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TITLE:
A Real-world *What-Where-When* memory test.

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SHORT ABSTRACT:
The Real-World What-Where-When memory test is a novel episodic memory test, in which participants need to recall which objects have been hidden in which locations on which of two distinct occasions. It is easy to run and is sensitive to normal cognitive aging.

LONG ABSTRACT:
Episodic memory is a complex memory system which allows recall and mental re-experience of previous episodes from one's own life. Real-life episodic memories are about events in their spatiotemporal context and are typically visuospatial, rather than verbal. Yet often, tests of episodic memory use verbal material to be recalled (word lists, stories). The Real-World What-Where-When memory test requires participants to hide a total of 16 different objects in 16 different locations over two temporal occasions, 2 hours apart. Another two hours later, they are then asked to recall which objects (What) they had hidden in which locations (Where) and on which of the two occasions (When). In addition to counting the number of correctly recalled complete what-where-when combinations, this task can also be used to test real-world spatial memory and object memory. This task is sensitive to normal cognitive aging, and correlates well with performance on other episodic memory tasks, while at the same time providing more ecological validity and being cheap and easy to run.

INTRODUCTION:
Episodic memory is memory for unique events from one's own past that are experienced as a reliving of the original event (mental time travel)[1,2]. It is also one of the first types of memory to be affected in the early stages of many forms of dementia[3,4]. The medial temporal lobe, and more specifically the hippocampus, is believed to be an important structure in the processing of episodic memories[5], and therefore any conditions that affect hippocampal function, like aging and many mood disorders, are also believed to affect episodic memory function. As such, episodic memory function can be a useful biomarker for a range of neurological and psychiatric conditions[6].

Methods for quantifying episodic memory, however, are still less than ideal. Real-world everyday episodic memories are integrative memories of unique events in their spatiotemporal context[7], usually incidentally encoded[4]. The two most common methods used in both the clinic and in academic research are word list learning[8] and recounting a story from one's own past[3]. Both methods have advantages and disadvantages. The advantage of the word lists over the story approach is that the assessor knows exactly what the right answers are. This is difficult to assess with spontaneous stories from the participant/patient's past, since often no objective evidence is available and even accounts from family members may have incorrect details in them. The advantage of the stories is that they actually assess the typical content and structure of episodic memories: events in spatiotemporal context, with information about What happened, Where and When bound together[7]. Word lists do not require any context to be recalled at all, and are often rehearsed several times (e.g. the Rey Auditory Verbal Learning Task).

Recently, several attempts have been made to construct episodic memory tasks that combine the strengths of the two classical tests while minimizing the drawbacks[9-22]. The current protocol is the most recent version of a What-Where-When episodic memory test which has been developed at Newcastle University[10,16,22]. The concept is based on the work with non-human animals, started by Clayton and Dickinson[23], and adapted for work with a range of other species[24-28], some of which have confirmed the sensitivity of this paradigm to medial temporal lobe damage[29]. It is one of several attempts at incorporating a What-Where-When framework in episodic memory testing with adult humans[18,20,30,31], but the only one to be performed in a real environment, without the use of computers, making it easy for participants/patients to engage with and low-cost to carry out.

PROTOCOL:

This protocol was approved by Newcastle University's Faculty of Medical Sciences Ethics Committee (approval number 515_1).

1. Preparation for the study

1.1) Before running the study, gather 20 small, easily identified/described objects, for example:

A tea light
A toy digger
A toy frog
A clothing hook
A spoon
A set of keys
A button
A lip balm
A toy snowman
A bottle cap
A die
A lighter
A comb
A wrist band
A padlock
A butterfly pin
A ruler
A guitar plectrum
A battery
A USB stick

1.2) Randomly select 8 of these objects for the first session, and 8 for the second session. There should be 4 extra objects that are not used in either session. Once the objects have been selected, use the same objects in the same locations and in the same sessions for all participants.

1.3) Make photographs of the 16 objects to be used. Make two sheets of these photographs: the first sheet for the first session (8 objects) and the second sheet for the second session (8 objects). Put the images of the objects on the sheet in the order the participants need to find them. Number the images to avoid any confusion. Fig. 1 shows an example.

[Place Figure 1 here]

1.4) Identify 16 hiding locations around the room. Ideally, the room is an office with many things in it. The locations should be unambiguously describable by a person not actually in the room. Also try and make the locations not purely associated with a clear object in the room, as this reduces spatial memory to object-object associations. Assign each object to one of the hiding locations, making sure that the locations used in the first and second session are randomly interspersed.

1.5) Make sure the lay-out of the room will remain the same for the duration of the study. In multi-use rooms, make sure the room can be put back in the same way before each participant.

2. Session 1

2.1) Before the participant arrives, put the 20 objects in a pile in a fixed location in the testing room, with the object picture sheet for session 1 next to it. The reason for having participants find the objects in a pile using the picture sheets is to force them to pay attention to the identity of the objects.

2.2) When the participant arrives, first give them an information leaflet explaining the study, talk them through the study, and have them read and sign the consent forms.

2.3) Take the participants to the door of the testing room and give instructions about what they will need to do in the room. The instructions can be modified to either induce intentional memorization or incidental memorization.

2.3.1) For Intentional memorization, read these instructions to the participant:

- The purpose of this task is for you to hide some objects in a room and you will be asked to remember them later.
- You will be presented with a pile of objects on the desk.
- Next to the pile you will find a sheet with pictures of the 8 objects that you must hide during this task.
- At the bottom left of each picture there is a number indicating the order in which you must hide these objects.
- You may only pick up and hide one object at a time.

- I will point to the location where you should hide each object.
- Once you enter the room you should start counting seconds out loud and continue doing that until you leave the room.
- Later in this study we will repeat this with different objects and different locations.
- After this you will be asked to remember what objects you hid, where you hid them and on which occasion.
- If you have any questions, please ask them now because you will not be able to once we enter the room.
- This is not a timed task, so please take as much time as you need.

2.3.2) For Incidental memorization, read these instructions to the participant:

- The purpose of this task is to test your multi-tasking abilities.
- You will need to count seconds out loud, without slowing down or skipping numbers, while I try to distract you with objects to look for and place in different places around the room.
- I will record your voice for later analysis of your counting.
- For the distractor, you will be presented with a pile of objects on the desk.
- Next to the pile you will find a sheet with pictures of the 8 objects that you must hide during this task.
- At the bottom left of each picture there is a number indicating the order in which you must hide these objects.
- You may only pick up and hide one object at a time.
- I will point to the location where you should hide each object.
- Once you enter the room you should start counting seconds out loud and continue doing that until you leave the room.
- Later in this study we will repeat this to test whether you get better with practice.
- If you have any questions, please ask them now because you will not be able to once we enter the room.
- This is not a timed task, so please take as much time as you need, but don’t forget to keep the count going at a steady rate.

2.4) The participant is then taken into the room and shown the pile of objects. The participant finds and takes the first object. The experimenter indicates where the object needs to be placed, and the participant places the object there. They then go back for the next object, and so on for all 8 objects on the picture sheet. The timing is determined by the speed at which the participant finds and hides the objects. This typically takes no more than 2 minutes.

2.5) At the end of the session, the participant is taken out of the room.

3. First break

3.1) Between session 1 and session 2, leave approximately 2 hours. Participants can be asked to do different tasks during this interval, or just be asked to go away (e.g. to have lunch) and to come back at the appointed time.

3.2) Before the participant returns, remove all the hidden objects from the room and put them back in the pile.

3.3) Replace the picture sheet with the picture sheet for session 2.

4. Session 2

4.1) Remind the participant of the instructions given before session 1.

4.2) Take the participant into the room, and repeat section 2.4), but now with different objects and locations. Again, the timing is determined by the participant.

4.3) Take the participant back out of the room.

5. Second break

5.1) The participant is again instructed to come back 2 hours later. Again, another battery of tests could be run during this interval.

5.2) Remove all objects from their hiding places. The room will not be needed again for this participant.

6. Session 3

6.1) If the participants had been instructed for Incidental memorization, they should at this point be debriefed, and told of the real purpose of the task. The effectiveness of the deceit should also be checked by asking the participants if they suspected the task was a memory task.

6.2) Ask them to freely recall which objects they had hidden in which locations and on which of the two occasions. Ask them to write this all down in the order in which they remember them. Encourage them to recall any information they can, including incomplete information (like remembering an object, but not its location, etc.). Give the participants all the time they need to recall as much as they can. Allow them to draw a map or diagram if they so wish.

6.3) After they have recalled all the information they can, ask them to complete the vividness scale and the task contemplation scale (Fig. 2).

[Place Figure 2 here]

6.4) Participants can then be further debriefed and sent away.

7. Data extraction and analysis

7.1) For the scoring sheet, create a list of all 16 objects, and another list of all 16 locations. For each object and location, determine whether it was remembered in combination with the correct session and location/object (respectively; What-Where-When)), whether in combination only with the correct session (only What-When or only Where-When) or only with the correct location/object (respectively; only What-Where), or whether it was recalled correctly, but without any correct combination (only What and only Where). The number of correctly recalled What-Where-When combinations and What-Where combinations should match for both lists.

7.2) Analyze the full What-Where-When combinations first. Because there are a total of 16 combinations to be recalled, the number of actually correctly recalled combinations can be treated as coming from a binomial distribution (16 'yes-no' answers), which should be analyzed with a Generalized Linear Model, using a binomial distribution with log-link function.

7.3) Then move on to analyzing the 3 incomplete combinations. To do this using the same analysis, the total number of incompletely recalled combinations of each type needs to be analyzed out of the remaining number of combinations that were not correctly recalled as a complete what-where-when combination. For example, if a participant recalled 5 correct what-where-when combinations, then the incomplete combinations need to be analyzed out of (16-5=) 11 possible incomplete combinations.

7.4) The number of objects or locations recalled without any combination can then again be analyzed in an analogous way out of the remaining combinations that have not yet been accounted for.

REPRESENTATIVE RESULTS:

Older people (65+) remember fewer complete What-Where-When combinations than do younger people (18-25; $X^2(1)=9.5$; $p=0.002$; Fig.3). Note that although as a group, older people perform worse than younger people, there are some older people who perform as well or better than some young people. This variation may be informative if it is predictive of other conditions.

One can also investigate how other episodic memory tests predict performance on the memory for What-Where-When combinations. For these representative results, the results of Kessels' Object-Location task[32] are presented. This task has several components, including Combined

Object Memory (COM), in which 10 different objects have to be remembered and replaced in their exact positions on an otherwise empty computer screen. In this version, the participants had 3 minutes between studying the layout of the 10 objects, and the test in which they had to recreate this layout. During these three minutes, they performed another task, in order to prevent them from holding the information in working memory. Individuals' performance on the COM task significantly predicted the number of correctly recalled WWW combinations ($X^2(1)=6.27$; $p=0.012$). The slope of the regression line is steeper for older people than for younger people ($X^2(1)=4.97$; $p=0.026$; Fig. 4).

Figure Legends:

Figure 1: Object identity sheets. These are the sheets that are placed next to the pile of 20 objects. The left hand sheet is placed there in phase 1 and the right hand sheet in phase 2. Participants are supposed to pick up the objects from the pile in the order indicated on the sheet. Note that in phase 2, all the objects from phase 1 have been collected up and added to the pile again, so that during phase 2, participants again search through a pile of 20 objects to start with.

Figure 2: Subjective experience reporting. After reporting on their memory for objects, locations and phases, the participants are asked to complete these two scales, which report on the subjective experience of their memories (top scale) and on how much they actually rehearsed the material after each hiding phase.

Figure 3: Age differences in WWW memory. The figure represents the total number of correct What-Where-When combinations remembered (out of 16 possible combinations) by all participants in the two age groups. The size of the symbols represents the number of individuals that remembered that number of combinations. The data in this figure are a subset of the data from Black-Dominique et al (in prep).

Figure 4: Prediction of WWW memory by other memory tasks. The number of correct What-Where-When combinations remembered by each individual is significantly predicted by the accuracy with which these individuals can remember and reconstruct a spatial array of 10 objects on a computer screen (Kessels' Combined Object Memory or COM task). The performance measure for the COM task is an error score which indicates how far away (in mm) the objects were placed from their correct locations. Errors for all 10 objects have been summed to obtain one error score per participant. The data in this figure are a subset of the data from Black-Dominique et al (in prep).

DISCUSSION:

The data show that performance on other tasks which are supposed to measure episodic memory predicts performance on the Real-World What-Where-When memory task as well. However, these correlations are likely to represent a shared subset of cognitive abilities used by the different tasks. The Real-World What-Where-When memory task has the advantage over these other tasks in that it tests people's memory for two actual events which happened in a real spatio-temporal context. Unlike asking people about events from their own lives, however, in this case, the experimenter or clinician knows exactly what happened in the event, since they set it up. This gives the task an ecological validity not shared with most other tasks, as even those that also apply a what-where-when framework, typically do this on a computer, thereby losing the immersion aspect of a real-world experience[18,20,30,31]. Only immersive Virtual Reality might combine the advantages of computer stimulation and a real-world-like experience, but this type of equipment is not readily available yet to most people, while the Real-World What-Where-When memory task is easy and cheap to run. For even more ecological validity, the task can be run as an incidental encoding task, which is impossible to do when asking people to memorize lists of words or word pairs. However, it can only be used to test incidental coding once. After the participants have taken part once, they will forever know that this is a memory task.

The task also has the advantage that it has several different outcome measures all from one experience: it can test purely spatial memory and purely object memory, as well as memory for the binding of the different elements. These different aspects could potentially be useful to separate different neuropsychological problems in patients. The task has drawbacks as well. The three phases have been compressed within a day, but in order to test long-term memory, the whole task takes at least 4.5 hours, usually a bit longer. This is not a problem when people are in the clinic or the testing environment for at least half a day anyway, but does constrain the circumstances under which it can be used. Single hiding episodes (essentially ignoring the temporal component of episodic memories) or shorter retention intervals are easy enough to implement and it would be interesting to find out how they affect performance on the task. Another drawback of having a manual task in a real-world environment is that scoring the outcome by hand takes longer than computerized tasks that can give a performance score immediately. That being said, counting up the number of correctly remembered what-where-when combinations takes very little time. It is scoring incomplete combinations that may take a bit longer.

The task as presented here can be used to look at other aspects of episodic memory as well. One could analyze the memory for the sequence in which the objects were hidden, and/or the effect of memory decay and interference between the two phases on the memory traces. Indeed, by adding more phases to the experiment, this simple memory task could be used to investigate quite detailed hypotheses about the temporal aspects of memory, including for example the scale invariance of the memory decay parameters[15].

In summary, this simple cognitive test of episodic memory has more ecological validity than existing tests, yet seems to distinguish similar groups as have been shown to be impaired in episodic memory using other tests. Further studies are needed to understand how sensitive this task is and whether it might be useful in, for example, early diagnosis of cognitive impairments.

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The authors have nothing to disclose.

REFERENCES

1 Tulving, E. in *Organization of memory* eds E. Tulving & W. Donaldson) 381-403 (Academic Press, 1972).
2 Tulving, E. Episodic memory : From mind to brain. *Rev Neurol* **160**, S9-S23 (2004).
3 Irish, M., Lawlor, B. A., Coen, R. F. & O'Mara, S. M. Everyday episodic memory in amnestic mild cognitive impairment: A preliminary investigation. *BMC Neurosci* **12** (2011).
4 Pause, B. M. *et al.* Perspectives on Episodic-like and Episodic Memory. *Front Behav Neurosci* **7**, doi:10.3389/fnbeh.2013.00033 (2013).
5 Eichenbaum, H., Sauvage, M., Fortin, N., Komorowski, R. & Lipton, P. Towards a functional organization of episodic memory in the medial temporal lobe. *Neurosci Biobehav Rev* **36**, 1597-1608 (2012).
6 Dere, E., Pause, B. M. & Pietrowsky, R. Emotion and episodic memory in neuropsychiatric disorders. *Behav Brain Res* **215**, 162-171 (2010).
7 Clayton, N. S., Bussey, T. J. & Dickinson, A. Can animals recall the past and plan for the future? *Nat Rev Neurosci* **4**, 685-691 (2003).
8 Tierney, M. C. *et al.* Use of the Rey Auditory Verbal Learning Test in differentiating normal aging from Alzheimer's and Parkinson's dementia. *Psychol Assess* **6**, 129-134 (1994).
9 Hayne, H. & Imuta, K. Episodic memory in 3- and 4-year-old children. *Dev Psychobiol* **53**, 317-322 (2011).
10 Holland, S. M. & Smulders, T. V. Do humans use episodic memory to solve a What-Where-When memory task? *Anim Cogn* **14**, 95-102, doi:10.1007/s10071-010-0346-5 (2011).
11 Cheke, L. G. & Clayton, N. S. Do different tests of episodic memory produce consistent results in human adults? *Learn Mem* **20**, 491-498, doi:DOI 10.1101/lm.030502.113 (2013).
12 Newcombe, N. S., Balcomb, F., Ferrara, K., Hansen, M. & Koski, J. Two rooms, two representations? Episodic-like memory in toddlers and preschoolers. *Dev Sci* **17**, 743-756, doi:10.1111/desc.12162 (2014).
13 Cheke, L. G. & Clayton, N. S. The six blind men and the elephant: Are episodic memory tasks tests of different things or different tests of the same thing? *J Exp Child Psychol* **137**, 164-171, doi:10.1016/j.jecp.2015.03.006 (2015).
14 Cheke, L. G., Simons, J. S. & Clayton, N. S. Higher BMI is Associated with Episodic Memory Deficits in Young Adults. *Q J Exp Psychol*, 1-24, doi:10.1080/17470218.2015.1099163 (2015).
15 Kwok, S. C. & Macaluso, E. Immediate memory for "when, where and what": Short-delay retrieval using dynamic naturalistic material. *Hum Brain Map* **36**, 2495-2513, doi:10.1002/hbm.22787 (2015).
16 Mazurek, A., Bhoopathy, R., Read, J. C. A., Gallagher, P. & Smulders, T. V. Effects of age

on a real-world What-Where-When memory task. *Front Aging Neurosci* **7**, doi:10.3389/fnagi.2015.00074 (2015).
17 Cheke, L. G. What-where-when memory and encoding strategies in healthy aging. *Learn Mem* **23**, 121-126, doi:10.1101/lm.040840.115 (2016).
18 Zlomuzica, A., Preusser, F., Totzeck, C., Dere, E. & Margraf, J. The impact of different emotional states on the memory for what, where and when features of specific events. *Behav Brain Res* **298, Part B**, 181-187, doi:http://dx.doi.org/10.1016/j.bbr.2015.09.037 (2016).
19 Plancher, G., Gyselinck, V., Nicolas, S. & Piolino, P. Age effect on components of episodic memory and feature binding: A virtual reality study. *Neuropsychology* **24**, 379-390 (2010).
20 Plancher, G., Tirard, A., Gyselinck, V., Nicolas, S. & Piolino, P. Using virtual reality to characterize episodic memory profiles in amnestic mild cognitive impairment and Alzheimer's disease: Influence of active and passive encoding. *Neuropsychologia* **50**, 592-602, doi:http://dx.doi.org/10.1016/j.neuropsychologia.2011.12.013 (2012).
21 Laurent, X., Ensslin, A. & Marí-Beffa, P. An action to an object does not improve its episodic encoding but removes distraction. *J Exp Psychol Hum Percept Perform* **42**, 494-507, doi:10.1037/xhp0000155 (2016).
22 Craig, M. *et al.* How does intentionality of encoding affect memory for episodic information? *Learn Mem* **23**, 648-659, doi:10.1101/lm.041491.115 (2016).
23 Clayton, N. S. & Dickinson, A. Episodic-like memory during cache recovery by scrub jays. *Nature* **395**, 272-274 (1998).
24 Skov-Rackette, S. I., Miller, N. Y. & Shettleworth, S. J. What-where-when memory in pigeons. *J Exp Psychol Anim Behav Process* **32**, 345-358 (2006).
25 Roberts, W. A. *et al.* Episodic-Like Memory in Rats: Is It Based on When or How Long Ago? *Science* **320**, 113-115, doi:10.1126/science.1152709 (2008).
26 Feeney, M. C., Roberts, W. A. & Sherry, D. F. Memory for what, where, and when in the black-capped chickadee (Poecile atricapillus). *Anim Cogn* **12**, 767-777 (2009).
27 Hoffman, M. L., Beran, M. J. & Washburn, D. A. Memory for "What", "Where", and "When" Information in Rhesus Monkeys (Macaca mulatta). *J Exp Psychol Anim Behav Process* **35**, 143-152 (2009).
28 Zinkivskay, A., Nazir, F. & Smulders, T. V. What-Where-When memory in magpies (*Pica pica*). *Anim Cogn* **12**, 119-125 (2009).
29 Binder, S., Dere, E. & Zlomuzica, A. A critical appraisal of the what-where-when episodic-like memory test in rodents: Achievements, caveats and future directions. *Prog Neurobiol* **130**, 71-85, doi:10.1016/j.pneurobio.2015.04.002 (2015).
30 Kinugawa, K. *et al.* Aging-related episodic memory decline: Are emotions the key? *Front Behav Neurosci* **7**, doi:10.3389/fnbeh.2013.00002 (2013).
31 Pause, B. M., Jungbluth, C., Adolph, D., Pietrowsky, R. & Dere, E. Induction and measurement of episodic memories in healthy adults. *J Neurosci Meth* **189**, 88-96, doi:http://dx.doi.org/10.1016/j.jneumeth.2010.03.016 (2010).
32 Kessels, R. P. C., Postma, A. & De Haan, E. H. F. Object Relocation: A program for setting up, running, and analyzing experiments on memory for object locations. *Behav Res Meth, Instr, Comp* **31**, 423–428 (1999).