app download for the study participants was 91.6% (11 of 12 participants used it in the first

Table 1. Participants previous interviews and app use. Feature events were included if they used that feature. The participants are ordered from most active to least active users in the month before the interview.

Pseudonym	Time since ABI	Previous user interviews	Time since download/ app initiation (at interview)	User status in month prior to interview	App events in month before interview	Number of feature flagged events between download and interview (in descending order of most use)	9 month follow up user status (at month 9)	Monthly app events during 9 month follow-up period (median, range of monthly app events over 9 month follow up)	Number of feature flagged events in follow up (in descending order of most use)
Leah	2–5 years	0	6	Highly active user	73 events	146 reminder events, 11 community events, 3 note events, 3 nudge events	Highly active user	200 events per month (range = 39.5)	271 reminder events, 85 journal or tracker events 17 community events, 2 nudge events, 2 task events
Lesley	2–5 years	0	5	Highly active user	70 events	36 community events, 23 reminder events, 10 note events, 2 task events	Highly active user	53 events per month (range = 22.5	41 community events, 24 reminder events
Sarah	> 5 years	2	5	Highly active user	58 events	20 reminder events	Highly active user	100 events per month (range = 35)	421 reminder events, 171 note events, 78 journal or tracker events, 15 task events
Leanne	> 5 years	3	7	Moderately active user	17 events	6 community events, 4 task events, 1 reminder event	Moderately active user	11 events per month (IQR = 14.5)	50 community events, 23 note events, 2 reminder events
Laura	2–5 years	2	5	Moderately active user	15 events	4 community events	Moderately active user	13 events per month (IQR = 17)	43 community events
David	> 5 years	3	6.5	Moderately active user	6 events	12 note events, 2 community events, 1 reminder event	Moderately active user	10 events per month (IQR = 24.5)	38 community events, 7 journal or tracker events, 1 reminder event
Colin	> 5 years	1	4.5	Occasional user	6 events	2 reminder events, 1 note event	Occasional user	1 event per month (IQR = 13)	15 community events, 9 note events, 3 reminder events
Samir	> 5 years	0	4	Occasional user	3 events	92 community events, 4 note events	Non-user (at month 5)	None	N/A
Samantha	2–5 years	0	5	Occasional user	2 events	No feature tagged events	Non-user	None	N/A
Philip	> 5 years	2	6.5	Occasional user	2 events	6 reminder events, 3 note events	Non-user	None	N/A
Thomas	2–5 years	2	5	Occasional user	1 event	No feature tagged events	Non-user	None	N/A
Scott	2–5 years	2	5	Non-user	None	N/A	Non-user	None	N/A

month) and this was 50% at the end of the study (6 of 12 participants still used it 13 to 14 months after download). Use was followed up nine months after the interviews for 11 of the 12 participants. One participant (Samir) had only 1 month follow-up because he was enrolled too late to follow up in the timeline for the study write up.

Qualitative analysis

Reliability between raters

The 20% of transcripts, initially, blind coded by MJ and JE overlapped in identifying key factors influencing the uptake and sustained use of a cognitive compensatory app. Both coders emphasised the role of familiarity with existing strategies (e.g. smartphone apps such as Notes or reminders) and the difficulty of transitioning to new tools, highlighting the importance of habit and simplicity in technology adoption. Additionally, both noted the significance of timing, with participants indicating greater potential benefit if introduced earlier in rehabilitation.

Some disparities in emphasis were observed. MJ placed more weight on the importance of reliability and user confidence in existing ATC, while JE underscored the role of clear and accessible community features as motivators for engagement. Coder 1 picked out 20 separate initial themes from their section of the transcript and 18 of these mapped on to the 6 main themes and 15 sub-themes that are shown in Figure 2. The overlap between the themes initially picked out and the themes and



Figure 2. A thematic map of the themes and sub-themes.

sub-themes established by the main coder was therefore 90%. Differences arose around the following coding; (1) A single comment about the familiarity of using a phone was interpreted by the 2nd coder as separate from the "competing with established strategies theme" or "ease of initial set up;" (2) One participant mentioned the low cost of the app and so this was picked out as a theme by coder 2 but not by coder 1; (3) Coder 2 has more codes for the positive impact of the community feature than coder 1.

While no numeric reliability threshold was established, the discrepancy was judged to be small enough to coder one complete the rest of the coding. The discrepancies were resolved with these aspects coded as (1) part of the "ease of initial set up" theme and (2) While cost and access are important considerations, this was not included as its own general theme or sub-theme since it was only mentioned by this one participant. This was included as part of the "perceived benefits" theme (where the perceived benefits must outweigh the costs of payment or any perceived negatives such as learning to use the app); (3) This disparity in number of codes picked out did not alter the structure of themes or sub-themes and so did not need to be resolved. Despite these differences, the alignment on core themes (familiarity, simplicity, and timing) supported confidence in the validity of the coding.

Main themes

The major themes found to influence long term use of ATC were Introduction and Initial Use (sub themes; R*ecommendation by Others, Ease of Initial Setup*), Perceived Benefits of the App, Technical and Functional Challenges (sub themes; *Technical Issues, Reliability, Simplicity*), User Customisation and Preferences (sub themes; *Reminder features, Calendar scheduling*), Community and Social Support (sub themes; *A Sense of Belonging, Contributing and Helping Others*) and Integration into Rehabilitation and Daily Life (sub themes; *Integration with Rehabilitation, Habit Formation, Competing with Established Strategies, Timing and Stage of Rehabilitation*). These themes are discussed in more detail below with quotes from participants. Figure 2 shows a thematic map of the themes.

Introduction and initial use

Participants discussed how they were introduced to Neumind or other technologies they use and their initial impressions using it. Subthemes were *Recommendation by Others* (therapists, family, people they met at community organisations) and *Ease of Initial Setup.*

Recommendation by others

Some participants noted that being introduced to the app by a trusted person helped them initially use the app. For example, Leah discussed being introduced to the app by someone at a charity group she attended:

> *"This was also at the beginning of lockdown, which was disastrous. And then I was sort of released from rehab, but found there was very little support for brain injury. I had to go and find it for both me and my husband… In… my area, there's a social prescribing thing. So I was referred to through… [name of charity removed]. And they have a garden… where people can go and do creative activities. And one of the people who was leading the creative writing, recommended that I use the app… But it's, it's been fantastic."* (Leah, highly active Neumind user, age range 30–40 years).

Ease of initial setup

A few participants discussed the process of downloading and first using the app and having a positive first experience. Samir, Sarah, Leah, Colin and David all spoke about having a positive first impression after downloading the app such as liking, the "*way it is set out"* and finding it "*easy to use*" (Sarah) or finding the setup *"relatively easy"* (Samir). Participants also responded positively to a "how to use" course that walked them through the Neumind app features when they first downloaded the app.

Perceived benefits of the app

Participants discussed the aspects they liked and disliked about the app (and other assistive technology they had used) during the sessions. They discussed a wide range of Useful Features with reminders, structured strategies like setting plans or routines, the community, and fatigue tracking as some the of the more frequently mentioned features.

For some participants, including Lesley, Michael, Leah and Colin, the benefit of Neumind or other technology they used was increasing confidence in their memory and in doing everyday activities, knowing they had support from the app and others linked to it. Colin (weekly active user) spoke about having "*100% confidence in*" his chosen assistive technology that he uses daily. Lesley (highly active user, age range 40–50 years) talked about how she needs the alerts from a phone for her memory day to day to avoid "*getting mixed up*" because, if she uses pen and paper methods she, *"write[s] it down and then forget that I've wrote it down. It's because the alarms go off [that I remember]*."

For Leah the app was part of her process of recovery and increase in confidence, with its use declining as she recovered;

> *"…my routine for leaving the house was one that I used to use quite a lot. Um, but I don't leave, leave the house that often anyway. Um, but now I've got my confidence to go out again. That's one I can come back to. I like the fact you can come back to things. So yeah, it's, it's changed in the, as I've improved and I've developed more confidence that, um, I, have less reminders now"* (Leah, highly active user).

It was also clear that having supportive learning resources in the app with information relevant to them and evolving content was a positive and a facilitator for use. Similarly, though from a negative perspective, Thomas found some of the content in the "Survivor Stories" course on Neumind off-putting due to its lack of perceived relevance to his own experience.

Technical and functional challenges

When discussing their ongoing use of the app some participants mentioned *Technical Issues* such as problems logging in, updates and app performance. Simple navigation and reliability were desired.

Technical issues

This research started following the initial roll out of the Neumind app (in Spring 2023). It was communicated to people using the app that there may be issues that would need to be resolved. One participant (Sarah) described the lengths she went to in order to overcome a bug, subsequently resolved, with the way the app loaded;

> *"Because with Neumind now, whenever they put an update on, I have to turn my phone on and off again to reset it, whereas I never had that issue before when they updated Alfred. So literally once a day, I pretty much have to update my phone and turn it on and off."* (Sarah, highly active user, age range 30–40 years).

Other clients mentioned not being able to find what they were looking for or difficulties navigating certain features. For example, Philip mentioned stopping using the app after he could not figure out how to delete reminders,

> *"I have to admit, I did lay down the app for a while. I didn't use it for, I'd say, two months. Because of the fact that I couldn't delete the reminders. And they bugged me."* (Philip, occasional user, age range 50–60 years).

Simplicity

When discussing app usability more generally, *Reliability* and S*implicity* were themes participants' mentioned regularly. For example, Colin discussed the need to keep communication from the app simple to avoid making people fatigued,

> *"…always strip the bejesus out of it and keep it simple. There's anything extra attention can go, memory can go and it impacts on fatigue. With the fatigue, everything I do I try and do it the easiest way."* (Colin, occasional user, age range 40–50 years).

A few participants mentioned that they liked the simplicity of different features such as notes and the "how to use" tutorial available on the app.

Reliability

Colin also mentioned the reliability of the apps he used for reminders and note taking, and that being able to trust they were reliable was important to him,

> *"It's very reliable. It's got your Apple stamp brand of quality and reliability and all that…I think subconsciously I say it is the ever reliable because I've been using it all these years and it's I've never had a problem with this. But I have used the Neumind app, but very rarely would I use it in a hurry because I'm just so used to the other ones. And I know I have 100 percent confidence in them. And my confidence in some things is shaken, but that's a situational thing to me."* (Colin, occasional user).

User preferences for customisation

Participants were given the opportunity to say what features they would like to be added to the Neumind app. The two main categories of responses included improving and customising the *Reminder Features* (e.g. personalised notification sounds, louder notifications) and *Calendar Scheduling* and integrating with other web or app calendars that they used.

Reminder features

Some participants wanted more noticeable reminders. For example, Samantha (age range 30–40 years) said she is so used to swiping notifications away and jokingly said, "*If there was something that could electrify me until I'd done something then that would be great!*" Colin mentioned wanting a notification that was "…*always on your phone*…" so it could not be missed. Thomas also wanted the notifications to be more like an alarm that "…*takes up the whole phone screen, and then boom. I have to dismiss it*." Thomas also wanted to be able to alter the notification sound to suit his needs. David found that the nudges (that fire at a randomly selected time each day) were interrupting him during meetings when he did not want them to, so wanted to be able to alter the time they go off.

Calendar scheduling

Another major addition that several participants requested of the Neumind app was the ability to sync with existing calendars. Scott summarised this need for the app to link to existing strategies that people use;

> *"But I think… implementing a standalone Neumind diary. As opposed to integrating outreach to Outlook and Google, etc. is a barrier to uptake… I use a Google diary I had because I had that before my stroke. And I use it because my wife and I both have it on the on our phones, on our tablets and computers. And it's one diary and we can have coordination. So I wouldn't use a diary and Neumind because I'm already cognitively challenged. And if you split the diary in two, the whole process falls apart… Because it's not doubling. It's not doubling the number of things I'm having to track by having two diary systems."* (Scott, non-user, age range 60–70 years)

Community and social support

Sense of belonging

Community and social support was a common theme for the participants. A *Sense of belonging* and connection with others facing similar challenges was important to people, and many participants liked the community feature in the Neumind app. Leanne discussed this at length.

> *"…it's been helpful to me with remembering things, setting tasks for myself, being able to speak to like-minded people which is really helpful, you know, supporting each other where after having a brain injury it's very lonely, it's a very lonely place, even if you are surrounded by people who don't, they don't get it, they don't understand, so being able to speak to people who have been through similar sort of things that I have, being able to share stories, experiences has been really, really helpful, so I suppose that's the best part about it."* (Leanne, moderately active user, age range 40–50 years).

On the other side of this, when a participant (Thomas) did not feel represented by the stories in the "survivor stories" section of the app, it made him feel disconnected and put him off using the app,

> *"I remember reading through all the Survivor Stories… Every one of them had a significant other or somebody from before. Every one of them. It has (not) a single guy who doesn't really have a whole lot of people looking out for him. That might be one of the things that drove me away that really frustrated me."* (Thomas, occasional user, age range 30–40 years).

Contributing and helping others

Participants also discussed the importance of feeling they are *contributing and helping others* in their situation. For Laura it was very important to her to help others in the same position she was in earlier in her brain injury recovery by passing on her expertise:

> *"It's not often you come across people who you know have brain injury. I'm 20 years down the line and I know there's questions I can always answer (in the Neumind community)."* (Laura, moderately active user, age range 30–40 years).

However, Laura did also communicate that she had encountered difficulties understanding or engaging with community questions.

Integration into rehabilitation and daily life

Integrated with rehabilitation

Some participants had completed work with therapists so that Neumind and other technology were *Integrated with Rehabilitation*. Others discussed technology that they had been introduced to by clinicians or others they met during their rehabilitation. The integration of the technology into rehabilitation and strategy use was positive for participants and engagement was high for the participants who mentioned this. For example, Sarah discussed how she used the app to remember appointments and tasks relevant to her recovery;

> *"I think I mostly used it for the same purpose, more for like prompts, whether that's an appointment for me… or whatever. If I've got to go somewhere or do something like my Personal Trainer, I put a reminder in, this Zoom I did. I've got the Zoom with my case manager, [local charity] meeting, hairdressers, you know, medicine. So I do use it a lot for the reminder prompts."* (Sarah, highly active user, age range 30–40 years).

Habit formation

However, successful integrating technology into everyday life required *Habit Formation* and some participants reflected that it was difficult to establish a new habit around Neumind, and other technology. For example,

> *"I've probably used it a little bit less the past few weeks, past month or so. But I don't think that's the app. I think that's me because I've been going through a lot of changes myself and trying to work out what I'm doing and where I'm doing and how I'm doing it. So I think I used it and I didn't, then I did and I haven't used it for a few weeks."* (David, moderately active user, age range 50–60 years).

Others had established Neumind, or other technologies as a daily habit. For example, Lesley said, "*I can't live without it…*" and Colin said his use of the Apple notes system was, "*burned into my brain, my psyche. It's there with my neural pathways*."

Competing with established strategies

Another barrier to the habitual and reliable use of a new technology-based strategy is that the new technology was *Competing with Established Strategies* (like physical planners and native phone apps). It was not perceived to be worth the effort for some participants to switch from these strategies to new ones or add the new technology in addition to the strategies already used.

For example, Colin said,

> *"I tend to just go to the (Apple) notes because… because my immediate memory is a problem, I just pick it up. Oh, no, it's a problem, you know, because I'm so familiar with it. I tend to jump on that instead. The Neumind app is really good, but I'm so familiar with the other one. It's very hard to go back to that."* (Colin, occasional user, age range 40–50 years).

For Colin he got all the help he needed from native phone apps that he was used to using. He also wondered if Neumind could link to his calendar system as that might make it easier to integrate into the strategies he already uses. This links to the user preference for calendar integration. If they had already established use of technology with a calendar, then it would be difficult to switch to a new system that did not link to that digital calendar.

Others, like Laura, used pen and paper methods, and did not feel the need to change this and replace it with a digital system.

> *"Reminders, I always have a notebook and pen in my bag. I've got my memory board on my kitchen wall at home. There's little plastic note sheets attached to kitchen cupboards. I have things like that all the time. I've not sort of used anything new in recent years. I'm a few years down the line and I didn't really feel I needed to change anything."* (Laura, moderately active user, age range 30–40 years).

Timing and stage of rehabilitation

Finally, it was clear from the feedback that the T*iming and Stage of Rehabilitation* was important in determining how and if it would be adopted. For Leah, who became a daily active user, she found the app at a critical moment when there was little other support available. She was also introduced to it by a trusted person at a charity organisation she had attended, again highlighting the importance of being introduced to the app by a trusted individual.

Another issue with timing is the life circumstances of the user as they begin using the app as a new strategy. For example, David said,

> *"I do like it. I have not used it as much as I thought I would, but I think that's more, I'm going through a lot of changes at the minute, so finding out where I'm at."* (David, moderately active user, age range 50–60).

Philip also had positive life circumstances that meant he did not use the courses feature as much as he might otherwise have due to a lack of time and perceived need,

> *"I've looked at them, but I've not really felt like I've needed them. Like I said, I'm working five days a week now."* (Philip, occasional user, age range 50–60).

User type theme comparison

The participants were split evenly into highly or moderately active users ($n = 6$, 5 female, 1 male) and occasional or non-users ($n = 6$, 1 female, 5 male) at interview. The daily or weekly users (who we have named as "active users") were also still active 9 months later, while the others referred to as "non-users" (5 male, 1 female) no longer used the app (apart from one participant, Colin, who was still an occasional user). A comparison of the themes from the feedback from these two user groups was considered useful in trying to understand what factors influenced usage over the long term.

Active users

Active users experienced tangible benefits from the Neumind app that they described in the interview. They saw the app as an integral part of their rehabilitation and daily life. They also tended to value the way the app could facilitate connections to their community and a sense of belonging.

Perceived benefits of the app (useful features)

Leah highlighted how the app's reminders played a critical role in rebuilding independence after their brain injury: "*I was using it quite a lot of the time to remember things because one of the things I've found*

since I've had my brain injury is I haven't gone out on my own. And it's helped me to, what I found difficult was developing a sense of independence again." They also used reminders for medication, hospital appointments, and even social activities like meeting friends for coffee, emphasising its flexibility in supporting both rehabilitation and broader life needs. This was highlighted by the app use data that showed that Leah set a large number of reminders in the initial months of use.

Lesley valued the app's reminders for maintaining routines and managing medication, again backed up by the large number of reminder events, particularly in her first few months after download: "*…it helps keep me in routine. So it does, it helps with my medication otherwise I would forget that I've took my medication*." They also received input from the community that helped them with their fatigue: *"(It) helps with fatigue as well, believe it or not, because there's people on it that can give you tips and stuff. So it's really good*."

Integration into rehabilitation and daily life (integrated as part of their rehabilitation)

Active users successfully incorporated the app into their daily routines. For example, Sarah used it extensively for reminders about appointments and tasks, finding the dual functionality of reminders and note-taking particularly beneficial: "*It's quite good when you've got Zooms and stuff and other things going on. It's good to set the reminders for it*."

Habit formation was key. Leanne noted how app notifications served as effective prompts to use the app regularly, and to apply her strategies for focusing her attention on her goals, even when life distractions interfered: "*I think I did one recently, actually, setting my, the stop and think, the stop think, and that one comes up every day now, so I'll set myself that one… I'm very aware that I do regularly, where I don't, um, I'll start something, and then go off and do something else, so the stop strategy is really, really good, because it makes me then think, oh, yeah, I need to stop and actually do things step by step properly*."

Community and social support (a sense of belonging)

The app's community features were highly valued. For instance, Laura emphasised the importance of connecting with others with similar experiences: "*Yeah, it's just always nice to meet other people (with a brain injury). I mean I guess I walk past them on the street every day but we don't stand out, do we?*" This sense of belonging motivated her ongoing use. Leanne similarly highlighted the value of speaking to "*like-minded people*" in the app's community, describing it as a remedy for the loneliness often associated with brain injuries. For both Laura and Leanne the community was the primary feature that they used throughout the time that app data was captured.

Non-users

Perceived benefits of the app (useful features)

Non-users often didn't explore the app's courses or strategies in depth and did not perceive they had a great need for the app. For instance, Philip, who became a non-user after initially being a monthly active user, said, "*I've looked at [the courses], but I've not really felt like I've needed them. Like I said, I'm working five days a week now*." This reflects how their established routines and long time since injury reduced the perceived relevance of the app's learning resources.

Integration into rehabilitation and daily life (competing with established strategies)

Non-users preferred pre-existing strategies over the app. Colin mentioned relying on the Apple Notes app and physical notebooks, explaining it was, "*burned in… my neural pathways*." He felt the app came "too late" in his recovery journey to replace established habits. He did acknowledge the Neumind app's potential value but felt it would have been more beneficial during earlier rehabilitation stages saying, "*…it would have been very, very, very beneficial had I had that. At, you know, the early rehab stages*."

Technical and functional challenges (app issues)

Non-users often faced technical barriers that disrupted engagement. For example, Thomas reported being logged out of the app and unable to log back in, which ultimately caused them to stop using it.

He noted, "*I forgot my login again… I'm pretty sure the last time I tried to get into it, I couldn't get in. (I) Probably got sidetracked or something*."

Leah, Sarah and Lesley (the three active daily users after 9 months) all also experienced some technical difficulties with using Neumind, or other apps. However, because they experienced the app the benefits of the app and found it integral to their daily life and/or recovery, they stuck with it and these issues did not impact use for long. For example, Sarah went to great lengths to get the app to work in spite of a bug that stopped the reminders from loading. Lesley reached out to others to support her to get set up with a new app after one she was using stopped working.

User customisation and preferences (reminder features)

A lack of customisation in reminders deterred some non-users. Thomas described how the app and its notifications "the other notifications on his phone making them easy to swipe away without noticing. He wished for more noticeable, customisable alarms. Others such as Colin and Scott wanted integration with current online calendars they were using.

Discussion

This study explored the factors influencing long-term engagement with assistive technology for cognition (ATC) among individuals with acquired brain injury (ABI). Using a mixed-methods approach, we examined qualitative interview data and quantitative app use metrics to identify key barriers and facilitators to sustained engagement. The findings align with previous research on ATC adoption while also providing new insights into the role of habit formation, emotional engagement, and integration into rehabilitation routines. The aim was to look at feedback for established adopters 4–5 months after their download of the app, and then follow their use up longer term (9 months). This differentiates this study from research that has tended to only track use over a few months. We wanted to understand how feedback after a few months might relate to longer term use over more than a year.

Long-term engagement and behaviour change theories

The findings align with established technology adoption and behaviour change models, particularly the Unified Theory of Acceptance and Use of Technology (UTAUT) [12] and the COM-B model of behaviour change [13]. As suggested by UTAUT, participants who perceived the Neumind app as useful for achieving their goals (performance expectancy) and easy to use (effort expectancy) were more likely to continue using it over time. Social influence also emerged as a significant factor, with participants noting that recommendations from clinicians or peers motivated them to initially adopt the app. Recommendations from clinicians, caregivers, and peers often play a crucial role in motivating individuals to adopt assistive technology for cognition (ATC). Individuals or organisations whose knowledge, experience, and credibility provide reassurance and confidence in adopting new technologies. Lindstedt and Umb-Carlsson [21] found that adults with ADHD were more likely to integrate cognitive assistive technology into their daily routines when supported by healthcare professionals, who provided both practical training and emotional encouragement. Similarly, Jamieson et al. [1] demonstrated that the efficacy of cognitive prosthetic technology for individuals with memory impairments was enhanced when professional support and structured training were available as part of clinical trials.

Participants with greater technological confidence or prior experience with smartphone-based tools were better equipped to integrate the app into their routines, underscoring the role of capability in successful adoption. This aligns with the "capability" component of the COM-B model and reflects findings from earlier research. For instance, Jamieson et al. [7] identified prior technology use as a key predictor of assistive technology uptake during rehabilitation. In contrast to many physical mobility aids—where users typically have no prior experience and are not expected to—digital assistive technologies like memory-supporting apps may carry implicit assumptions about baseline tech familiarity. Moreover, healthcare professionals often receive structured training in physical aid usage, but less so in the implementation of assistive technologies for cognition (ATC), potentially limiting effective support.

Opportunity factors such as caregiver involvement and structured onboarding further enabled sustained app use, echoing findings from Whittal et al. [22]. Motivation, particularly shaped by the perceived relevance and benefits of the app, was also found to be critical for continued engagement.

Habit formation and procedural learning

This study underscores the critical role of habit formation in sustaining long-term engagement with ATC. Habit loop theories [14] suggest that the formation of consistent app-use routines, triggered by cues such as reminders and rewarded by perceived benefits like increased independence, promotes sustained use. Participants who had successfully integrated app use into their daily routines were significantly more likely to continue engaging with it over time.

Conversely, participants who did not integrate ATC into their existing routines often reverted to familiar compensatory strategies, such as paper-based planners or built-in smartphone apps. Additionally, the timing of ATC introduction was crucial; participants who adopted the app earlier in their rehabilitation journey were more likely to develop habits around its use.

Emotional engagement and social support

Emotional engagement and social reinforcement were important for some participants in sustaining long-term ATC use. Participants who felt a sense of belonging within the app's community features or developed an emotional connection to the technology itself were more likely to maintain consistent use. This aligns with Self-Determination Theory [23], which emphasises the role of autonomy, competence, and relatedness in maintaining motivation. Previous studies on ATC adoption, as well as the reviews of evidence and clinical standards, have tended to focus on functional benefits and practical support from others. Our findings provide some preliminary evidence that fostering of user communities and encouraging emotional investment are helpful strategies for sustaining ATC engagement. Five of the six "active users" who kept using the app over the follow-up, used the community in the first few months. Only 1 of the six "non-users" who did not keep using the app regularly used the community feature. It is not possible to determine whether use of the community feature drove continued engagement, or if increased engagement was incidental since they were using the app for its other features. However, the qualitative feedback from participants does indicate that some users were drawn to the community as a primary reason for using the app. The feedback also highlighted some potential issues with this type of community engagement where there may be difficulties communicating ideas (i.e., like Laura found when answering community questions) or ensuring everyone feels represented (i.e., Thomas who did not feel represented by the "survivor" stories).

Barriers to long-term use

The participants in this study had a 91.6% retention rate over the first 30 days. This is much higher than the average for health or mental apps which have a retention rate of just above 3% [16,17]. This difference may be due to selection bias since more engaged users were likely to be early adopters and be more engaged. For comparison the 30-day retention rate for all Neumind app users was 51.18% for March 1st to 31st 2025 (users continuing to do any action in the app each day over a 30 day period). The participants in this study then had a 50% retention rate for our long term follow up. While this is high it is comparable to the 43.89% 12-month retention rate for Neumind app users between 1st April 2024 to 1st April 2025 (correspondence from the Neumind team, data from anonymised app metrics).

Unsurprisingly, technical and usability challenges were significant barriers to sustained engagement. Issues such as app bugs, login difficulties, and insufficient customisation of features led to frustration and disengagement among some participants. Additionally, the complexity of certain app features deterred less technologically confident users, highlighting the need for simplicity and user-centred design. It is relevant that these users were some of the first to use Neumind, which was in continued development during the early the study, particularly the first 6 months. Bugs and user design issues were fixed and

altered with feedback from users during these stages. It is also possible that these issues will have been over-represented since the interview was with a researcher who was also associated with the Neumind team. Therefore, people may have wanted to mention any issues they were having in the knowledge that they would receive support to help them or that issues would be passed to the developers.

Looking at the app use data, if use was low in the first few months it continued to be low, or stop entirely. On the other hand, those who did use the app as a highly or moderately active user early on kept using with the same regularity for the full follow up period. This suggests that an important barrier to long term use is not quickly finding a valuable feature early on. Most of the participants who did not use the app remarked that they had other strategies that worked for them, or that they did not have much need for the technology (Colin, Philip, Scott and Samir). Thomas and Samantha did mention features they would have liked that could have led them to re-engage such as more noticeable or customisable reminders.

Integration with existing calendars was mentioned by a number of participants. In response to this feedback the Neumind team developed a Google Calendar integration. However, this only works one way (Neumind reminder into to Google Calendar) and not the other (reminders from Google Calendar, email and other places going to Neumind). This means the utility of the integration is limited because it leaves people needing to use Neumind as well as Google calendar. This leads to a common issue that patients and clinicians report which is that they have to use so many different tools that don't always communicate with each other, that it can become overwhelming. It would be unrealistic to aim to develop an app with the same feature set as Google Calendar or Apple Calendar – this software has had years of highly funded development and exists within web architecture that supports syncing with other software. Considering this, a better approach may be to focus more on the specialist function of the tool, for example as a support for those in recovery following a brain injury. In Neumind's case this has led to the creation of a clinician dashboard and focus on the rehabilitation specific features, rather than trying to recreate some of the functionality of much more established and ubiquitous apps.

Implications for practice and future research

The findings have implications for both ATC development and clinical implementation. Ensuring that ATC solutions are easy to use, customisable, and seamlessly integrated with existing rehabilitation strategies will be essential in supporting long-term engagement. The results indicate that early intervention is particularly beneficial, suggesting that ATC is particularly effective when introduced early with support from a clinician, caregiver or trusted individual in rehabilitation pathways to maximise its potential benefits. This is something that could be investigated in future research to establish empirically the best time to introduce ATC an inform recommendations for clinical practice. Given the strong role of emotional and social engagement in sustaining use, developers should consider incorporating structured community-building features, such as peer support networks or mentorship schemes, to foster a sense of belonging among users.

The Neumind team continually improve the app according to feedback of the users such as the feedback gathered during this study. Following from this work, the feedback was turned into development actions such as fixing user experience issues with being logged out, improving the material in the courses and improving the flow for reminder setting, editing and deleting. The team have since moved to develop a clinician dashboard that links to the app with the aim to incorporate the app within rehabilitation and support the care people receive in community or outpatient rehabilitation. The feedback gathered during this study was part of this iterative development process; building on the feedback gathered during this research, further clinician and patient feedback has been provided to inform development of the full platform (dashboard plus app).

Sustained engagement with these tools may be improved by embedding them into existing rehabilitation pathways and providing resources such as reminders, goal-setting frameworks, and ongoing clinician-led support. From a clinical perspective, these findings reinforce recommendations in clinical guidelines for the integration of assistive technology for cognition into neurorehabilitation [6]. This could incorporate structured training for healthcare professionals to build confidence and competence in

recommending and supporting ATC use. System-level initiatives could facilitate habit formation and ultimately improve uptake and retention.

Further research should explore how different user subgroups interact with ATC over longer periods. Longitudinal studies tracking engagement beyond the first year of use would help clarify the long-term sustainability of these interventions. Additionally, future work should examine how different cognitive profiles affect the likelihood of sustained ATC use, providing more tailored design recommendations for diverse ABI populations. Finally, it was noted that 5 of 6 female participants were highly or moderately active users compared to 1 of 6 male users. While this sample is small and differences in use due to sex was not mentioned by participants, it may be interesting to further explore differences between males and females in adoption of, or establishing new habits with ATC.

Limitations

While this study provides valuable insights into long-term ATC engagement, several limitations must be acknowledged. The sample size was small ($n = 12$), limiting the generalisability of findings to the wider ABI population. However, our sample size was quite large relative to some conventions for usability testing [24]. It was also unclear what the cause of the brain injury was for seven of the participants who did not specific the type of brain injury from a list in the app onboarding when they were signing up to use Neumind. Future research could follow usability testing convention of smaller usability testing sprints with iterative development or use calculations of the number of problems identified to guide how many people should be involved in user interviews [24]. Future research should also gather more detailed information about the cause of participants' brain injuries in order to gain more understanding of differences that may occur in long-term use (e.g. between people with TBI compared to non-traumatic ABI).

Selection bias is another potential limitation. Participants were recruited from an existing Neumind user community, meaning they may have been more motivated or technologically proficient than the broader ABI population. Individuals who struggle with technology or disengage early may have been underrepresented in the sample, potentially overestimating the extent to which ATC can be successfully integrated into rehabilitation routines. This also might explain why many of the people who did not use Neumind had well established other technological strategies that they used instead.

The focus in this paper on one app (Neumind) rather than general assistive technologies for cognition (ATC) has some advantages and disadvantages. Advantages include the knowledge that the same set of features and usability issues are being discussed – this allows more detailed understanding of the issues that come up. For example, perceived benefits, and feedback about the personalisation of nudges, courses and the community features were specific to Neumind. These may not have arisen as themes if general ATC had been discussed with a wider range of features and interfaces. Focusing on one technology rather than a range of technologies also makes it easier to define uptake and use over time. On the other hand, it can be beneficial to get an overview of the issues for all ATC. One advantage is that it gives an indication about how many, and what kinds of tools people use and who may get more or less benefit from different types of technologies. This can then inform clinicians about best practice and what may work in practice. In this case we chose to focus on one app because it allowed us to home-in on specific user issues that came up to provide a deeper understanding on the factors influencing uptake and long-term use.

Additionally, while this study assessed app engagement over a prolonged period (9 months), an even longer follow-up (e.g. 12–24 months) would provide a more comprehensive understanding of sustained engagement. The absence of a direct comparison group also makes it difficult to determine whether the engagement patterns observed are specific to the Neumind app or generalisable to ATC more broadly.

Conclusion

This study contributes to the growing body of literature on ATC adoption by providing detailed insights into the cognitive, social, and emotional factors influencing long-term engagement. Findings underscore the importance of habit formation, social reinforcement, and emotional investment in sustaining use

beyond initial adoption. Addressing usability barriers, improving customisation, and embedding structured support mechanisms could enhance long-term adherence, ultimately increasing the effectiveness of ATC in neurorehabilitation.

Author contributions

CRediT: **Matthew Jamieson**: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Visualization, Writing – original draft; **Ellis Parry**: Conceptualization, Project administration, Software, Writing – review & editing; **Luke Parry**: Software; **Rufus Russell**: Software, Writing – review & editing; **Jessica Fish**: Methodology, Supervision, Writing – review & editing; **Sam Gentry**: Project administration, Software; **Andrew Bateman**: Supervision; **Jonathan Evans**: Formal analysis, Supervision, Writing – review & editing.

Disclosure statement

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