Mapping Measures: Relations Among Outcomes of a Virtual Morris Water Maze

Rafael A. Garcia & W. Jake Jacobs

Department of Psychology, University of Arizona, Tucson, AZ, 85721

Introduction

A recent study found that instructions can alter navigation and behavior using the C-G Arena (a virtual analogue of the Morris Water Maze; MWM) . While group status (instruction type) predicted the between-group differences on 'traditional outcomes' (latency, distance travelled, quadrant dwell time during a persistence probe), large within-group differences were left unaccounted for (particularly in a group given false instructions). In a reanalysis of a subset of those data, we will combine the various outcomes to try to account for some of these individual differences. It is our hope that these approaches can be used in the future to further describe and predict the participant behavior in these spatial navigation tasks.

Materials and methods

One hundred and eighty students were assigned to one of three groups that differed by a critical instruction: Acquisition ("the target is always in the same place"), Congruent ("the target is between the picture of the rock formation and the picture of the black animal"), and Incongruent ("the target is in a different place on each trial). Each participant was asked to find a target on the floor of a computer-generated room as quickly as possible. During the first three trials, the target was always visible and in a different location. During the next twenty trials, the target was fixed and invisible until contact was made. During the next trials, the room had no accessible target. Instead, each participant performed a persistence probe trial (shortened trial with no target) and two location probes (participants were asked to go where the target should be and press the spacebar in two room layouts: standard and omitted; Figure 1).

Trial latencies, travel path lengths, quadrant dwell times during the persistence probe trial (combined into a discrimination score), and estimated target locations during the location probes were recorded.

Additionally, participants were asked to identify the correct quadrant placement of the target and whether s/he thought the target was always in the same or different location every trial (same = 1 and different = 0).

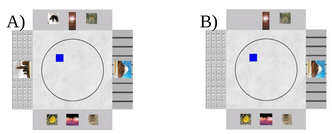

Figure 1: C-G Arena configurations. A) standard configuration B) omitted configuration

Better place learning is indicated by shorter latencies, shorter paths, greater discrimination, reporting the same location each trial, correctly identifying the target placement, and shorter deviations from where the target should be during the location probes.

Two composite scores were created from the measures above: a *Navigating* score (-1 times mean of z-scores for [1] and [2]) and *Locating* (mean of z-scores for [5], [7], and [8]; [7] & [8] reversed). Measures [3] and [6] were then used as benchmarks to test the incremental validity of *Navigating* and *Locating* above and beyond the effect of instructions. Separate models were run for each instruction group as it was hypothesized that the *Navigating* and *Locating* would predict more of the individual differences in the Incongruent Group.

Results

		[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Latency	[1]	----							
Path Length	[2]	**0.79**	----						
Persistence Probe	[3]	**-0.30**	**-0.32**	----					
Spatial	[4]	**-0.82**	**-1.00**	**0.33**	----				
Same/Diff	[5]	**-0.32**	**-0.50**	**0.31**	**0.50**	----			
Target Placement	[6]	**-0.30**	**-0.31**	**0.24**	**0.32**	**0.23**	----		
Location Probe ST	[7]	**0.37**	**0.26**	**-0.41**	**-0.27**	**-0.26**	**-0.23**	----	
Location Probe OM	[8]	**0.26**	**0.37**	**-0.22**	**-0.36**	**-0.52**	-0.11	**0.33**	----

Bivariate correlations among MWM outcomes. [1]-[3] are "traditional" outcomes used in human and non-human research. [4] is a composite of [1]-[3] from Livingstone & Skelton (2007). [5] & [6] are outcomes are reported by participants following the MWM task. [7] & [8] are adapted from a task in Hardt , Hupbach, & Nadel (2009).

Better place learning is indicated by shorter latencies, shorter paths, higher

Bolded correlations are significant at p < 0.01.

Instructions, *Navigating*, and *Locating* significantly predicted both Target Placement and Persistence Probe ($F(4,174) = 17.71$, $p < 0.01$, $R^2=0.29$) and ($F(4,174) = 38.39$, $p < 0.01$, $R^2=0.47$, respectively). Furthermore, *Navigating* and *Locating* were significant even after taking out the effect due to instructions for both Target Placement ($F(1,174) = 25.99$, $p <0.01$, $R^2=0.11$ and $F(1,174) = 11.16$, $p <0.01$, $R^2=0.05$) and Persistence Probe ($F(1,174) = 30.93$, $p <0.01$, $R^2=0.09$ and $F(1,174) = 26.36$, $p <0.01$, $R^2=0.08$).

Acquisition: After taking out the effect due to instructions, *Locating* was significantly associated with Target Placement ($r = 0.39$, $p < 0.01$) and Persistence Probe ($r = 0.34$, $p < 0.01$), while *Navigating* was associated with Target Placement ($r = 0.34$, $p < 0.01$) but not Persistence Probe ($r = 0.18$, p = ns).

Congruent :After taking out the effect due to instructions, *Locating* was not significantly associated with Target Placement ($r = -0.08$, p = ns) or Persistence Probe ($r = 0.23$, p = ns), while *Navigating* was significantly associated with Target Placement ($r = 0.30$, $p < 0.05$) and Persistence Probe ($r = 0.43$, $p < 0.01$).

Incongruent: After taking out the effect due to instructions, both *Locating* and *Navigating* were significantly associated with Target Placement ($r = 0.41$, $p < 0.01$ and $r = 0.41$, $p < 0.01$) and Persistence Probe ($r = 0.59$, $p < 0.01$ and $r = 0.46$, $p < 0.01$).

Discussion

We successfully replicated the finding that the MWM outcomes correlate and seem to "point" in a similar direction. What we have done here, however, is we have begun to tease apart individual differences in the strategies used to navigate the virtual space. While this has been done in other studies (Hardt & Nadel, 2009), we are unaware of it being done with so many convergent measures.

Furthermore, this analysis indicates that participants in Acquisition groups rely on *Locating* processes, participants in Congruent groups rely on *Navigating* processes, and participants in Incongruent groups (after removing the effect of instructions) rely on some combination of the two. This is consistent with the "blinding" effects that we have found previously (Garcia & Jacobs, in prep).

Hopefully, other researchers using the MWM can use this strategy to further expand their own research programs.

Literature cited

Garcia, R. & Jacobs, W. (in preparation). How can we be so blind?

Hardt, O. & Nadel, L. (2009). Cognitive maps and attention. *Progress in Brain Research, 176*, 181-194.

Hardt, O., Hupbach, A., & Nadel, L. (2009). Factors moderating blocking in human place learning: The role of task instructions. *Learning & Behavior, 37*(1), 42-59.

Livingston, S. & Skelton, R. (2007). Virtual environment navigation tasks and the assessment of cognitive deficits in individuals with brain injury. *Behavioral Brain Research, 185*, 21-31.

For further information

Please contact W. Jake Jacobs at wjj@email.arizona.edu or Rafael Garcia at ragarci2@email.arizona.edu. More information on this and related projects, as well as the CG Arena, can be found at http://web.arizona.edu/~arg/

ARG
Anxiety Research Group