

Predicting language outcome and recovery after stroke

A new Wellcome Trust funded study is showing that language function continues to improve over decades following stroke. Louise Ambridge, Alex Leff, Jenny Crinion and Cathy Price report

The acute onset of aphasia following a stroke is a traumatic and life-changing experience for patients and relatives. The inevitable question asked of many SLTs, doctors

and other health professionals at this time is, “Will I (or my relative) be able to speak normally again?” To date, the responses to this question tend to be aimed at providing encouragement whilst perhaps setting relatively low expectations to ‘prepare’ patients and relatives for the worst.

Many people with aphasia who visit us at the Wellcome Trust Centre for Neuroimaging to take part in our aphasia research report being told they would not, or were unlikely to, communicate normally again. While the reasons for providing patients and relatives with the worst-case scenario are understandable, this is not often helpful and, it could be argued, may lead to a sense of hopelessness or despondency. This leads to further concern that negative beliefs about the

likelihood of recovery could affect patients’ and relatives’ attempts to communicate or engage in therapy.

Similarly, many participants in our research reported being discharged by their local speech and language service within a year of their stroke with the explanation that ‘all that could be done had been done’, despite the fact they remained severely communication impaired. The perceived implication for the patient is often that they have reached their maximum potential even though their ‘dose’ of speech and language therapy was reported to be closer to homeopathic than therapeutic (Crinion

and Leff, 2007).

There are of course many reasons for the limited availability of long-term aphasia therapy, not least the financial constraints on services. Whether or not this is the case, the over-arching theme is that it is extremely difficult to provide patients with anything other than general or anecdotal information about the likely duration and extent of language recovery after aphasic stroke. In this context, how can SLTs maximise each individual’s chance of overcoming their communication impairment and succeeding in the long term? One approach is to obtain and use

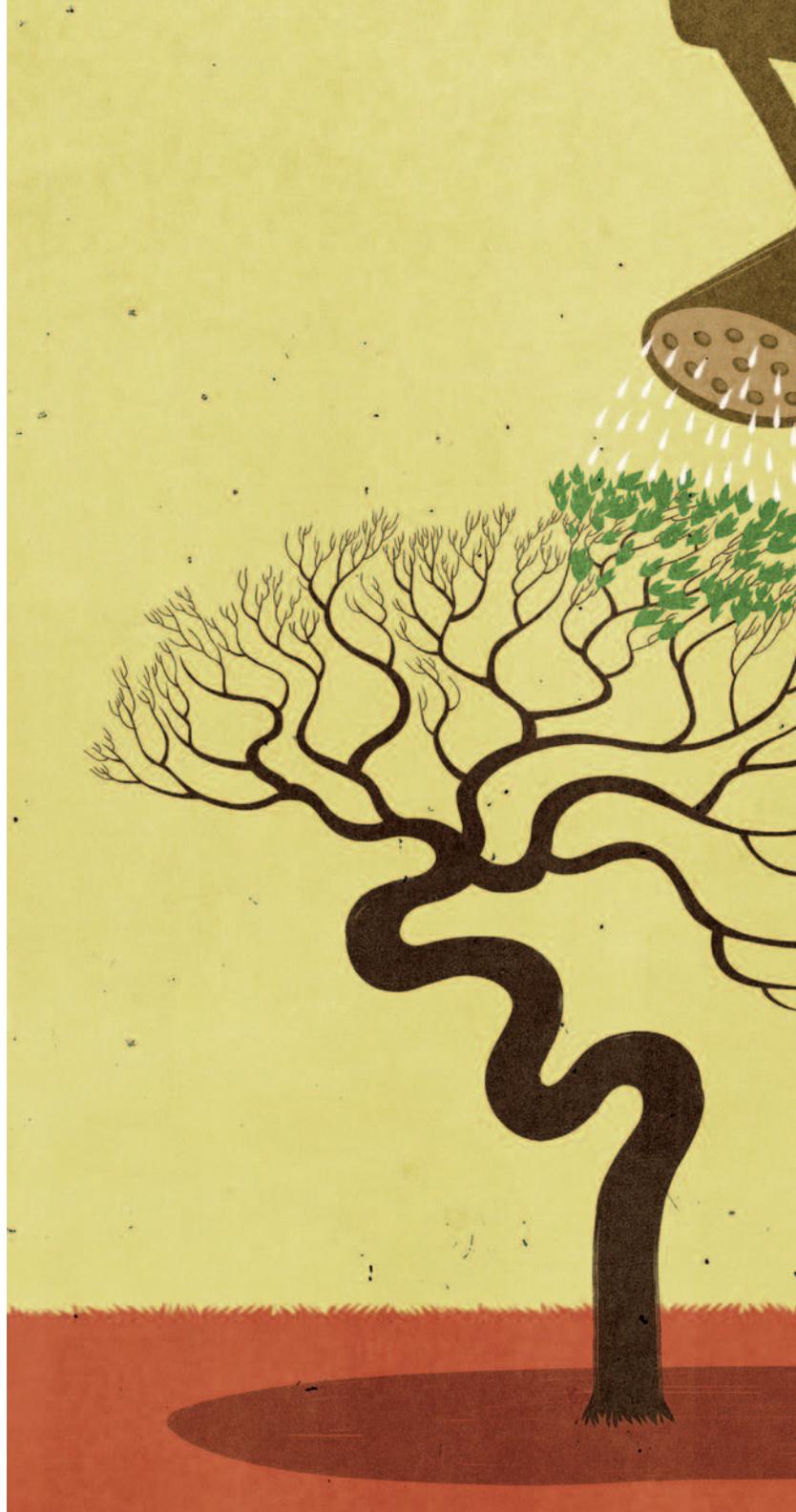


ILLUSTRATION BY SHOUT

PLORAS FACTS

3-D maps of brain damaged areas created and analysed by specialised software

Data from patients at different stages post stroke grouped according to area of brain damage

Highlights recovery patterns most consistent across those who have same area of brain damage

Hundreds of stroke patients scanned and language tested to ensure accurate and specific predictions about language recovery

Evidence indicates people with aphasia can benefit from intensive interventions more than five years after causative event

of the person's performance on the clinically used aphasia test battery – the Comprehensive Aphasia Test (Swinburn et al, 2004).

In the long term, the plan is to make patient-specific predictions about likely improvement in language abilities over time. These predictions are based on the exact size, shape and location of stroke damage to the brain. In practical terms, future patients with aphasia may be shown the rate and level of improvement that other individuals with the same area of brain damage experienced over time.

This could of course be discouraging if the outlook was poor and improvement was shown to plateau at an early stage post stroke. However, the study has already demonstrated that language function continues to improve over decades, with some patients eventually achieving language scores within normal limits (see figure one). It is interesting to note the rate of recovery varies dramatically for different language skills.

Focus on the brain

The PLORAS study looks for recovery patterns that are most consistent across patients who have the same area of brain damage (as determined by brain imaging). These patterns provide an expectation of the typical time course of recovery and can be used as a starting block for examining the efficacy of therapy. Recovery clearly depends on which parts of the brain have been damaged and language recovery can be consistently good following many types of brain damage. This demonstrates that despite the disruption to language in the first few months after stroke, the undamaged parts of the brain are capable of supporting residual language function.

The recovery process can nevertheless

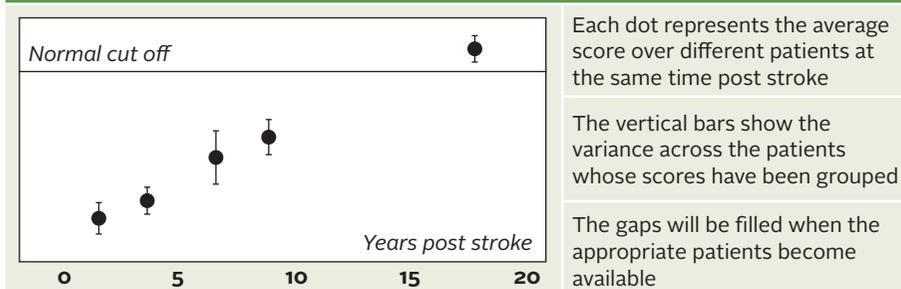
be slow, occurring over many months or years. Ideally, patients should be tested longitudinally to look at improvements in their language function at regular intervals over time. However, longitudinal studies of recovery are limited by financial factors. It is also perhaps unrealistic to expect that older patients will be available for regular re-testing over long-term periods. For these and other reasons, the PLORAS study combines data from many different patients

information on how other patients with similar brain injuries recovered over time.

PLORAS principles

At the Wellcome Trust Centre for Neuroimaging we are conducting an ongoing study called 'Predicting Language Outcome and Recovery After Stroke' (PLORAS). The study involves building a database of language recovery patterns in patients with and without aphasia. The PLORAS database combines detailed information about the effect of the stroke on brain structure (from magnetic resonance imaging (MRI) scanning) with the results

Figure one: Speech production scores from 53 patients with damage to the 'arcuate fasciculus'



“Negative beliefs about the likelihood of recovery could affect patients’ and relatives’ attempts to communicate or engage in therapy”

who vary in the time since their stroke but are grouped carefully according to the parts of the brain that have been damaged.

Location location

This focus of the PLORAS study on the location of brain damage may be surprising given many previous studies have reported that the effects of damage to a particular brain area are inconsistent amongst different patients (Mohr et al, 1978; Lazar and Antoniello, 2008).

However, a renewed optimism of the importance of understanding the location of brain damage has arisen for several reasons. First, brain imaging studies of the healthy brain have shown there is remarkable consistency in which areas of the brain are involved in specific language functions. Second, it is now clear the effect of damage to one brain region depends on whether or not other parts of the brain are also damaged. Therefore, the PLORAS study does not focus on the presence or absence of damage to individual brain regions; it creates a map of all the damaged brain regions. This new approach has only become possible following a number of recent advances in brain imaging techniques.

The need for specificity when defining damaged areas of the brain can be illustrated by analogy to the effect of damage to the body. For example, understanding the effect of a fractured hand, and how to treat it, depends on which part of the hand is fractured. More specifically, the effect of a fractured thumb will depend on whether or not the fingers are also fractured.

With new MRI techniques used in the PLORAS study, it has become possible to create much more precise descriptions of the boundaries of damage to the brain than were previously possible. The area of damage can now be translated into a 3D map showing the

exact shape, size, depth, volume and location of the damaged region. This is then analysed with specialised software to ensure that only patients with the same region of damage are grouped together for analysis. Clearly, this in turn requires a very large patient population and it is for this reason the PLORAS study is continuing to recruit and scan new patients. The more patients scanned at a particular time point, the more accurate the predictions will be for the recovery of future patients.

Illustrating aphasia recovery

Participation in the PLORAS study involves testing patients’ language function with the Comprehensive Aphasia Test and carrying out structural MR brain scans on the same patients at timed intervals after stroke. Participants come from all over the UK for half a day of language testing and brain imaging. Researchers combine summary scores for each subsection (repetition, naming, spoken picture description, reading etc) with the imaging data. The type of language difficulty can then be explicitly related to the area of brain damage taking into account the time since stroke.

Figure one shows that single word speech production skills improve over many years in patients who have damage to the white matter tracts that connect Wernicke’s and Broca’s area (the arcuate fasciculus). The results pertain to one specific area of brain damage and specific language abilities – composite score for single word naming, repetition and reading. Future work aims to establish similar findings for different types of strokes and language functions.

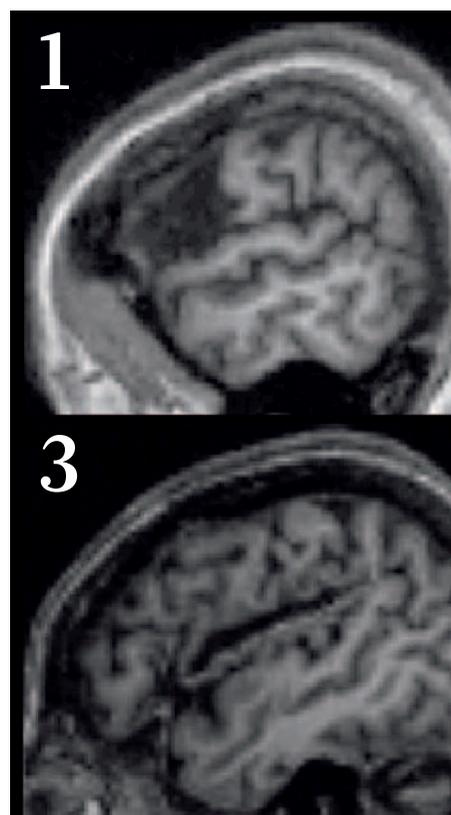
Implications for aphasia therapy

Our results to date, although preliminary, clearly show the longevity of aphasia recovery and should be encouraging to

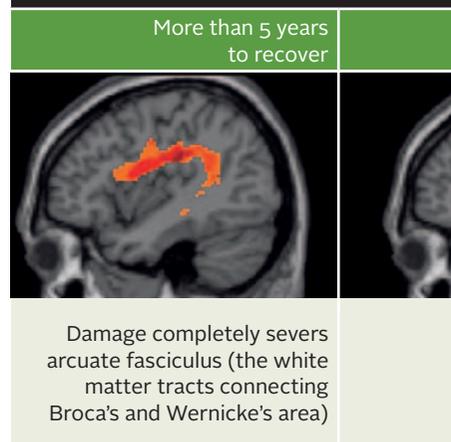
patients, relatives and clinicians. In the future they will provide a comprehensive basis for clinician-patient discussions around recovery.

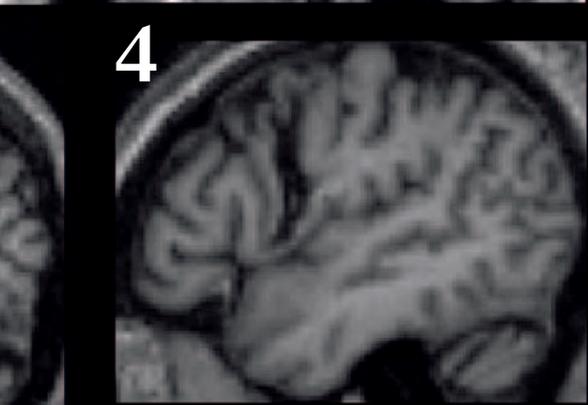
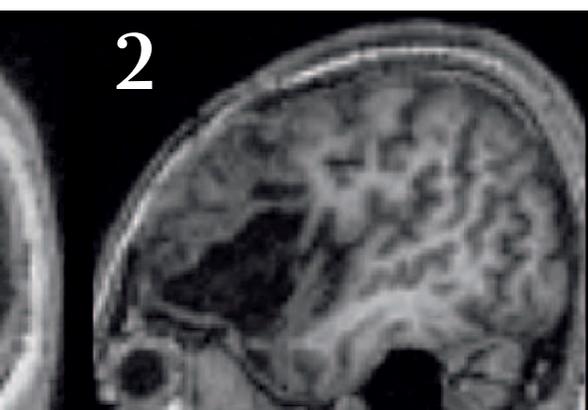
Many studies show the importance of the intensity of aphasia therapy (Bhogal et al, 2003; Holland et al, 1996) in improving language outcome. In highlighting the length of time over which language recovery continues, the ongoing PLORAS study asks us to examine the importance of the duration of aphasia therapy.

That maximal language recovery is not limited to the first year after aphasic stroke has significant implications for how speech and language therapy services are delivered. Our preliminary results suggest there is no ‘ceiling’ in terms of improvement over time, at least for single word production. In fact, patients can continue to make significant improvements in language tasks for many years after their stroke. This suggests



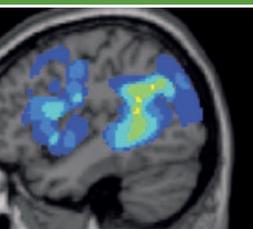
Recovery time for speech production





following different lesion location

Less than 1 year
to recover



Damage to Broca's area and/or parietal lobe but white matter tracts to motor cortex are intact

Less than 1 year
to recover



Damage to motor cortex but Broca's area and parts of arcuate fasciculus are intact

Which of these patients have aphasia? Who will recover first?

Case Study

Chris Mowforth, 57, who volunteered for the PLORAS study shares his story of aphasia recovery

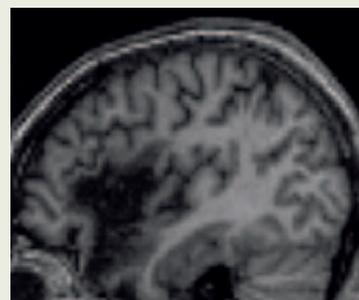


On the morning of 24 January 2003 I had two strokes. I had no feeling in my right side from my arm to my toes and I could not speak at all. About two or three days after my strokes when the orderly came round with the drinks trolley I managed to say "tea" because it was the only thing I could remember – which is ridiculous as I don't like tea.

This carried on for some time. I was in hospital for about three weeks and I started therapy for speech and writing. My leg and arms came back quite quickly but my speech was very limited for three months or so and gradually improved over time. I had speech and language therapy for about two years but my writing is terrible. My language is alright now as long as someone starts the conversation. I can respond to others' comments and sometimes I can respond in some way that gives the conversation some move on. If there are more than three or four people present I can talk only in small comments because I have to work out what I'm going to say and I can't always get my point in.

Although I can't do all the things

I used to be able to do I have been able to return to work for three days a week at a company that deals with spare parts for aircraft. It is encouraging to know about long-term speech recovery from the research, particularly for those who suffer a stroke when quite young. Although it might take a long time, there is hope that they can get their speech back again to something like "normal". The research has helped me to focus my time and realise I can get better with time.



Chris Mowforth's stroke damaged 55cm³ of his left frontal lobe but he no longer has aphasia

that even very chronic stroke patients with aphasia could benefit from ongoing impairment-based aphasia therapy.

Our research illustrates the brain is capable of re-learning language. The next step is to establish how the brain does this. The challenge for the SLT is to identify which treatment approach to use and how to deliver the most effective therapy programme to maximise the brain's natural long-term recovery processes. By understanding the functions of the brain regions that support language recovery, the long-term aim of the PLORAS study is to provide insights into the strategies that could be usefully taught to patients.

Involving your clients

The success of our study depends on studying as many people after their stroke as possible. Patients must be willing to come to London for an MRI scan and language testing on at

least one occasion. We welcome not only English speakers but also multilingual stroke survivors. Participants can be any age and at any stage post stroke. We provide travel expenses and can also supply brain images on CD and/or in print. Interested SLTs acting on behalf of patients should contact Louise Ambridge (monolingual English speaking patients, email: l.ambridge@fil.ion.ucl.ac.uk) or Louise Ruffle (multilingual patients, email: l.ruffle@ucl.ac.uk) to request written information. SLTs with specific questions or comments about PLORAS are invited to contact Professor Cathy Price (email: c.price@fil.ion.ucl.ac.uk). ■

Louise Ambridge (SLT), Alex P Leff (Consultant Neurologist), Jenny T Crinion (SLT), and Professor Cathy J Price contribute to the PLORAS project at the Wellcome Trust Centre for Neuroimaging, Institute of Neurology, UCL, London



References & resources

Bhagal S, Teasall R, Speechley M, Albert M. Intensity of Aphasia Therapy, Impact on Recovery – Aphasia Therapy Works! *Stroke* 2003; 34: 987.

Crinion JT, Leff AP. Recovery and treatment of aphasia after stroke: functional imaging studies. *Current Opinion in Neurology* 2007; 20:6, 667-73. Review.

Holland AL, Fromm DS, DeRuyter F, Stein M. Treatment efficacy: aphasia. *Journal of speech, language, and hearing research* 1996; 39, S27-S36.

Lazar, RM Antoniello D. Variability in recovery from aphasia. *Current Neurology and Neuroscience Reports* 2008; 8, 497-502.

Mohr JP et al. Broca aphasia: pathologic and clinical. *Neurology* 1978; 28, 311-324.

Swinburn K, Porter G, Howard D. *Comprehensive Aphasia Test*. London: Psychology Press, 2004.