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Longing for a better memory? Be careful what you wish for, says **Jessica Marshall**

Unforgettable

SOME things in life are best forgotten. Unfortunately for AJ, forgetting is a luxury she can only dream of.

A 42-year-old woman from California, AJ remembers every day of her life since her teens in extraordinary detail. Mention any date since 1980 and she is immediately transported back in time, picturing where she was, what she was doing, and what made the news that day. It's an ability that has baffled and amazed her family and friends for several decades, but it comes at a price. AJ is locked in a cycle of remembering that she describes as a "running movie that never stops". Even when she wants to, AJ cannot forget.

She is one of a handful of people with similar abilities now working with neuroscientists to find out how and why they remember so much. As their brains are probed for clues, one thing is becoming clear: having a normal healthy memory isn't just about retaining the significant stuff. Far more important is being able to forget the rest.

It's seven years since AJ's extraordinary abilities first came to light, when she wrote to neuropsychologist James McGaugh at the University of California, Irvine, asking for help. She described her constant recall as "non-stop, uncontrollable and totally exhausting" and as "a burden" of which she was both warden and victim.

Intrigued, McGaugh and his colleagues Elizabeth Parker and Larry Cahill, also at UC Irvine, set about investigating AJ's memory. In initial tests, they found that she was able to correctly identify the dates of every Easter for 24 years, plus where she was and what she was doing on those dates (details later verified

against her diary entries). Not only that, AJ could identify the day of the week for any date since 1980 and was able to give the correct date for seemingly forgettable events such as the date of the "Who Shot J. R.?" episode of the TV soap *Dallas* (*Neurocase*, vol 12, p 35).

Convinced her condition was new to science, the team dubbed it "hyperthymestic syndrome" – from the Greek "thymesis", for remembering. They have since identified a handful of other people who appear to have a similar condition. So what makes "hyperthymestics" different from the rest of us, and can they tell us anything about the murky workings of normal memory?

The root of hyperthymestic syndrome could lie in any of the stages of normal remembering. Broadly speaking, a memory is formed in three stages: first it is encoded, then stored, and later retrieved. It may be that AJ and her fellow hyperthymestics carry out these three tasks with much greater efficiency than the rest of us. But there's another, perhaps more intriguing possibility. AJ's extraordinary memory could also be explained by a failure of the strategies our brains use to help us forget the things we don't need to remember.

In simple terms, new memories start life as the temporary excitation of synapses in a network of neurons. If you recall a memory, the same neural pathways are reactivated. The more times this happens, the more important the brain deems the memory to be and the more likely it is to be converted into a long-term memory, by forming permanent connections between the neurons. These connections are reinforced each time the





memory is recalled, making it easier to retrieve. The brain contains so many potential synaptic connections that, in theory at least, there is no limit to the number of long-term memories that the brain can store. So why don't we remember everything?

"A system that records every detail willy-nilly and makes that information accessible on an ongoing basis is one that will result in mass confusion," according to Dan Schacter of Harvard University. He says we forget because the brain has developed strategies to weed out irrelevant or out-of-date information. Efficient forgetting is a crucial part of having a fully functioning memory. When we forget something useful, he says, it just shows that this pruning system is working a little too well.

Forget to remember

In his 2001 book *The Seven Sins of Memory* Schacter describes several ways that we forget. He calls one "sin" transience. This is a strategy whereby we discard information that is out of date – an old phone number or what we ate last week, for example. Since retrieving and using information solidifies it in memory, our mind gambles that the information we rarely retrieve is safe to discard.

Another sin is absent-mindedness where, for example, we fail to properly encode information about where we put our keys because our attention is elsewhere. Yet another problem is blocking, where the brain holds back one memory in favour of a competing memory, so we don't get muddled, for example, where a single word has two different meanings (see "The need to forget" page 33). Occasionally we retrieve the one we don't want first, then struggle to remember the other.

Schacter argues that each of these strategies has an adaptive purpose, preventing us from storing mundane, confusing or out-of-date memories. We want to remember our current phone number, not an old one, and where we parked the car today, not last week.

Clearly, AJ's memory doesn't work in quite the same way. The question is, why not? So far, there is no clear answer, but one clue could lie in the fact that AJ, and a similar individual called Brad Williams, both have ►



obsessive qualities. Could they simply be rehearsing the details of their lives over and over? While neither AJ nor Williams is autistic, like some autistic savants they are unusually interested in dates. "In both of these cases, they know the calendar. There's something about attention to and knowledge about the calendar that accounts for part of this," says McGaugh. Indeed, AJ holds a mental calendar of months and years in her head, and describes the calendar as something she "just knows".

In addition, AJ has kept a daily diary for 32 years, and says that she has "always needed order". She and Williams both have collections of TV guides going back several years. These compulsive strategies may be helping organise and reinforce memories, meaning they are less likely to get filed and forgotten.

Crucially, though, while AJ's memory is impressive, it is not indiscriminate and could not be described as photographic. McGaugh's team discovered this several hours into a testing session by asking AJ to close her eyes and describe what the researchers were wearing. She had no idea. Similarly, she could not recall which dates the team had quizzed her about a month earlier. "Her autobiographical memory, while incredible, is also selective and even ordinary in some respects," McGaugh says. This was evident in AJ's poor performance on tests in which she was asked to memorise word lists or recognise faces. Not only that, AJ had been an average student, unable to apply her prodigious memory to her studies.

Williams's memory also has its limits. He still has to work at learning his lines for the

"Having a normal, healthy memory isn't just about retaining the good stuff – it's about forgetting the rest"

community theatre productions he acts in and, despite being a Scrabble aficionado, he has not memorised word lists beyond the two-letter ones. "It is the autobiographical memories, I guess, that seem to be effortless to me," he says.

Both Schacter and Michael Anderson at the University of St Andrews in the UK believe that what appears to be an innate ability may have a lot to do with the obsessive rehearsing of past events. It may be that AJ and Williams get so much satisfaction from remembering autobiographical details that they have become experts on the history of their own lives; things they find less interesting are not so well stored.

Trick of the mind

There are numerous other examples of memory expertise out there, as K. Anders Ericsson of Florida State University in Tallahassee and others point out. Consider waiters who learn to remember umpteen diners' orders, chess masters who can reproduce the positions of all the pieces on an active chessboard after just a glance, or actors who memorise complete plays by Shakespeare.

"Our work has pretty much concluded that differences in memory don't seem to be the result of innate differences, but more the kinds

of skills that are developed," Ericsson says. He sees no evidence to suggest that the skills of AJ and Williams need additional explanation.

McGaugh rejects the idea that hyperthymestic syndrome can be explained away so easily, however. Even if these people are obsessed, he argues, that does not explain how they are able to memorise so much. "You'd have to assume that every day they rehearse it, or at the time rehearsed very strongly, saying 'I've got to remember that Chilean President Salvador Allende died on this day – 11 September, 1973.'" AJ agrees, and describes her remembering as automatic. She points out that such rehearsals would take up more hours than there are in the day. Williams, too, says his remembering is effortless. "We give these people very obscure questions when we quiz them," adds McGaugh. "The probability of these explanations dwindles as you look at the evidence."

Of course, it may be that hyperthymestic syndrome relies not just in the encoding, but also in the retrieval of memories. No one knows whether forgotten memories truly disappear, or whether we simply lose the ability to retrieve them. Perhaps AJ and Williams are just better at retrieval than most, or perhaps related memories are more strongly linked in their brains so that one memory leads seamlessly to the next. AJ in

particular is prone to get lost in remembering: one recollection triggers another and another and she claims to be powerless to stop them. "It's like a split screen, I'll be talking to someone and seeing something else," she told McGaugh. This aspect of AJ's memory demands explanation, says Schacter. "Why is she stuck in retrieval mode?"

Anderson wonders whether AJ has some deficiency in the unconscious control mechanisms which normally prevent unwanted memories from flooding back. It would be very difficult to test for such unconscious processes, but Anderson has shown that it is possible for people to consciously suppress memories. To investigate these mechanisms in people with normal memory function, he trained people to remember word associations, then instructed the group to "forget" half of the associations they had learned. Sure enough, people remembered less of what they were told to forget (*Nature*, vol 410, p 366). Anderson then used a functional MRI scanner to look at brain activation during such trials.

As volunteers consciously suppressed the retrieval of learned associations, Anderson observed activation in a part of the prefrontal cortex – the area of the brain associated with impulse control and executive function (*Science*, vol 303, p 232). One participant in the trial was an Iraq war veteran who told Anderson that he was constantly fighting to suppress memories of the experience. "He showed massive activations in our task," says Anderson, indicating that he had become very skilled at pushing back his memories.

By her own accounts, AJ seems unable to do this. She describes her constant retrieval of memories as mentally exhausting and says that negative memories return to haunt her again and again. So it is a possibility that AJ's control mechanisms are impaired in some

Forget me not

Forgetting may serve a useful purpose, but that doesn't mean we have to take it lying down. Here are some hints to remember:

1. Pay attention. "A rock-solid characteristic of memory is that it is enhanced by attention," says Michael Anderson of the University of St Andrews in the UK. So, for example, make a conscious effort to think about where you leave your keys when you come in. You could even try saying aloud 'I am putting my keys on the table'.

2. Be organised. Memories are like pieces of mail, says Anderson. It takes very little effort to open your mail and throw the contents all over your desk, but when you need

to retrieve one, it won't be easy. If you file related pieces of mail together, it's a snap. So when you need to remember something, try to link it to an existing strong memory. If you want to remember that the French verb 'fumer' means 'to smoke', remember that it is similar to the English word 'fumes'. Mnemonics can also help file concepts together, making them easier to retrieve.

3. Get emotional. Emotional arousal enhances memories – even when the memories themselves aren't emotional. Adam Anderson at the University of Toronto in Canada showed subjects neutral pictures of houses and faces followed by emotionally

charged pictures. They found that the neutral pictures were remembered better when they were followed by emotionally arousing pictures (*Proceedings of the National Academy of Sciences*, vol 103, p 1599)

4. Review. Retrieving items from memory makes them more likely to be remembered in future and keeps them from being bumped out of the way by new memories. So rehearse the name of the person you just met within 30 seconds, and once or twice more with increasing time between rehearsals. "The reason most people don't have good memories for names is that they're lazy," says Michael Anderson.

way. Anderson notes that in McGaugh's memory tests, AJ demonstrated that she was deficient in tests of executive function and reasoning, skills that are needed for decision-making and inhibition of unhelpful responses. This could mean that she is less able to block the retrieval of memories than other people and could explain why she is unable to stop once she gets started.

McGaugh agrees that this may be facilitating AJ's memory retrieval, but also offers another explanation. He points out that, although they can't yet say whether AJ and Williams have abnormally low activity in their prefrontal cortex, decreased activity in this brain area is associated with increased activity in the basolateral amygdala – a part of the brain associated with the improved storage of memories. If this were the case for AJ, she may be better at storing memories than most, while also being worse at blocking their retrieval.

For now it is far from clear what, if anything, hyperthymestic syndrome can tell us about normal memory, but more clues are on the way. McGaugh has recently conducted MRI scans on both AJ and Williams and is now comparing their scans with those of control subjects with normal memories. Unfortunately, even if his analyses were to reveal striking differences, the matter may not be settled, says Ericsson. If the scans show that the hyperthymestic's brains are different, this may reflect changes brought about by their obsessional behaviour and encoding strategies, rather than an innate difference. Ericsson has taken brain scans of expert memorisers and found them to be different

from the norm, in ways that vary depending on the strategies each uses to remember.

As AJ and Williams continue to provoke debate in the scientific community, it is tempting to wish for a little of what they have, if only to make it easier to remember names, happy moments and to win prizes in pub quizzes. Williams, in particular, seems unfazed by his gift. He is a radio presenter and his listeners call in once a week to try and "stump Brad", attempting to pose trivia questions he can't answer. Williams seems pretty much in control of his ocean of memories, so could we all learn similar skills without becoming swamped by the tide in the process?

It's possible, in theory. There are several tried-and-tested methods to improve our memories. Paying more attention to what we want to remember is a good start, and organising our thoughts a little better helps, too (see "Forget me not", above). Such exercises may prevent our brains from throwing the baby out with the bath water, but next time you curse your memory when you forget a name, an appointment or your own phone number just remember, your brain is trying to do you a favour. ●

Jessica Marshall is a science writer based in Saint Paul, Minnesota

Further Reading: *The Woman Who Can't Forget: The extraordinary story of living with the most remarkable memory known to science – a memoir by Jill Price, with Bart Davis* (Free Press, May 2008).

THE NEED TO FORGET

Test your ability to suppress one memory in favour of another

Each of the words below has a verb meaning and a different noun meaning which is more commonly used. For each of them, quickly try to come up with a word association for the verb meaning. For example, for DUCK, write "crouch". Most people find it difficult to temporarily "forget" associations with the more dominant noun meaning, and want to write "quack" next to DUCK

● LOAF	● SHED
● POST	● FENCE
● COURT	● LOBBY
● ROOT	● STUMP
● SOCK	● FAWN
● LODGE	● PRUNE
● SIGN	● DUCK <i>crouch</i>
● BARK	● RAIL
● PINE	● SINK
● BOWL	● RING

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