Estrogen as a Mediator of the Relationships Between Multitasking, Spatial Orientation & Navigation

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Introduction

Research has shown lower estradiol levels are associated with improved performance on a task of mental rotation (Hampson, Levy-Cooperman, and Korman, 2014), implicating estrogen in visuospatial processing. Other research has shown a relationship between multitasking and visuospatial processing (Reyes, Garcia, Aguilar, Snow, and Fischer Beers, 2019). The current study investigated the potential mediating role of estrogen on relationships among multitasking performance, spatial orientation, and navigation abilities. To examine the relationship between spatial ability, multitasking, and working memory, three assessments were used: the Multitasking Assessment Test (MTAT), the Perspective Taking and Spatial Orientation Test (PTSOT), as well the Santa Barbara Sense of Direction scale (SBSOD). The MTAT asks participants to remember written descriptions of physical objects and place them in a designated space. The PTSOT requires participants to picture standing at an object while facing another object and estimate the angle in degrees, to measure their spatial awareness (Hegarty, & Waller, 2004).. Finally, spatial navigation abilities were measured using the SBSOD, in which participants self-report navigation strategies and abilities (Hegarty, Richardson, Montello, Lovelace and Sabbiah, 2002). We hypothesized that performance on the MTAT would correlate with performance on the PTSOT and with self-reported navigation skills on the SBSOD. Furthermore, we hypothesized that relationships between these three assessments would be mediated by estrogen, as measured by cycle phase.

Methods

Procedure
- Participants provided informed consent and completed a demographic questionnaire.
  - The survey included grade level, GPA, participant age, date of last menstrual cycle, and birth control usage.
- Participants gave a saliva sample to measure their estrogen levels.
- Participants completed the Multitasking Assessment Test (MTAT).
  - Participants completed a practice test followed by two tests.
  - Each test presented 12 items, one at a time, to sort into bins based on various colors, sizes, and shapes.
  - Results were measured based on time to placement of an object into the correct bin.
- Participants also completed the Perspective Taking and Spatial Orientation Task (PTSOT), which requires participants to imagine standing at an object while facing another object and estimate the angle in degrees.
- Finally participants completed the Santa Barbara Sense of Direction Scale (SBSOD), a survey to measure their self-reported experience with navigation.

Results

Scoring:
- For the MTAT, the average response time to sort the objects into the correct bins across the two tests was computed.
- The PTSOT was scored by subtracting the measurement of the actual angle from the angle estimated by the participant and using the absolute value to compute the error score..
- The questions on the SBSOD were scored using a 5 point Likert scale and the average was computed.

Analysis:
- Participants ranged in age from 18 to 67 years old (M=22.89).
- No significant correlations were observed between the MTAT scores and the PTSOT scores, between the MTAT scores and the SBSOD scores, or between the PTSOT scores and the SBSOD scores, $p > .05$. (See Table 1.)
- A one-way ANOVA was computed which showed no effect of menstrual cycle phases on MTAT response times [$F(2,40)=1.559, p < .05$], no effect of cycle phase on PTSOT scores [$F(2,36)=.131, p >.05$], and no effect of cycle phase on SBSOD scores [$F(2,37)=.780, p >.05$].

Table. 1

Correlations

		GPA	Avg response time computed (across 2 tests)	PTSOT Average Error Score	SBSOD
GPA	Pearson Correlation	1	−.218	−.213	.019
	Sig. (2-tailed)		.182	.213	.912
	N	39	39	36	36
Avg response time computed (across 2 tests)	Pearson Correlation	−.218	1	.040	.010
	Sig. (2-tailed)	.182		.813	.952
	N	39	41	37	38
PTSOT Average Error Score	Pearson Correlation	−.213	.040	1	−.081
	Sig. (2-tailed)	.213	.813		.649
	N	36	37	37	34
SBSOD	Pearson Correlation	.019	.010	−.081	1
	Sig. (2-tailed)	.912	.952	.649	
	N	36	38	34	38

Figure 1. Multitasking

BIN 1
FORMS: square
COLORS: red
SIZES: huge
This bin holds no more than **5** objects.
There are **0** objects already assigned to this bin
POSSIBLE POINTS: **3**
press the **ENTER KEY** to continue
What would you like to know about 7?
Type SIZE, COLOR or FORM

medium

Would you like to ask another question of this same object?
YES: type 'y'
NO: type 'n'

Figure 2. Orientation

Example:
Imagine you are standing at the **flower** and facing the **tree**. Point to the **cat**.
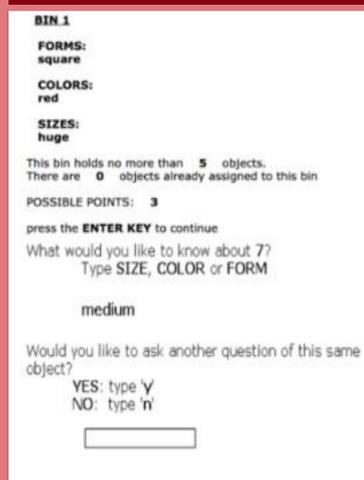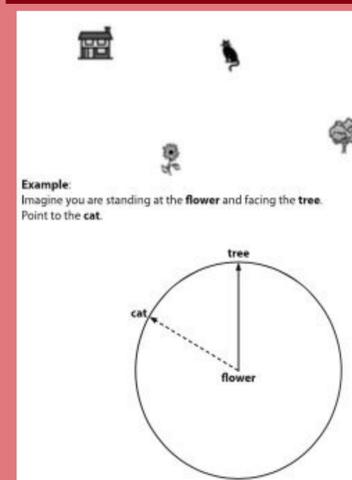
Discussion

- Inconsistent with past research, the results showed no correlation between multitasking and spatial orientation abilities as measured by the PTSOT.
  - Differences in scoring methods for the PTSOT may account for this.
  - Direct comparison of PTSOT scoring methods may help clarify.
- No relationship between multitasking ability and self-reported sense of direction was observed.
  - How participants viewed their own ability to navigate was likely not related to the visuospatial component of the MTAT.
- No correlation was found between PTSOT scores and SBSOD scores.
  - Navigation abilities may not be related to perspective-taking, which is more similar to a mental rotation task.
- Cycle phase had no effect on any of the other measures, suggesting these capacities may not be estrogen-related.
  - Other hormones may mask effects of estrogen.
- Future directions include analysis of salivary estrogen to determine if estrogen levels affect performance on any of the other measures.

Literature Cited

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