

Working memory anniversary editorial

Working memory gets a workout: reviewing the legacy of Baddeley and Hitch (1974) fifty years on

John Towse  
Mark Hurlstone  
Amy Atkinson  
Satoru Saito  
Robert Logie

Working memory gets a workout: reviewing the legacy of Baddeley and Hitch (1974) fifty years on

The study of immediate memory processes, oftentimes referred to in psychological research as 'short-term memory', is almost as old as experimental psychology itself. Pinning down dates when short-term memory tasks became part of standardized tests is certainly tricky (see Brysbaert & Nicolas, 2024). Yet, if the reader indulges us in the assertion that Ebbinghaus (1885) represents some of the earliest pioneering work in experimental psychology (see Munro et al., 2021) then short-term memory has been involved pretty much from the start.

Despite many studies and much careful theorising, once the concept of short-term memory had been first articulated and operationalised at the start of the twentieth century, key issues lacked a satisfactory resolution. The architecture that supports immediate memory, and its functional explanatory role in cognition, remained either elusive or problematic. In other words, whilst there was a lot of interest, research and interpretation, nothing seemed effectively to stick as an enduring framework to guide and to bind the research community. This is the context for the above quotation from Baddeley and Hitch (1974) – the sense of exasperation is palpable.

*"Despite more than a decade of intensive research on the topic of short-term memory (STM), we still know virtually nothing about its role in normal human information processing... Despite the frequency with which STS {short-term storage} has been assigned this role as an operational or working memory, the empirical evidence for such a view is remarkably sparse..."*

*"It appears then, that STS constitutes a system for which great claims have been made by many workers (including the present authors), for which there is little good evidence"*

Baddeley and Hitch (1974; pg. 47).

Therefore, one critically important aspect of Baddeley and Hitch (1974) is that rather than simply recapitulate the same types of experiments and independent variables of preceding studies, they took a step back to ask broader questions about the purpose of memory and its link to cognition. From that vantage point, it was then able to report, digest and integrate a large and programmatic set of studies that evidenced and characterised the connection between retention and information processing. It formed the bedrock of what became working memory. The volume of empirical work presented in the 1974 chapter is remarkable by today's standards – who would even countenance putting a *dozen* experiments in a *single book chapter*, rather than parcelling them up into multiple journal articles? Yet, this approach undoubtedly reaped rewards, because it allowed Baddeley and Hitch to shape and constrain their views through data. Indeed, any research output that incorporates such a large volume of integrated empirical studies that it warrants a summary table of outcomes (their Table X) is one that surely commands a certain respect and interest. This empirical work was also presented as a more formal research report in Hitch and Baddeley (1976),

published here in the *Quarterly Journal of Experimental Psychology* and thereby making this anniversary celebration special issue venue particularly appropriate and meaningful.

Another crucial component was that the chapter provided them the freedom to interpret and speculate about the theoretical framework for working memory. And this framework started both to lay out an architecture for immediate memory, but also a functional vision that connected memory to other aspects of cognition. Working memory wasn't just something to be studied in and of itself, but also as a potentially integral part of other key cognitive processes, such as reasoning and decision-making.

We propose that these important ingredients helped to propel the working memory framework into forefront of experimental psychology and has kept it there as a vibrant, dynamic and useful account over the last 50 years. As a result the model has undoubtedly enjoyed tremendous success. It has stimulated work in experimental psychology (e.g. Baddeley, 1986; 2007; 2019; Baddeley et al., 2025), but also developmental (e.g. Gathercole et al., 2004; Towse et al., 1998; Camos & Barrouillet, 2018), neuropsychological (e.g. Della Sala & Logie, 1993; Logie & Della Sala., 2005; Shallice & Papagno, 2019; Vallar & Shallice, 1990), and neuroimaging research (e.g. D'Esposito & Postle, 2015; Majerus, 2019; Osaka et al., 2007; Rose et al., 2016; Wager & Smith, 2003), alongside computational modelling to formally define the function of some of its components (e.g. Burgess & Hitch, 2006; Hitch, 2023; Hurlstone et al., 2014; Page & Norris, 1998). It has also been productively applied across a wide range of more practical contexts including cognitive ageing (e.g. Allen et al., 2021; Bopp & Verhaeghen, 2005; Johnson et al., 2010; Logie & Morris, 2015), Alzheimer's disease (e.g. Baddeley et al., 1986; 1991; 1999; Logie et al., 2004; 2015), vocabulary acquisition (e.g. Gathercole & Baddeley, 1989), atypical childhood development (e.g. Henry, 2012; Holmes et al., 2010), reading (e.g. Cain, 2006), arithmetic (e.g. Cragg et al., 2017; Hitch, 1978; Logie et al., 1994), and working memory training (e.g. Gathercole et al, 2019) to name but a few exemplars. Some of us have noted just how far working memory has already played and continues to play a seminal role in experimental psychology (Saito & Towse, 2007; Logie, 2023), and we expect this to continue in years to come.

Yet we also suggest that there were at least two further, noteworthy, features contributing to the success and prominence of working memory, albeit less commonly elucidated. One of these is the dose of humility with which the framework was articulated:

*"The account which follows should therefore be regarded essentially as a progress report on an ongoing project. The reader will notice obvious gaps where further experiments clearly need to be performed, and it is still more than probable that such experiments will modify to a greater or lesser degree our current tentative theoretical position. We hope, however, that the reader will agree that we do have enough information to draw some reasonably firm conclusions, and will feel that a report of work in progress is not too out of place in a volume of this kind."*

Baddeley and Hitch (1974, pg. 49)

We argue that this absence of hubris is important. First, in terms of creating spaces for subsequent research to develop and grow. Second, by encouraging ideas to mature and evolve through the accumulation of additional evidence. The explicit signposting of an

unfinished, ongoing project has been an important invitation for researchers to contribute and add to the working memory story as part of the Baddeley and Hitch (1974) framework and as part of model variants (see Conway et al., 2007; Logie et al., 2021; Miyake & Shah, 1999). We view this special issue as a continuing part of the process – bringing new data and new topics to be integrated within working memory as well as to extend and indeed challenge our understanding.

We also want to propose an additional factor in the success of working memory. It is the healthy and diverse community of researchers that contribute to and sustain working memory. That community regards working memory as a serious endeavour, whilst also recognising the importance and value of having a bit of fun. Encouraging people to discuss working memory constructively has been core to what Alan and Graham have attempted to promote since the launch of the framework. As a result there have been many formal and informal meetings about working memory since 1974, local, regional and international. Notable are the past decennial anniversary conferences in 1994 (Cambridge), 2004 (Kyoto), and 2014 (Cambridge), that resulted in special issues of *QJEP* (1996), of *Cortex* (2007), and of *Memory and Cognition* (2015). To celebrate 50 years of the Baddeley and Hitch (1974) model, a further anniversary meeting was held in Leeds (2024), contemporaneous with this special issue collection. At the 2014 and 2024 meetings, the following poem was written and presented [by RL] as an affectionate tribute to Alan and Graham. It exemplifies and combines a deep respect with a lightness of approach – a combination that for many is the recipe making working memory research so rewarding and productive.

As guest editors we (JT, MH, AA and SS) are delighted to have compiled this special issue in 2024, commemorating 50 years since the emergence of working memory. We believe this collection of articles reflects many of the core attributes that have so far kept working memory relevant, and continue to do so. That is, papers comprise work focusing both on theoretical ideas and reviews alongside work that is centred around new and original empirical evidence. Articles combine basic empiricism with applied theorising, and reviews of several key topics relating to working memory. The special issue brings together authors who are broadly in agreement with the Baddeley and Hitch (1974) approach and its subsequent developments (Baddeley et al., 2021), as well as those more sceptical. It also includes contributions from experienced authors (including Alan and Graham themselves) as well as earlier-career researchers who bring fresh, novel perspectives. In this spirit, the special issue has been developed and curated with the conviction that we all benefit from a respectful and collegiate exchange of views.

Working memory has come a long way in the last fifty years from the vision laid out in Baddeley and Hitch (1974). From a concept tentatively discussed initially, to one that is central to thousands of studies conducted each and every year. We are excited to see what the future holds for the concept of working memory and the fields of experimental psychology that draw on it.

**Logie, R.H. (2014/2024). Ode to Alan Baddeley and Graham Hitch**

Presented at the Conference Dinner for the Third International Conference on Working Memory, Cambridge, UK, July 10, 2014 and the Fourth International Conference on Working Memory, Leeds, UK, June 26, 2024.

*(Based on Lear, E. (1871) 'The Owl and the Pussycat')*

Baddeley and Hitch, they went to sea  
In a beautiful Cambridge punt.  
They took with them graphs and plenty of laughs  
Wrapped up in a quizzical grunt.  
Hitch looked up to the stars above  
And sang to a small guitar,  
'Is my memory storing, is my memory exploring? What a puzzling memory you are  
You are,  
You are!  
What a puzzling memory you are!'

Baddeley said to the Hitch, 'You clever old stitch,  
How rhythmically you query.  
It would be great, to articulate  
But what shall we do for a theory?'  
They floated away for a year and a day  
To the land where the data trees stoop,  
And there on the shore was a short-term store, With a phoneme stuck in its loop  
Its loop  
Its loop  
With a phoneme stuck in its loop

'Dear Hitch do you think that we're on the brink  
Of a breakthrough nearly in reach? '  
They recited in thirds and lengthened the words  
With suppression and irrelevant speech.  
'But science is tough, this is just not enough'  
Said Baddeley while driving his car.  
They stopped being sad and sketched out a pad  
Then went for a beer in a bar  
A bar  
A bar  
Then went for a beer in a bar.

'To reach our real goal, we need some control'  
Said Hitch, as their thoughts became random.  
With homunculus stew, they pondered anew  
To do two tasks - in tandem.  
With just a mention, of divided attention  
They subjected their model to test;  
And while chewing some beans with some variable means

They updated, switched and suppressed  
Suppressed  
Suppressed  
They updated, switched and suppressed.

Their punt took a turn, as they started to learn  
Of rivals that grew thick and fast.  
A fried egg won't do nor a cache or two,  
And complex span will never last.  
These are all duffers, let's bind with a buffer  
To promote our runcible pitch.  
While refreshing your mind, with your theories aligned  
A toast to Baddeley and Hitch  
And Hitch  
And Hitch  
A toast to Baddeley and Hitch.

## REFERENCES

- Allen, R.J., Atkinson, A., & Brown Nicholls, L.A. (2021). Strategic prioritisation enhances young and older adults' visual feature binding in working memory. *Quarterly Journal of Experimental Psychology*, 74, 363-376.
- Baddeley, A.D. (1986). *Working Memory*. Oxford, UK: Oxford University Press.
- Baddeley, A.D. (2007). *Working Memory, Thought, and Action*. Oxford, UK: Oxford University Press.
- Baddeley, A.D. (2019). *Working Memories: Postmen, Divers, and the Cognitive Revolution*. Oxon, UK: Routledge.
- Baddeley, A.D., Bressi, S., Della Sala, S., Logie, R.H. & Spinnler, H. (1991). The decline of working memory in Alzheimer's disease: A longitudinal study. *Brain*, 114, 2521-2542.
- Baddeley, A.D., Cocchini, G., Della Sala, S., Logie, R.H. & Spinnler, H. (1999). Working memory and vigilance: Evidence from normal aging and Alzheimer's disease. *Brain and Cognition* 41, 87-108.
- Baddeley, A.D., Eysenck, M.W., & Anderson, M.C. (2025). *Memory (Fourth Edition)*, Oxon, UK: Routledge.
- Baddeley, A. D., & Hitch, G. (1974). Working memory. In G.H. Bower (Ed.). *The Psychology of Learning and Motivation* (Vol. 8, pp 47-89). New York: Academic Press.

Baddeley, A.D., Hitch, G.J. & Allen, R.J. (2021). A multicomponent model of working memory. In R.H. Logie, V. Camos, and N. Cowan (eds.), *Working Memory: State of the Science*, pp 10-43. Oxford, UK: Oxford University Press.

Baddeley, A.D., Logie, R., Bressi, S., Della Sala, S. and Spinnler, H. (1986). Dementia and working memory. *Quarterly Journal of Experimental Psychology* 38A, 603-618.

Bopp, K.L. & Verhaeghen, P. (2005) Aging and Verbal Memory Span: A Meta-Analysis. *The Journals of Gerontology: Series B*, Volume 60, Issue 5, P223–P233, <https://doi.org/10.1093/geronb/60.5.P223>

Brysbaert, M., & Nicolas, S. (2024). Two Persistent Myths About Binet and the Beginnings of Intelligence Tests in Psychology Textbooks. *Collabra: Psychology*, 10(1). <https://doi.org/10.1525/collabra.117600>

Burgess, N. & Hitch, G.J. (2006). A revised model of short-term memory and long-term learning of verbal sequences. *Journal of Memory and Language*, 55, 627-652.

Cain, K. (2006). Children's reading comprehension: The role of working memory in normal and impaired development. In S. Pickering (ed.), *Working memory and education* (pp. 62–93). New York: Academic Press.

Camos, V. & Barrouillet, P. (2018). *Working Memory in Development*. London: Routledge.

Conway, A.R.A., Jarrold, C., Kane, M.J., Miyake, A., & Towse, J.N. 2007). *Variation in Working Memory*. Oxford, UK: Oxford University Press.

Cragg, L., Richardson, S., Hubber, P. J., Keeble, S., & Gilmore, C. (2017). When is working memory important for arithmetic? The impact of strategy and age. *PLOS ONE*, 12(12), e0188693. <https://doi.org/10.1371/journal.pone.0188693>

Della Sala, S., & Logie, R. (1993) When working memory does not work. The role of working memory in neuropsychology. In F. Boller & H. Spinnler (Eds.). *Handbook of Neuropsychology Vol 8*, pp 1-63. Amsterdam: Elsevier Publishers BV.

D'Esposito, M. and Postle, B.R. (2015) The cognitive neuroscience of working memory. *Annual Review of Psychology*, 66, 115–142

Ebbinghaus, H. (1885/1964). *Memory: A Contribution to Experimental Psychology* (H. A. Ruger & C. E. Bussenius, Trans.). New York, NY: Dover (Original work published in German, 1885).

Gathercole, S., & Baddeley, A. D. (1989). Evaluation of the role of phonological STM in the development of vocabulary in children: A longitudinal study. *Journal of Memory and Language*, 28, 200-213.

Gathercole, S. E., Dunning, D. L., Holmes, J., & Norris, D. (2019). Working memory training involves learning new skills. *Journal of Memory and Language*, 105, 19–42.  
<https://doi.org/10.1016/j.jml.2018.10.003>

Gathercole, S.E., Pickering, S.J., Ambridge, B. & Wearing, H. (2004). The structure of working memory from 4 to 15 years of age. *Developmental Psychology*, 40, 177-190.

Henry, L. (2012). *The Development of Working Memory in Children*. London: Sage.

Hitch, G.J. (2023). The phonological loop as a neural network. In Logie, R.H., Wen, Z., Gathercole, S., Cowan, N., Engle, R. (Eds.). *Memory in Science for Society: There is nothing as practical as a good theory*, pp 185-211. Oxford University Press.

Hitch, G.J. & Baddeley, A.D. (1976). Verbal reasoning and working memory. *Quarterly Journal of Experimental Psychology*, 28, 603-621.

Holmes, J., Gathercole, S.E., & Dunning, D.L. (2010). Poor working memory: Impact and interventions. *Advances in Child Development and Behavior*, 39, 1-43.

Hurlstone, M. J., Hitch, G. J., & Baddeley, A. D. (2014). Memory for serial order across domains: An overview of the literature and directions for future research. *Psychological Bulletin*, 140(2), 339– 373.

Johnson, W., Logie, R.H. & Brockmole, J.R. (2010). Working Memory Tasks Differ in Factor Structure Across Age Cohorts: Implications for Dedifferentiation. *Intelligence*, 38, 513-528.  
DOI:10.1016/j.intell.2010.06.005

Lear, E. (1871/1956) The owl and the pussycat. In Green, R.L. (ed.) (1956) *The Book of Nonsense*, pp 75-77. London: Dent and Sons. Originally published in Lear, E. (1871). *Nonsense Songs, Stories, Botany, and Alphabets*. London: R.J. Bush.

Logie, R.H. (2023). Strategies, debates, and adversarial collaboration in working memory: The 51<sup>st</sup> Bartlett Lecture. *Quarterly Journal of Experimental Psychology* 76, 11, 2431-2460.  
DOI: 10.1177/17470218231194037

Logie, R.H., Camos, V., & Cowan, N. (Eds.) (2021). *Working Memory: State of the Science*. Oxford, UK: Oxford University Press.

Logie, R.H., Cocchini, G., Della Sala, S. & Baddeley, A.D. (2004). Is there a specific executive capacity for dual task co-ordination? Evidence from Alzheimer's Disease. *Neuropsychology*, 18, 504-513.

Logie, R.H. & Della Sala, S. (2005). Disorders of visuo-spatial working memory. In P. Shah and A. Miyake (Eds.) *Handbook of Visuospatial Thinking*. Cambridge University Press: New York, pp 81-120.



- Logie, R.H., Gilhooly, K.J. & Wynn, V. (1994). Counting on working memory in arithmetic problem solving. *Memory and Cognition* 22, 395-410.
- Logie, R.H. & Morris, R.G. (2015). *Working Memory and Ageing*. London, UK: Psychology Press.
- Logie, R.H., Parra, M.A., & Della Sala, S. (2015). From cognitive science to dementia assessment. *Policy Insights from the Behavioral and Brain Sciences*, 2, 81-91.  
DOI: 10.1177/2372732215601370
- Majerus, S. (2019). Verbal working memory and the phonological buffer: The question of serial order. *Cortex* 119, 122-133.
- Miyake, A. & Shah, P. (Eds.) (1999). *Models of Working Memory*. New York: Cambridge University Press.
- Munro, G., Laborda, M.A., Miguez, G., Quezada-Scholz, V.E. (2021). Ebbinghaus. In: Vonk, J., Shackelford, T. (eds) *Encyclopedia of Animal Cognition and Behavior*. Springer, Cham.  
[https://doi.org/10.1007/978-3-319-47829-6\\_89-1](https://doi.org/10.1007/978-3-319-47829-6_89-1)
- Osaka, N., Logie, R.H. & D'Esposito, M. (Eds.) (2007). *The Cognitive Neuroscience of Working Memory*. Oxford, UK: Oxford University Press. (pp 389). ISBN 978-0-19-857039-4
- Page, M. P., & Norris, D. (1998). The primacy model: A new model of immediate serial recall. *Psychological Review*, 105(4), 761–781.
- Rose, N. S., LaRocque, J. J., Riggall, A. C., Gosseries, O., Starrett, M. J., Meyering, E. E., & Postle, B. R. (2016). Reactivation of latent working memories with transcranial magnetic stimulation. *Science*, 354(6316), 1136–1139. <https://doi.org/10.1126/science.aah7011>
- Saito, S., & Towse, J. N. (2007). Working memory as a construct in cognitive science: An illustrious past and a highly promising future. *Psychologia*, 50, 69-75.
- Shallice, T., & Papagno, C. (Eds.) 2019. Impairments of short-term memory buffers: Do they exist? Special issue of *Cortex*, 112, 1-181.
- Towse, J.N., Hitch, G.J., & Hutton, U. (1998) A reevaluation of working memory capacity in children. *Journal of Memory and Language*, 39, 195-217.
- Wager, T.D., Smith, E.E. (2003). Neuroimaging studies of working memory. *Cognitive, Affective, & Behavioral Neuroscience* 3, 255–274. <https://doi.org/10.3758/CABN.3.4.255>
- Vallar, G. & Shallice, T. (1990). *Neuropsychological Impairments of Short-Term Memory*. Cambridge: Cambridge University Press.