Professor Robert Logie and Dr Alicia Forsberg

Working memory across the adult lifespan

[music 00:00-00:07]

Isabella Melking: This is Forward Thinking. I am Isabella Melking.
Our ability to keep track of ongoing thoughts, plans, actions, current tasks and changes around us, is essential for everyday living. This ability is known as working memory, a system of the brain that allows us to focus on what we are doing, switch tasks, solve problems, or do several things at once, such as walking and talking.
However scientists disagree about what limits our working memory ability, and how those limits change as we grow older. The research project 'Working Memory across the Adult Lifespan' brings together three separate teams, each with different ideas about how memories work. Here to discuss are psychology researchers Professor Robert Logie and Alicia Forsberg, both part of the University of Edinburgh project team.

Alicia Forsberg: I'm Alicia Forsberg, and I'm one of the post-docs on the WoMAAC project, and I'm here today with Professor Logie.

Robert Logie: And I'm Robert Logie. I'm a professor at the University of Edinburgh, and I'm the lead researcher on this project, which is looking at what's called working memory, and how it changes across the adult lifespan. An interesting thing about the project is that it involves a group of scientists from different countries who disagree with one another, and we got together to try and work out our disagreements, get some resolution, and perhaps understand something more about human memory.

AF: So I guess first of all, we should distinguish between working memory and short-term memory. So how would you define the difference?

RL: Working memory refers to what we have in our mind right now, what we're thinking about right now, but also ability to manipulate, to process, to deal with that information. So short-term memory refers to ability to hold onto information over a couple of seconds, as we're going through our daily lives. And what we store changes from moment to moment as we move round the world. But we don't only store information. We can also manipulate it, we can calculate, we can problem-solve. So if we're trying to remember a set of numbers we can also add them up and subtract them, we can hold partial solutions to problems as we act on providing a solution, and so on. So short-term memory is really part of working memory. Short-term memory is the bit that stores information whereas working memory is referring to how we use the information that is stored.

AF: So I guess a good distinction would be if you give someone a sequence of digits to remember, and just ask them to repeat it back, that would be measuring their short-term memory, but if you give then the sequence of digits and them to repeat them to you backwards, that would be a task measuring working memory.

RL: That's exactly right. But if you think about it even outside of the lab, in our daily lives, every waking moment of our life we're keeping track of what's going on round about us to make sense of the world, and we're continually updating our information about what's around about us, in order to interact it properly. In order for me to understand what you're saying, and for you to understand

what I'm saying, you have to remember what I've just said. And that has to continue to update, it doesn't help you understand what I'm saying now to recall what you heard maybe ten minutes ago.

AF: Mm

RL: So this idea that we're continually updating the contents of our working memory, and trying to process it, trying to understand the world around us.

AF: So how did the idea for the WoMAAC project come about? Working with people who have different ideas about how memory work[s]?

RL: There's a tradition, particularly in studying how the brain operates and works, for different groups of people to develop their own theories, their own understanding of memory, and to work with people who are like-minded, who have the same kind of ideas, who tend to agree with them. It's very unusual, particularly in our area of research, for different groups to work together that disagree. And the whole idea of this project was to say well, maybe if you just work in your own individual labs, then you just perpetuate debates, and never actually get anywhere in terms of really advancing understanding. So the whole point of the project is to get different groups together to directly address their differences, see how much is a real difference, how much is just apparent, and superficial, and then set up research projects where we use the same kinds of experiments, we use - approach it in the same way, but we have different expectations for the outcome of the research, and then test those different outcomes. Hopefully the result of that will be instead of lots of different new theories, one more integrated idea that gives us a real genuine advance in understanding of how human memory works.

AF: Briefly, what can we say the differences between the different models on the project?

RL: The three approaches that are involved in this project are characterised really by the extent to which we see memory as a single thing, a single entity or a single ability, that is governed by what's quite often referred to as a tension, this idea we kind of have a limited capacity resource, which we call a tension, and that for example when we have to do two things at the same time, that attention is divided up. And the more you divide it up, the weaker each task is performed, so because it's a limited resource, then we can reach that capacity very quickly, it's a limited capacity. And that's in contrast to the idea that we actually have multiple different things that we can do with it that our brain can cope with at the same time, and we can do things in parallel, and that we have very specific abilities that can deal with particular kinds of tasks. So we have one ability that helps us remember words and deals with language, there's another ability that helps us remember what things look like and where we are. Yet other abilities that might deal with remembering movements and pathways, and so on. So that characterises major differences between the two different kinds of models, but there are three groups. Where is one model that has a sort of hybrid of these two, where it recognises that there may be some multiple abilities available, but that we switch between these abilities, and the ability to switch between them is limited by some sort of central capacity for attention.

AF: Yeah, that made think about something I thought was very interesting when I started working on the project, that a task that I'd used before in my research, and then as the running memory task, was referred to as the focus of attention task. So I think, you know, for most people, if we would say we have conducted a study finding that we can improve memory, or we can improve attention, that would be very different things, and it's quite a challenge to convey the differences,

you know, if the same task is actually measuring these different things and how they intersect and so on.

RL: Sure, a lot depends on which kind of theory you start off with. So if you start off with the idea that we have a single limited capacity, attention, then putting a demand on that is going to cause maybe problems, we wouldn't be able to do the task terribly well, because it's pushing the capacity to its limits. However, if it's the case that we have different aspects of what a brain can do, and some of these things can be done together, in parallel, without interfering, then you might well be able to do your running memory task, and at the same time think about what you're going to have for dinner, and, or perhaps a cycle or walk down the street. So the idea of walking and talking is a good example of this.

AF: Mm. So far in the project, have you been very surprised by any of the results?

RL: I think all the researchers involved, in all eight researchers have been involved in this across three countries, and the most surprising result is that the experiments that we've run cannot be explained by any of the three theories that we started with. So as I mentioned earlier, we have different expectations of what might come out of our research, and so we specified what those were in advance, and then after we looked at the results, and we discovered that actually the expectations were not met by any of the three theories. So this got us thinking about why that might be, so that some aspects of the results could be dealt with by one idea, other aspects of the results could be dealt with one of the other theories or ideas. So how might we resolve this? And we're starting now to look at the changes in the way that people do tasks, as a possible way to resolve the differences. So one other tendency in experimental studies of how cognition works, how memory works, how attention works, is that there's one way which a particular task is performed by people in an experiment. However, if you start to think about the possibility that the same task might be performed in different ways by different people, or in the same person on different occasions, then you might start to get some insight as to why these differences have arisen. So give you an example, you ask people to remember what a set of colours are that they looked at. Some people might remember them as the visual appearance, what the colours looked like. Other people might remember the names of the colours. And depending how they do the task, you'll get very different kinds of results, and depending on the experimental manipulations, you might get people changing the way they do a task, and by examining this we're now beginning to get a better insight into why these differences have arisen, and perhaps come towards a more integrated theory that incorporates elements of all three.

AF: So how are you able to investigate how the approach differs?

RL: One way is you simply ask people 'how did you do this?' and of course people are not always fully aware of what's going on inside their heads. So we have to check if what they say kind of matches how they're performing on the task. Now what we have found is that when we do ask people in our experiments, that there seems to be a very interpretable, a very sensible association between what they say and how well they perform. So when they're given a difficult task, what do they say changes about how they do the task? And what they say fits with the change in the performance.

AF: That's very interesting.

RL: Mm. So looking at these kinds of strategies is relatively novel also in these kinds of studies,

because there tends to be just the focus on how well people did, how fast they can respond, how much can they remember. But if we start asking questions about how you're remembering this, or why is it that you're slower here than there, it gives us enough more insight into what's going on. Another approach we can take to this, of course, is we instruct people to perform tasks in particular ways, and then look at how the different instructions affect the way that people perform the tasks.

AF: Mm. So one example is in one of the studies we have people trying to remember eight different colours that are selected to be difficult to name. And some of them report that actually they divide them into warm and cold colours, and then assign them numbers depending on how dark they were, and then they could verbally rehearse those numbers. Do you think that's an interesting insight into how working memory works, or is it more an artefact of the task in itself?

RL: Well, this is a real difficulty that we're trying to address in the project, and that is that when researchers develop their theories of how memory functions, how it works, there's this kind of assumption that say everybody does the task in the same way. And they don't really consider that there might be different ways of doing the task. So if we start to think about that, then maybe we get better insight. The other is that if we do assume that there's only one kind of memory system in the brain, instead of thinking that maybe people have a set of kind of mental tools, and that what we do is we choose which tools we want to use to perform a task, and in different combinations. And this then allows us to understand the different ways in which people can do the same task. So if you want to take the analogy of trying to get a screw into a bit of wood, that you could use a hammer to do that, or you could use a screwdriver. Now if you don't have a screwdriver, then maybe a hammer will do the job. But it wouldn't do it quite so efficiently. So it may well be a bit like this with kind of mental tools, that people vary in how good they are at choosing the right mental tools for the tasks that they're being asked to perform.

AF: Mm. Do you think this relates back to the - the issue of different researchers testing their own, not also theories, and then finding that the results tends to fit with their own theory? Simply they design a task that's somehow bringing out a certain type of response?

RL: I think the kind of tasks that people are asked to do in the different labs, possibly the exact wording of the instructions to participants, there could be different background to the participants that take part, and so on and so forth. So there could be a lot of differences between labs that result in these different patterns of outcomes. One of the things we're doing in WOMAAC project is that we're doing things exactly the same in different laboratories at the same time, so it's a real test of the ideas, trying to get rid of as many differences, other differences between the labs as we can.

AF: Mm

RL: Now one of the things that of course is very important about this kind of project, and its success, is that first of all we have to get on as people. We have to be able to go and have a coffee together or dinner together afterwards, and not sort of result in major arguments. That's - that's a really important factor for the success of the project, you have to really like the people what you're working with, even if you disagree with them professionally.

AF: Yes

RL: And then it's also important that we all have an open mind when we start. Even when we start from different perspectives that we have to be open to the possibility that we're wrong. And to

think about alternative interpretations of the kind of results that we get from our experiments.

AF: Yes

RL: And those elements are really essential for this kind of project to work. The project is referred to as a kind of adversarial collaboration, whereas collaborating between people that disagree with one another. But actually if it's too adversarial, then the whole thing could fall apart, and the project's been running for three years and we're still friends, so that's - that's a good sign.

AF: Yes. Yes, and I guess that could be quite surprising to people who do not do work in psychology, that this kind of collaboration doesn't happen more often.

RL: Yes, indeed it's kind of surprising to me when I start to think about it, er, that it's just the way that this kind of research has tended to work, and it's just very rare that we get groups of people who disagree working together. It really doesn't happen until somebody takes the initiative to chat to people who they interact with at conferences, or that there's work they've seen in print in published papers. And then see - well, do we get on these people, are we open-minded enough to look for resolution? And maybe that doesn't work out terribly well a lot of the time, if people are - have too much of a vested interest in what they've developed themselves.

AF: Yeah. Why do you think that tends to happen? Do you think there's something with the wider reward system in academia?

RL: Well, yes, I mean you want - like to think that all scientists are - are motivated by advancing understanding. But of course there are also issues of career progression, and one very good way of establishing a reputation is becoming expert in a very narrow topic, to develop your own theory rather than adopting somebody else's. And there's a quote from some time ago, from an American researcher, that theories in cognitive psychology are a bit like a toothbrush.

AF: Mm

RL: Everybody needs one, but you don't want to use one belonging to somebody else. And that general approach to developing theory, it helps people with developing their own careers as academics. But it's less efficient in terms of advancing understanding.

AF: Mm. Which should be the ultimate goal.

RL: Yeah, indeed it should.

AF: One can hope.

RL: The other thing to think about, of course, is how this has relevance outside of the lab, because, you know, we're dealing with these experiments in laboratory conditions, and we're looking at how people perform and do these different kinds of tasks. But it's worth just chatting a bit about how it benefits people outside - is there any benefit to the general public from this? And clearly, if we can have some understanding of how memory works, then we can also understand what happens when it goes wrong. We can look at effects across age, and if we can understand what changes with age, and what is preserved with age, we can then target help that people need for those things that are deteriorating or declining with age, we don't patronise people by helping them with things they're

perfectly good at. So helping people continue to have active contributions to working and social life, can arise from this kind of project. And then understanding the kinds of problems that people suffer from as a result of say worse kinds of brain damage, that can arise if we get a clear understanding of how the healthy brain works. We can perhaps understand the nature of the problems that people suffer when they've had some kind of brain damage.

AF: Hm. So I guess for a concrete example, do you think that this research on memory, attention, processing, could help for instance designing websites in a way that's easier to use, perhaps for older adults?

RL: It certainly could if we know how people process information, how they store information, how they change, and one of the things we have found in some of our research is that, as people get older, they're less good at dealing with remembering what things look like and where they are, and they're really quite good at dealing with language. Now a lot of websites and computers are based purely on visual input, on visual icons and so on. And the linguistic aspects of their abilities are really underused, and so older people might find computers easier to use if they relied less on visual appearance and icons and so on, that are more suitable for younger people. So those kinds of insights could certainly be helpful in an increasingly digital age, to make sure that older people still have easy access to electronic facilities that society's increasingly dependent on.

AF: Mm

RL: One of the things we should finish with is just to mention that we have available a set of memory tests that come from our lab, as of memory challenges, that are available on the internet for anybody to use, to understand their own memory a bit better, but also hopefully contribute to some of our research, if we get enough people taking part.

AF: Yeah, and they include some tasks that are a bit more fun than typical memory tasks.

RL: That's right. We'd hope that they would be fun to do, and - and challenging -

AF: Yes

RL: at the same time. Go to our project website, which is womaac.psy.ed.ac.uk, that's W-O-M-A-A-C-dot-P-S-Y-dot-E-D-dot-A-C-dot-U-K, and you'll see lots of information about the project and have access to the various online tests.

IM: If you want to know more about the topics discussed in this podcast, follow the links on the Forward Thinking blog, at forwardthinking.ppls.ed.ac.uk. You can also subscribe to our podcast on iTunes for more research news and views from philosophy, psychology and language sciences here at the University of Edinburgh.

[music 21:10 to end at 21:25]