

Counting Span Task: Administration and Scoring

This is a test of working memory capacity. The version described here is very similar to an experimental procedure used by Engle et al., (1989). However, this version was used in research reported by Pluck et al., (2016). The participant is asked to count aloud particular targets amongst successive visual arrays, and to store in memory the total from each array for later recall. Such working memory capacity tasks have been found to correlate very highly with other measures, such as academic achievement.

The task administration materials for this version can be downloaded from www.gpluck.co.uk.

The task involves the participant counting instances of a particular target presented on a computer screen in PowerPoint file. The targets are dark blue circles, i.e.,



Also present in the arrays are distractor shapes that share a feature with the target, either the same colour or the same shape, i.e.,



or



The participant must therefore perform conjunctive searches to locate the targets (Treisman & Gelade, 1980). They must also count aloud, without pointing. When they have counted all of the targets, they should say out loud the total. So, for example in the screen shown below, the participant should say aloud as they count, "1", "2", "3", "3".



The experimenter immediately advances to the next slide and the participant again counts the dark blue circles. When a slide is presented that shows only a "?" then the participant should

recall all of the totals from the preceding arrays. Notice that is essentially the same as performing a standard digit span task, such as used in the Wechsler intelligence tests, but with additional tasks to provide extra cognitive load. The cognitive load is provided by the additional conjunctive search and by the need to read aloud during the counting. In the version provided here, the spans tested start at only two (i.e., two arrays to be counted), and move up in size until nine arrays must be counted. The experimenter can choose to use a stopping rule, such as zero scores on two sequences of the same length (which is consistent with Wechsler tests of digit span), or to require the participants to perform all lengths. However, the test could be customised to research needs, perhaps shortening by removing the later trials. In one study with undergraduates, we continued only up until sets of 5 numbers to recall, without finding a ceiling effect (Pluck et al., 2019).

The stimuli materials are presented in a PowerPoint file. The experimenter advances to next slide by pressing the space bar on the keyboard (or touching the screen on a tablet). It is important to advance to the next slide immediately when the previously array is completed, to prevent the participants from 'refreshing' their phonological working memory. Participants should be prevented from taking breaks before starting the next array for the same reason. In addition, it is very important for the experimenters to be consistent. Between or within experimenter variation in how fast they advance the slides would add much unwanted to variation to task performance. Some practice and inter-rater training may be necessary to ensure data that consistently measures the participants working memory capacity.

During recall, the participant should attempt to recall in sequence. However, if they can only identify one or two items and can specify the location (e.g. 'the last number was 6') that can be recorded. Partial scoring has the best psychometric properties on complex span tasks such as this (Conway et al., 2005). For example, if a participant recalls two of four words the receive 0.5 points, but if they recall all four correctly, they receive a full point. The total score for the test is the sum of the different recall attempts, which would be 16 if the full test is administered, with or without a stopping rule.

If you use this test in a publication or a thesis it should be cited to:

Pluck, G., Ruales-Chieruzzi, C. B., Paucar-Guerra, E. J., Andrade-Guimaraes, M. V., & Trueba, A. F. (2016). Separate contributions of general intelligence and right prefrontal neurocognitive functions to academic achievement at university level. *Trends in Neuroscience and Education*, 5(4), 178-185.

For further guidance on administration of the Counting Span Test see Conway et al., (2005), Pluck et al., (2016), or Pluck et al., (2019).

I can be contacted about this test via my website: www.gpluck.co.uk

Dr Graham Pluck

References

- Conway, A. R., Kane, M. J., Bunting, M. F., Hambrick, D. Z., Wilhelm, O., & Engle, R. W. (2005). Working memory span tasks: A methodological review and user's guide. *Psychonomic bulletin & review*, 12(5), 769-786.
- Engle, R. W., Tuholski, S. W., Laughlin, J. E., & Conway, A. R. A. (1999). Working memory, short-term memory and general fluid intelligence: A latent variable approach. *Journal of Experimental Psychology: General*, 128, 309-331.
- Pluck, G., Ruales-Chieruzzi, C. B., Paucar-Guerra, E. J., Andrade-Guimaraes, M. V., & Trueba, A. F. (2016). Separate contributions of general intelligence and right prefrontal neurocognitive functions to academic achievement at university level. *Trends in Neuroscience and Education*, 5(4), 178-185.
- Pluck, G., Villagomez-Pacheco, D., Karolys, M. I., & Montaña-Córdova, M. E. & Almeida-Meza, P. (2019). Response suppression, strategy application, and working memory in the prediction of academic performance and classroom misbehavior: A neuropsychological approach. *Trends in Neuroscience and Education*, 17.
- Treisman, A. M., & Gelade, G. (1980). A feature-integration theory of attention. *Cognitive Psychology*, 12(1), 97-136.

Scoring

Sequence to recall	Participant's response	Number correct and points:	
3-5	<input type="checkbox"/> <input type="checkbox"/>	0= 0 1= .5 2= 1	
7-4	<input type="checkbox"/> <input type="checkbox"/>	0= 0 1= .5 2= 1	
4-6-3	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	0= 0 1= .33	2= .66 3= 1
7-5-9	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	0= 0 1= .33	2= .66 3= 1
6-7-3-5	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	0= 0 1= .25 2= .5	3= .75 4= 1
5-8-9-5	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	0= 0 1= .25 2= .5	3= .75 4= 1
4-7-3-6-7	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	0= 0 1= .2 2= .4	3= .6 4= .8 5= 1
6-9-4-3-6	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	0= 0 1= .2 2= .4	3= .6 4= .8 5= 1
3-6-5-8-9-4	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	0= 0 1= .17 2= .33 3= .5	4= .67 5= .83 6= 1
6-4-3-8-7-9	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	0= 0 1= .17 2= .33 3= .5	4= .67 5= .83 6= 1

7-4-3-9-6-5-7	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	0= 0 1= .14 2= .29 3= .43	4= .57 5= .71 6= .86 7= 1
8-4-3-7-5-6-4	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	0= 0 1= .14 2= .29 3= .43	4= .57 5= .71 6= .86 7= 1
9-4-6-3-7-8-5-4	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	0= 0 1= .13 2= .25 3= .38 4= .5	5= .63 6= .75 7= .87 8= 1
6-3-5-4-8-7-9-6	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	0= 0 1= .13 2= .25 3= .38 4= .5	5= .63 6= .75 7= .87 8= 1
5-8-6-7-5-4-3-6-7	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	0= 0 1= .11 2= .22 3= .33 4= .44	5= .56 6= .67 7= .78 8= .89 9= 1
6-4-3-7-8-5-7-3-9	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	0= 0 1= .11 2= .22 3= .33 4= .44	5= .56 6= .67 7= .78 8= .89 9= 1