

A step towards solving the enduring puzzle of 'infantile amnesia'

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Children play in the fountain at Somerset House. Credit: Matteo Angelino via Flickr

A study led by Professor James Russell shines a light on the phenomenon of 'infantile amnesia'. He argues that children's ability to recall events depends on their being able to unify the environmental elements of when, what and where. Most children develop this ability aged between two and three.

Most of us cannot remember toddling around at the age of 18 months or so, let alone being breast or bottle fed as tiny infants. Our early life is a blank to us. It is a blank in the sense that it is not accessible to so-called

"episodic memory," which means conscious or "re-experiential" recall of autobiographical events.

Sigmund Freud coined the term '[infantile amnesia](#)' to describe this phenomenon. He explained the lack of early memory in terms of repressed sexual desires. Today, few people find Freud's arguments persuasive - but the term, infantile amnesia, and the puzzle it presents to scientists, persists.

In seeking to understand how the brain develops its remarkable capacity for episodic memory, cognitive psychologists have tended to explain amnesia for early lives by arguing that our first experiences have the 'wrong' kind of format to be accessed by the backward-casting adult mind.

But what does this primitive format lack and when does memory become truly episodic and adult-like?

A team led by Professor James Russell from the University of Cambridge's Department of Psychology has shed some light on this fascinating puzzle by carrying out a study on two- and three-year-olds, an age that many developmental psychologists believe to be marked by an absence of episodic memory.

The results of the team's most recent study 'Pre-school children's proto-episodic memory assessed by deferred imitation' were published online last month (October 2014) in the journal *Memory*.

Russell and co-researchers Dr Patrick Burns (University of Cambridge) and Dr Charlotte Russell (King's College, London) conclude that young children fail to engage in re-experiential/episodic memories because they are not yet able to bind where and when information to information about objects and actions when recalling something that they have

experienced.

"A young child may simply know that mum is wearing a red blouse today without any recollection of the original event that told them this – for example, seeing mum emerging from the bedroom wearing the blouse, on her way downstairs," said Russell.

Psychologists use the term spatiotemporal information to describe the when and where of an episode. There are a number of reasons why spatiotemporal information is crucial to episodic memory, but Russell has a distinct approach to the matter, one inspired by the work of the German Enlightenment philosopher Immanuel Kant.

Kant argued that perceptual experience itself is marked by its taking place in space and time. If this is so, Russell argues, re-experiential memory will also be spatiotemporal. According to Kant, the temporal aspect of experience consists of coding the simultaneity and order of elements within the event.

Russell explained: "If we have an experience of an event involving, say, a football and a cat, then spatially each of them will be perceived as being in a certain relation to our body - left or right, near or far. In addition, they will be near to, or far away from, each other. Temporally, they will either be simultaneously present in the event or appear one after the other. Crucially, an episodic/re-experiential memory of the event should involve the memory inheriting these spatiotemporal properties."

Another key feature of re-experiential memory of events is that it will tend to be all-of-a-piece rather than elemental. In other words, because events are experienced holistically rather than element-by-element, the re-experiential memory of them will, again, inherit this holistic property.

"When we hear or read sentences, they will be experienced in a serial or digital manner with phrases embedded in clauses and clauses embedded in sentences. One may call this semantic experience in reference to the term, 'semantic memory', used by Endel Tulving in 1972 to distinguish it from episodic memory," said Russell.

"If we experience an event, by contrast, we experience it as a whole - this is episodic memory. Let's return to the example of the child with the red-blouse-wearing mother. In the original event, the child saw mum in a red blouse - the what of the potential memory - on her left emerging from the bedroom - the potential where of the memory - as mum was about to descend the stairs - the potential when of the memory.

"These spatiotemporal elements were experienced together, as a whole, as elements of one event. They were not fed to the child as bite-sized factual chunks as in 'the blouse was red', 'mum was on my left', 'after that she went down the stairs'. This kind of elementally-chunked experience could result in a kind of [semantic memory](#)."

In order to test whether two- and three-year-olds are able not only to retain the what-when-where of an episodic memory but also to recall these three in a holistic, non-elemental way, the team gave more than 370 pre-schoolers two kinds of memory test. In each one, the children had to imitate on the second day what they had seen the experimenter do on the first day.

In the first task the children saw the experimenter move two icons on a touch-screen in a certain order to make the computer show a smiling face and play a happy song. Note that in this task the spatial element (the location to which the icons had to be moved) was defined not only by three-dimensional landmarks but also by the relation to the child's own body (eg 'in the corner to my top-right-hand').

In the second task, the what of the performance was two kinds of action (pumping or twirling) which had to be performed on the handles of a music box belonging to hippo (see photograph) in a certain order to turn it on. Note that in this case the location of the actions could be defined by three-dimensional landmarks such as 'near the door' or 'in front of the window'.

Next, in order to find out if recall was holistic/non-elemental or elemental, the researchers applied a statistical model to determine whether it was likely for children to recall the what-when-where of the memory in elemental fragments (eg just recalling what and where but not when) or whether memory tended to be all-of-a-piece.

The results of the study were very clear. Although performance was better than chance after two-and-half years in both tasks, only in the second task (the music box in a room) was recall non-elemental/holistic.

The crucial difference between the two tasks was in terms of the spatial information. In the second task, in which there was evidence for genuine episodic memory, the spatial information was environment-centred, such as 'the twirling took place near the window'.

In explaining the apparent dependency of this primitive form of episodic memory on environment-centred spatial coding, Russell said: "The reasons for this are two-fold. Conceptually, while episodic memory tends to be from our own point of view, the very idea of a 'point of view' requires it to be a point of view of something – some objective spatial layout. So anything that encourages the child to code actions and objects in terms of their environment-centred features like 'near the door' will tend to reveal episodic abilities, if they are there at all.

"In terms of neuroscience, a structure in the brain called the hippocampus is crucial to the performance both of environment-centred

spatial coding and to the laying down of episodic memory traces. We know that the hippocampus is undergoing rapid development around two years of age. Though later episodic abilities, such as those developing around four and five years with the acquisition of a theory of mind, are likely to be more frontal in nature."

The findings of Russell and co-researchers that episodic memory begins, and infantile amnesia fades away, at the age of around two-and-a-half years appear to fit with the results of studies by other psychologists.

"Professor Madeline Eacott at Durham University found that two-and-a-half was the earliest age at which adults can retrieve re-experiential memories for significant events such as the birth of a sibling. We can also recall events about our own birth, but this is obviously going to be semantic in nature," said Russell.

While discovering more about the earliest origins of [episodic memory](#) is of inherent scientific interest, there are practical applications of this work, and it also affords avenues of investigation beyond infantile amnesia.

"Firstly, it suggests that very young children may actually be quite accurate reporters – for example, of abusive events. Secondly, it is possible that even younger children would succeed on tasks like the ones we have carried out if the temporal element were simultaneity rather than order. It's not hard to believe that an 18-month-old can have a re-experiential memory of what happened in the morning," said Russell.

"I recall the very full account of a zoo trip my daughter gave me when she was a year-and-a-half. Why shouldn't this have been based on an episodic trace, albeit not one that would be available to adult recall?"

More information: Paper PDF: [www.psychol.cam.ac.uk/peoplefi ...](http://www.psychol.cam.ac.uk/peoplefi...)

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Provided by University of Cambridge

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