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The Spatial Reconstruction Task is a Sensitive Measure of Declarative Memory in Adults with Traumatic Brain Injury

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Subtle impairments in **declarative memory** can go undiagnosed by existing clinical test batteries. The **spatial reconstruction task** may be a sensitive and feasible measure for characterizing memory impairment post-TBI.

Rationale & Background

Memory impairment is one of the most common complaints following a traumatic brain injury (TBI)[1].

Hippocampal damage is common following TBI, with even mild TBI resulting in changes to hippocampal structure and function[2].

Existing clinical tests of declarative memory are sensitive but time-intensive or are quick but insensitive to subtle (but meaningful) impairment.

In the experimental memory literature, the SR task has shown increased sensitivity in detecting hippocampal pathology and memory deficits over traditional neuropsychological measures which holds promise for detecting subtle memory deficits in TBI[3,4,5].

Participants

25 patients with moderate-severe TBI
- Mean age: 35 (SD = 9), Mean yrs education: 15 (SD = 2)
- Moderate-severe as defined by Mayo Classification Scale[6]
- Chronic phase of recovery: > 1 year post-TBI (M = 3.5 years)

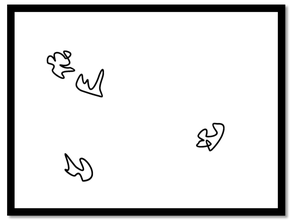
25 demographically-matched neurotypical comparison (NC) participants
- Mean age: 36 (SD = 10), Mean yrs education: 16 (SD = 2)

Subtest	TBI Mean (SD)	NC mean (SD)	t statistic	p-value	# of TBI patients > 1 SD below normative mean
Executive Function	102 (9.23)	108.94 (7.80)	-2.58	0.01	1
Attention	93.18 (9.48)	100.17 (7.04)	-2.67	0.01	3
Working Memory	103.64 (12.77)	113.28 (7.86)	-2.93	0.006	1
Processing Speed	100.41 (19.38)	111.56 (19.19)	-1.87	0.07	5
Declarative Memory	108.68 (15.44)	116.33 (13.63)	-1.66	0.10	2
Vocabulary	108.55 (6.49)	112.28 (6.93)	-1.74	0.09	0

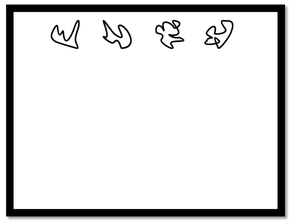
Participant Cognitive Profiles: NIH Toolbox Standard Scores
As a group, patients with TBI did not significantly differ on the picture sequence memory test

Methods

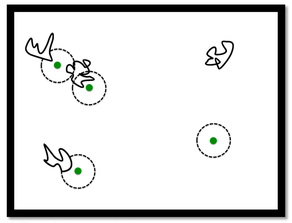
Participants completed a 25-trial, tablet-based version of the SR task. On each trial, participants were asked to remember the locations of novel objects on the screen. The number of items to-be-studied (set size) varied from 2-10.



Study Phase
Participants study the locations of novel objects. Participants were allotted three seconds of study time per item.

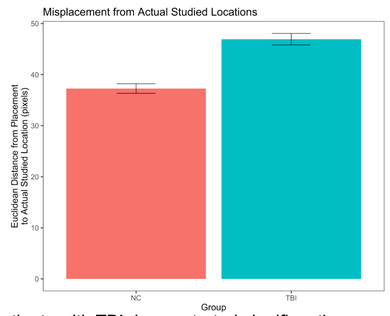


Test Phase
Novel objects disappear for 4 seconds, and reappear at the top of the screen. Participants attempt to drag each object back to its studied location

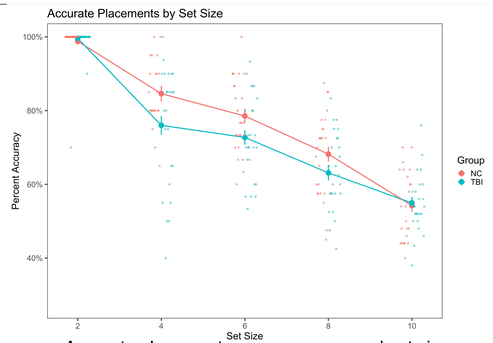


Participants' placements are compared to original studied locations. Here, studied locations are represented with a green dot, surrounded by an accuracy threshold. In this example, the participant has made one accurate placement. (Note that, while the objects in the upper left corner fall within the accuracy threshold, they are "swapped" relative to their studied locations)

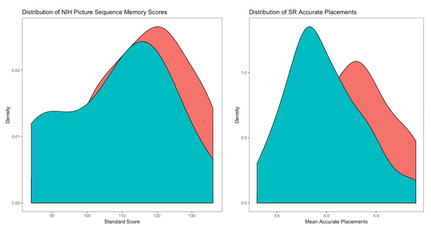
Results



Patients with TBI demonstrated significantly more misplacement (sum of the Euclidean distance between each object placement and its studied location compared to neurotypical comparison participants t(39.88) = 3.21, p = 0.003).



Accurate placements across groups and set sizes were analyzed with a mixed effects model. There was no significant interaction between set size and group (p = 0.68). There was a significant main effect of set size (b = -0.05, p < 0.001), with decreasing accuracy as set size increased and a main effect of group (b = -0.04, p = 0.01), with patients with TBI performing significantly more poorly relative to comparison participants.



A comparison of distributions of scores on the declarative memory subtest of the NIH Toolbox (left) and SR performance (right)

Results

A subset of the neurotypical comparison participants (n = 16) completed an alternate form (i.e. same set sizes, but changed object locations) of the SR task a second time, with at least one month of intervening time.

Test-retest reliability for the misplacement metric was 0.80
Test-retest reliability for accurate placements was 0.63

Discussion & Future Directions

- Patients with TBI were impaired on the SR task, relative to NC participants. This group difference is in contrast to patients' performance on the declarative memory subtest of the NIH Toolbox, where patients did not significantly differ from NC participants, and all but two patients scored within a standard deviation of the normative mean.
- Despite memory ability "within the normal range", patients with TBI demonstrated significantly impaired performance on the SR task relative to NC participants. This suggests that the SR task may be a more sensitive measure of declarative memory, identifying subtle disruptions in memory function that go unnoticed by commonly used assessments of declarative memory.
- The SR task implemented in the current study included larger set sizes than have been implemented in previous studies, in an attempt to capture subtle deficits in declarative memory. Adapting the spatial reconstruction task to a computer-adaptive format may contribute to the utility of the task as a clinical assessment.
- The tablet-based SR task is easily portable and does not require a verbal response, which increases its utility for patients with concomitant communication impairments. Continued development of the SR task could provide an efficient, clinically feasible measure of declarative memory that could be easily implemented across multiple clinical settings (at bedside, in outpatient settings, in schools, and in home heath contexts).

References

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