Toward more effective, personalised therapies for aphasia

Sophie Roberts and Dr Tom Hope, Predicting Language Outcome and Recovery After Stroke (PLORAS), UCL

Watch the talk

Talk Transcript – Sophie Roberts

Hello, my name is **Sophie Roberts** and I'm a **speech and language therapist**, and a PhD student at **UCL**.

The title of our talk is "**Towards more effective, personalised therapies for aphasia**".

I'm going to talk first about some of the **challenges** in r**esearching aphasia therapy**, and will also present the **results** from a **new therapy study**.

And then my colleague **Tom** is going to talk about **predicting individual response** to **aphasia therapy**.

So first of all, **aphasia** is a **communication disorder** that affects roughly **one third** of **stroke survivors**. It affects **speech** and **language expression** or **understanding**, or both, and it impacts **social participation** and **quality of life**.

Aphasia can cause **different kinds** of **impairment**.

The most common is **word-finding difficulty**. So for an example, someone might have trouble thinking of a word, such as "elephant", even though in their mind they know exactly what it is.

Other **common difficulties** with **aphasia** include **problems understanding** when others **speak**, or **difficulties** with r**eading**.

Aphasia recovery varies for each person.

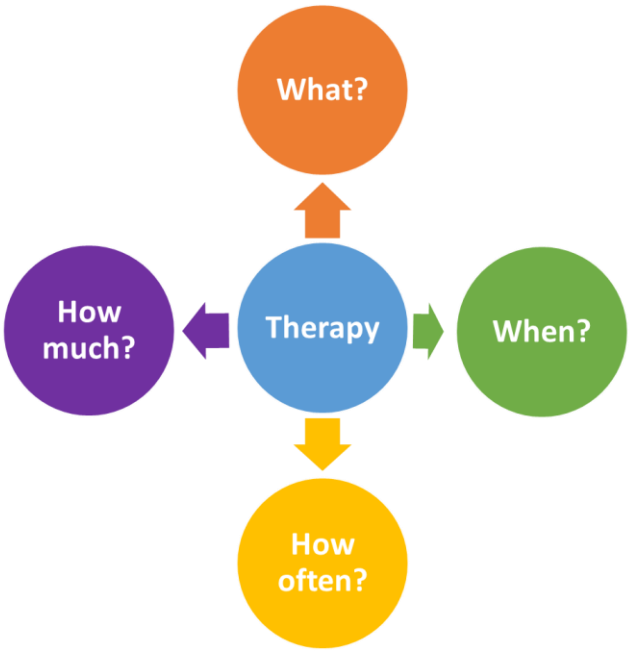
Some people **recover** quickly, **within weeks**, whereas others recover slowly, **after years**.

Recovery depends on:

- **'Stroke factors'**. So for example, the **location** of **damage**, and **how much** of the **brain** has been **damaged**.
- **Behaviour**: so **speech** and **language ability** immediately after the stroke.
- **Demographics**: for example, **how old** someone is when they have their stroke, and
- **Therapy**, which is the **focus** of the **research** that we'll talk about here.

Therapy delivery varies depending on the therapist.

This **diagram** below shows some of these **variables**.



First of all: What. **What is the therapy?** What **language skill** does it **target**? Does it target **speaking** or **reading**, or **something else**?

And then **'How much?'** and **'How often?'**

How much therapy is **enough**, and **how often** does it need to be to **cause significant** and **long-lasting improvements**, without being harmful?

And **'When?'**: **When** in the **recovery pathway** is therapy likely to be **most effective**?

Early post-stroke, when the **patient** is still **recovering**? Or **later post-stroke**, when the **patient** is more **stable**, but the **brain** is **less plastic**, and potentially less responsive to therapy.

Because of all of this variation, it's **difficult** to **assess** the **impact** of **therapy**.

Therefore, **current evidence** for its **effectiveness** is **weak**.

Research requires **many patients** in order to **control** for these **different factors**.

This brings us on to the **first study**, where we used this approach of selecting a **smaller group of patients** from a **wider pool**.

The aim was to **investigate** how **therapy dose** in the **first month** after stroke affects **long-term speech production**.

And a **key difference** about this **study**, compared to previous ones, is that we studied **clinical therapy**.

This means it **wasn't** given as **part of a research trial** – it was simply **whatever patients received** at the time after their stroke.

We selected **patients** from the **PLORAS database**, who met the following **criteria:**

- They all had a **stroke** in the **left hemisphere** of their brain.

- They were all **conscious** and **alert** one week after their stroke. This was so we knew they would have been able to engage in therapy.

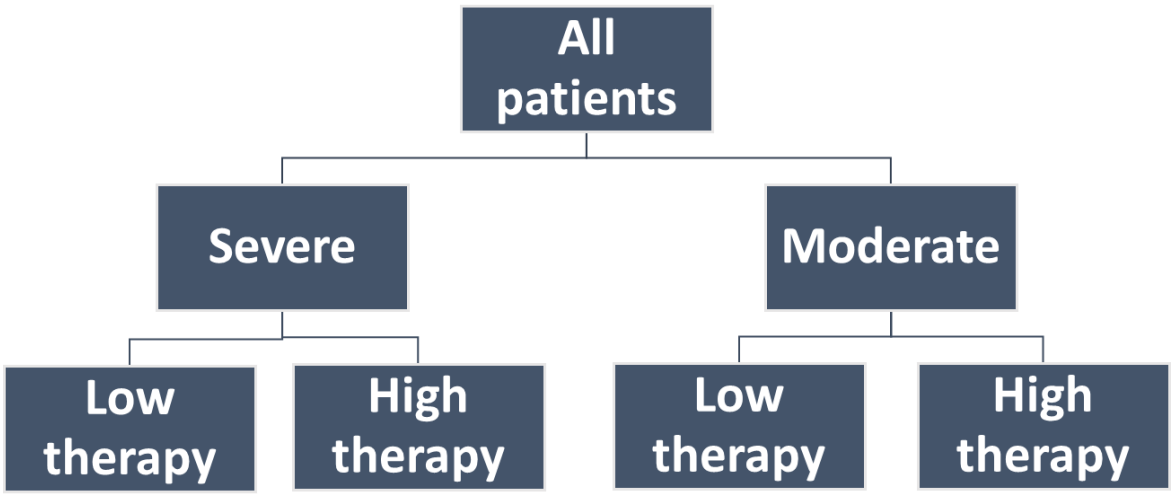
- They were either **severely or moderately aphasic** one week after their stroke.
  And this was because we needed measure improvement, which we couldn’t be able to do for patients with milder aphasia who recovered quicker.

- And we selected patients for whom we could **count** and **determine how much therapy** they had in the first four weeks after their stroke.

We also **excluded** any **patients** who had **lots of therapy** after that first month.

And this was so that we could match the groups and control for any effect of later therapy on long-term recovery.

We categorised those patients into **two groups** according to their initial severity: **Severe** and **Moderate**.



We then **categorised** those groups **again**, according to the amount of early therapy they received.

Patients in the **Low therapy group** received **less than one hour per week**.

Patients in the **High therapy group** received **one hour or more per week**.

We **measured speaking improvements** in two different ways.

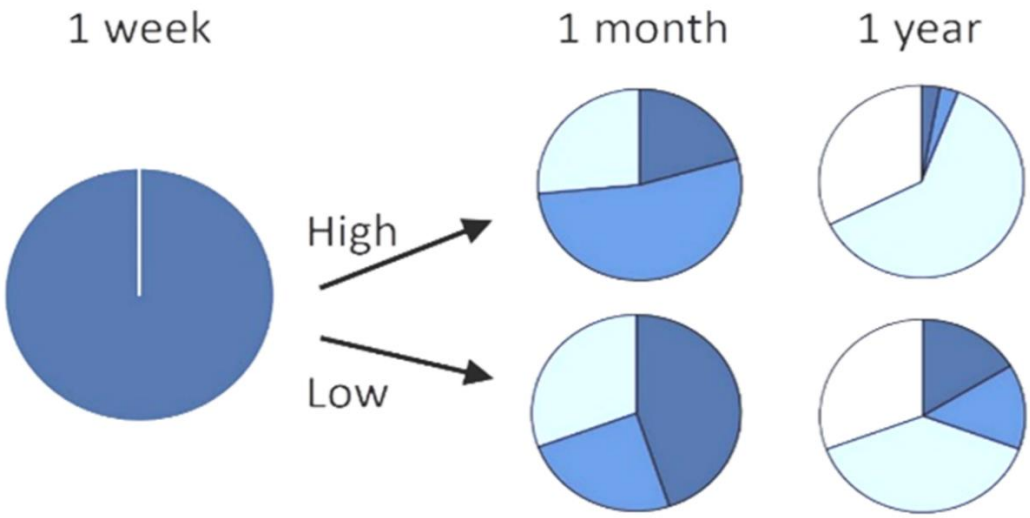
The first we used **self-rated scores**. Each patient was asked to rate their speaking ability **one week**, **one month**, and **one year** after their stroke.

The second way used scores from a **standard aphasia assessment**, which measures ability to **retrieve words**, **repeat words**, **speak** in **full sentences**, and **write**.

Our results showed that when we **control for multiple factors**, there was a **significant effect of therapy**.

More patients recovered after **High therapy** compared to Low therapy.

The **chart** (below) shows the **outcomes** for each **therapy group** at **one month** and **one year** after the stroke.



And the **darker colour** indicates **Severe speech difficulties**.

So you can see on the left, **at one week**, **everybody** had **Severe speech production difficulties**.

The **lighter colours** indicate **Recovery**.

You can see on the right hand side, at **one year**, most **High therapy** patients, which is the top chart, are in the l**ighter coloured groups**, which means **most of them recovered**.

After **Low therapy**, which is the bottom chart, about **one third** of the **patients** are still in the **darker coloured groups** at **one year**, which means they still had **severe speech difficulties**.

That **concludes** my part of the talk. I'm going to pass over to **Tom**, who's going to talk about **predicting individual response** to **therapy**.

Talk Transcript – Dr Tom Hope

Thank you Sophie.

So having established that **higher doses** of **clinically routine therapy** might be **more beneficial** than lower doses, we now turn our attention to attempts to improve on what is currently done.

My colleagues and I at UCL devote a lot of research to **new therapies** for **aphasia** after stroke. And one thing we very often see, is that in any given therapy study, **some patients** will **respond** much **better** to the therapy under consideration **than others**.

In recent years, we have begun to ask whether these **differences** might be more than just random variation – or specifically, whether we might be able to **predict** them ahead of time. To the extent that we can, this offers the compelling prospect of being able to recommend for each patient the particular therapy that might most accelerate their recovery.

So, I'm going to show you two results that to my mind show that this kind of recommendation might well be possible in the future.

So, this **first study** is focused on a treatment for **reading impairment** called **iReadMore**. This is a **computerised application**, it can be used on computers or tablets, and it's designed for use at home in a **self-administered manner**, over a period of weeks or perhaps months.

So, the idea is that the patient takes it home and it engages them in the **mass practice** of **reading single words**. You know, read hundreds and hundreds or perhaps thousands and thousands of words, and over time their word reading gets better.

In past work, we got a group of **23 patients** to use this **application** at home for several weeks and we found that as a **group** they did infact **improve significantly** in their **reading**. But exactly as we always find, **some patients** appeared to **respond** much **better** than others to the treatment.

So, in order to try to **predict** those **differences**, we went back to the **patient data** that we acquired before the patients took the application home with them.

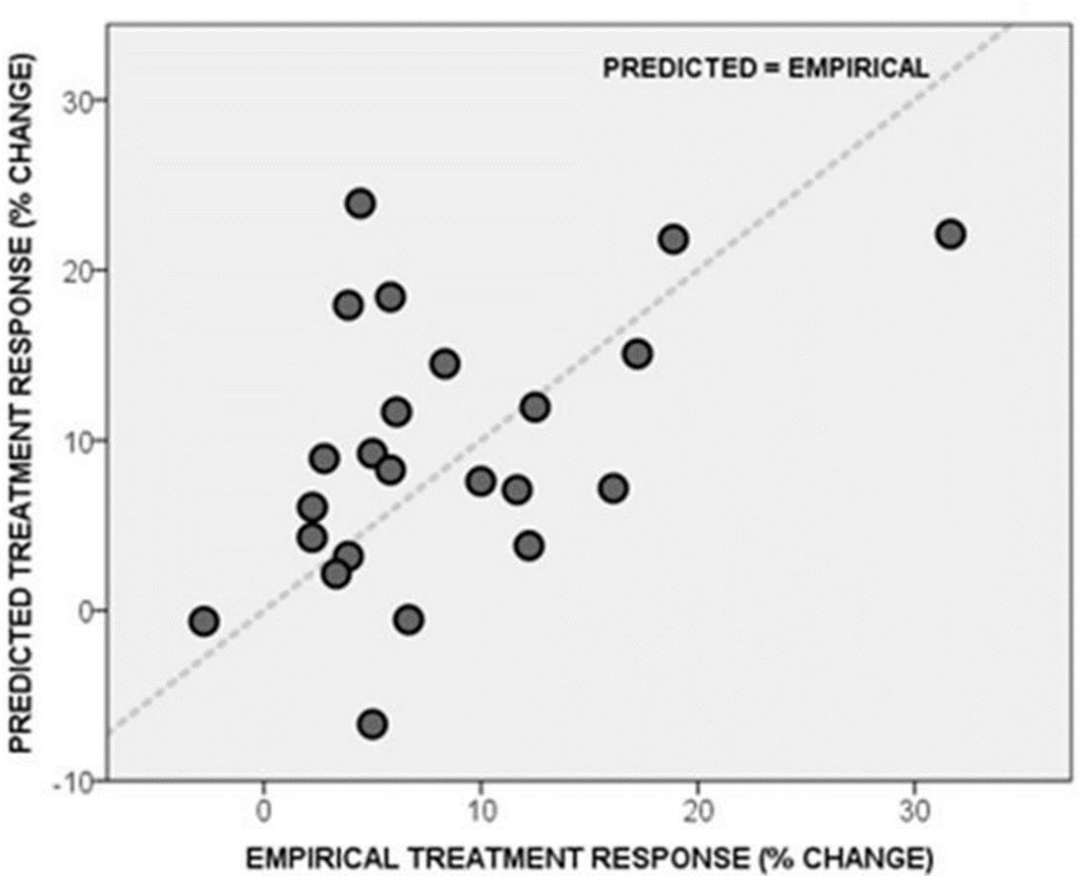
These data included

- **demographic data**, things like their age, age at stroke onset, and sex,
- **pre-treatment cognitive data,** typically scores on standardised assessments of cognitive impairment severity, and
- **structural brain imaging data**, which we used to infer the extent and location of brain damage that each patient has suffered.

So we **relate** all of these diverse sets of **pre-treatment data** to the patients' **treatment responses** using **machine learning**.

And, crucially, we also **simulate** what would be required to **predict treatment responses** for **new patients**, by dividing our group of patients into groups, and making predictions for each group on the basis of models trained with data only from other groups.

And the headline is that the predictions from this process are really not bad.



So what we're seeing here is a **scatterplot**, each **patient** contributes one **circle** to the plot and each **circle** relates the **predicted treatment response** for that patient to the same patient's **empirical treatment response**.

So, if the **predictions** were **perfect**, then all of the **circles** would lie on the **diagonal line** (where predicted response equal empirical response).

So, we can see from the plot that the **predictions** are **imperfect**, but remember that this is a **small sample**, and certainly these predictions are good enough to give us **confidence** that in a larger sample to work with, they might well be able to **train models** that that make **predictions** that are **accurate enough** to be **useful**.

Armed with what we consider to be good success in the first study, we thought we would apply similar methods to a different treatment, this time for **naming impairments** or **anomia**.

This **treatment** is structurally quite **similar** to iReadMore, it's a **computer application**, it can be used on computers or tablets, it's designed for **self-administered** use at home over a period of weeks or months.

So in many ways it's very similar to iReadMore, except that the **focus**, the task that it **encourages patients** to practice in is not reading but **picture naming**.

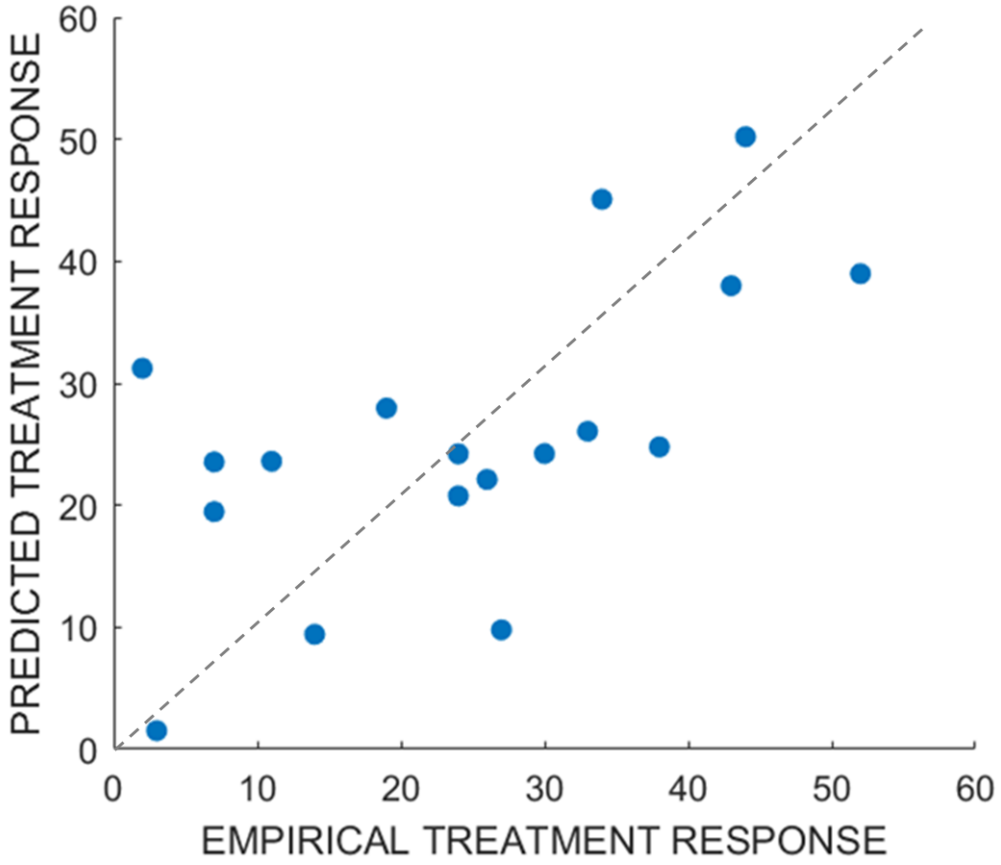
So here is an example, where in this case the patients would have to say the word 'fruit' to get the answer right.

So, again, as with iReadMore we conducted a group study where patients took this application home with them, and we found that as a **group** those patients' **naming skills** did actually **improve significantly**.

But exactly as in study 2, we found that **some patients improved much more** than others. So we sought to **predict** that **improvement** from **pre-treatment data**, where the data was much the same sort of stuff as in study 2, namely **demographic data**, **pre-treatment cognitive scores** and **structural brain imaging** data.

So, just as in the previous study, we used **machine learning** to relate **pre-treatment data** to the **treatment responses**. And we also simulated what would be required to make predictions for new patients by dividing the patients into groups, and making predictions for patients in each group after training with data from other groups.

And here again, the predictions really aren't bad.



So this is a plot on the exactly the same format as we had for Study 2. Each **patient**, remember, contributes **one circle** to this this plot. And exactly as before, we find **the predictions** are **imperfect**, they're not all precisely on that diagonal line where predicted score empirical score, but they're not miles away from it. And again, this kind of result gives us **confidence** that we can do well enough to be useful given more patient data to learn from.

So, that brings me to the end of those two studies, I'll just summarise what both I and Sophie have said.

Namely that, first, we now have **reasonably compelling evidence** that **higher doses** of **clinically routine therapy** make for **better stroke outcomes** than lower doses, at least as regards to the first month after stroke.

And second, that **individual variation in responses** to specific therapies is at least **somewhat systematic** and **predictable**.

So taken together, we hope results like this will open the way for a more **effective** and **personalised rehabilitation science** for **aphasia**. And indeed just a more positive science for the rehabilitation of aphasia.

Glossary

Anomia: a type of aphasia, where the patient has difficulty recalling the names of everyday objects.

Aphasia: Aphasia is a communication disorder that affects expression and/or understanding of speech and language.