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A large-scale study of academic specialization and sex effects on Corsi block performance

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This study aimed to investigate the relationship between sex, educational specialization (science, technology, engineering, and mathematics (STEM) vs. non-STEM), and performance on the Corsi block-tapping task (CBT). Behavioral outcomes included the total number of correct responses, mean reaction time (RT), and mean RT for correct responses. The sample comprised 5,455 first-year Russian university students (mean age = 18.5; 62% female). Data were analyzed using rank-based analysis of variance (ANOVA) and hierarchical linear regression models. On average, male students outperformed female students in terms of both accuracy and response speed, while STEM students achieved higher scores than non-STEM students but did not differ in RT. Notably, sex differences in the number of correct responses disappeared within educational groups, whereas sex differences in RT persisted among educational groups, regardless of educational specialization. Regression analysis revealed that mean RT (correct responses), age, sex, and educational specialization collectively explained approximately 20% of the variance in performance accuracy. The predictive contribution of educational specialization exceeded that of sex, while the interaction between these variables was not significant. These findings suggest that, while both educational specialization and sex contribute to individual differences in visuospatial working memory performance, educational specialization emerges as a slightly more influential predictor of accuracy than sex, particularly in the number of correct responses. In contrast, reaction time appears to be more consistently associated with sex-related differences, irrespective of educational specialization. The results highlight the importance of considering both cognitive and contextual factors in the assessment of spatial working memory.

KEYWORDS
Corsi block-tapping task, visuospatial working memory, stem education, reaction time, sex differences, educational specialization

1 Introduction

Visuospatial working memory, the ability to temporarily store and manipulate spatial information, is a core component of human cognition, supporting reasoning, learning, and academic achievement across disciplines (Baddeley, 2010; Fanari et al., 2019; Gountas and Moraes, 2024). Among its standard assessment tools is the Corsi block-tapping task (CBT), which requires participants to reproduce sequences of spatial locations and is widely used in neuropsychological and educational research (Berch et al., 1998; Kessels et al., 2000; Facchin et al., 2024). Computerized implementations like eCorsi have facilitated large-scale, standardized data collection while preserving the task's psychometric properties (Brunetti et al., 2014; Arce and McMullen, 2021).

Research has long debated the role of sex in visuospatial working memory. While some studies report a modest male advantage (Piccardi et al., 2008; Nori et al., 2015), others find no consistent differences between the two sexes (Farrell Pagulayan et al., 2006; Kessels et al., 2000). These mixed findings could stem from both biological factors, such as brain structure or hormonal influences (Williams and Meck, 1991; Zilles et al., 2016), and environmental or experiential factors, such as academic choices, spatial training, or engagement in domain-specific tasks (Moè, 2016; Jirout and Newcombe, 2015).

From the perspective of information processing theory (Baddeley, 2010), sex-based or training-related differences in working memory could reflect variations in how cognitive resources, such as attention, rehearsal strategies, or storage capacity, are deployed during task execution. Expertise Theory (Chi, 2006) further suggests that extended experience in domains involving spatially demanding tasks, e.g., STEM disciplines, could foster adaptive strategies or structural efficiency in memory encoding and retrieval.

Despite growing interest in the role of environmental scaffolds for cognitive skill development, relatively few large-scale studies have systematically examined how sex and academic specialization (e.g., science, technology, engineering, and mathematics (STEM) vs. non-STEM) interact to shape spatial working memory. While prior research has addressed either sex-based differences or academic domain effects in isolation, studies directly comparing their relative and combined contributions remain scarce, particularly in culturally specific educational systems.

Moreover, it remains unclear whether cognitive differences observed between male and female students in spatial tasks persist when academic specialization is taken into account. If the academic environment plays a compensatory or amplifying role, it could have implications for equity-focused interventions aimed at improving spatial skills among underrepresented groups in STEM (Cheryan et al., 2025; Moè, 2016).

The present study aimed to investigate the interaction between academic specialization (STEM vs. non-STEM) and sex in shaping performance on the Corsi block-tapping task among university students.

2 Materials and methods

A total of 5,455 first-year Russian university students (62% women, $M = 18.5$, $SD = 1$) participated in the study. The participants were asked to indicate their sex (male/female) as part of a standardized demographic questionnaire. Throughout this study, we use the term sex to refer exclusively to this self-reported binary variable. Academic specialization was also self-reported by the participants in response to the question: “Please indicate your current field of study.” Based on their responses, students were classified into two groups: the STEM group (33.4%), comprising those who selected technical sciences, and the non-STEM group (66.6%), comprising those who selected humanities.

We limited our sample to first-year students to minimize variability in cognitive and academic experience within each academic specialization. By focusing on the entry stage of university education, we aimed to capture baseline differences associated with self-selection into academic specialization.

A computerized Corsi block-tapping (CB) task with 12 trials (2 sequences per level, with difficulty ranging from 4 to 9 items) was used. The task followed a standard adaptive Corsi paradigm. Each trial began with the presentation of nine blocks in fixed screen locations. A sequence of blocks was then highlighted in yellow, starting with two items and increasing by one on each correct response. Each item in the sequence was displayed for 300 ms with a 300-ms blank interval. After the full sequence, a sound cue signaled the start of the response phase, during which participants reproduced the sequence by clicking the corresponding blocks with a mouse. Cursor input was disabled during sequence presentation and re-enabled during the response phase. Each click had to be made within a 10-s window; if no response was detected within that time, the trial advanced automatically. Responses were compared to the target sequence for accuracy. The task continued until the participant either reached a sequence length of nine or made two consecutive errors. The primary outcome measure was the longest sequence correctly reproduced, i.e., the individual's Corsi span.

Data were collected using the PsyData platform (https://psydata.ru, accessed 28 July 2025). Informed consent was obtained from all participants. The study was approved by the Ethics Committee of the Psychological Institute of the Russian Academy of Education.

Multivariate outliers were identified and removed using the robust Mahalanobis distance, computed from response times for correct answers and adjusted for total score levels, based on the 99th percentile of the chi-squared distribution. A total of 113 participants were excluded from the initial sample due to extreme response times, as such values may indicate inattentive or non-compliant task engagement.

Group comparisons (sex × specialization × age group) for CB outcomes were conducted using ART-ANOVA (ARTool package), with effect sizes reported via partial η^2. Group means and standard deviations (SDs) were tabulated by sex, specialization, and age.

Spearman's correlations between RTs and total score were calculated with Holm-adjusted p-values. A series of nested linear regressions examined the predictive roles of age, sex, specialization, and RTs on CB performance. Model comparisons used adjusted R^2, AIC, and BIC, with structured summary tables.

3 Results

Descriptive statistics for the whole sample, educational specialization, and sex differences by educational specialization are presented in Table 1. Our data are consistent with earlier reports in healthy adult populations (Kessels et al., 2000; Farrell Pagulayan et al., 2006; Arce and McMullen, 2021; Facchin et al., 2024), indicating that the computerized CB version remains appropriate for use in large, diverse samples of university students.

The total mean RT and the mean RT for correct answers are strongly positively correlated ($\rho = 0.83$, $p < 0.001$). In addition, both the total mean RT and the mean RT for correct answers show a weak but statistically significant positive correlation with the number of correct answers ($\rho = 0.17$, $p < 0.001$ and $\rho = 0.19$, $p < 0.001$, respectively).

The results of the between-group comparison for specialization, sex, and age group as well as their interactions are presented in Table 2.

TABLE 1 Descriptive statistics (Mean and standard deviation (SD)) for the number of correct answers, total mean reaction time, and reaction time for correct answers.

Sample	All	STEM	Non-STEM	STEM male	STEM female	Non-STEM male	Non-STEM female
Mean reaction time (RT) (ms)	5495.65 (2533.73)	5486.96 (2659.94)	5499.90 (2469.97)	5331.16 (2560.29)	5825.48 (2837.34)	5093.42 (1853.56)	5609.10 (2600.34)
Mean RT (correct answers) (ms)	4554.29 (2436.06)	4571.70 (2655.82)	4545.77 (2321.29)	4411.40 (2578.19)	4919.98 (2787.68)	4158.07 (1691.37)	4649.93 (2453.03)
Total score	5.54 (2.13)	5.96 (2.17)	5.34 (2.08)	6.00 (2.15)	5.86 (2.22)	5.41 (2.02)	5.32 (2.09)

TABLE 2 Differences in the number of correct answers, mean reaction time, and reaction time (RT) for correct answers for specialization, sex, and age.

Outcome	Effect	F (signif)	η^2 (partial)
Mean reaction time (RT)	Sex	4.25*	0.001
	Specialization	0.45	0.000
	Age	2.97**	0.004
	Sex × Specialization	3.52	0.001
	Sex × Age	1.25	0.002
	Specialization × Age	2.23*	0.003
	Sex × Specialization × Age	1.51	0.002
Mean RT (Correct answers)	Sex	12.95***	0.002
	Specialization	0.17	0.000
	Age	3.25**	0.004
	Sex × Specialization	3.02	0.001
	Sex × Age	0.95	0.001
	Specialization × Age	3.02**	0.004
	Sex × Specialization × Age	1.51	0.002
Total Score	Sex	1.22	0.000
	Specialization	4.38*	0.001
	Age	2.59**	0.004
	Sex × Specialization	0.13	0.000
	Sex × Age	1.74	0.002
	Specialization × Age Group	0.99	0.001
	Sex × Specialization × Age	3.75***	0.005

Cross indicates interaction. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

For mean reaction time, significant main effects of sex ($F = 4.25$, $p < 0.05$, $\eta^2 = 0.001$) and age group ($F = 2.97$, $p < 0.01$, $\eta^2 = 0.004$) were observed, indicating that males and younger participants responded more quickly on average. Although the main effect of educational specialization was not significant ($F = 0.45$, $p > 0.05$), a significant interaction between specialization and age group ($F = 2.23$, $p < 0.05$, $\eta^2 = 0.003$) was detected, suggesting that age-related differences in reaction time may vary depending on educational specialization. Other interaction effects did not reach statistical significance.

For the mean reaction time of correct responses, a stronger effect of sex was observed ($F = 12.95$, $p < 0.001$, $\eta^2 = 0.002$), along with a significant effect of age ($F = 3.25$, $p < 0.01$, $\eta^2 = 0.004$). Additionally, a significant interaction between specialization and age emerged ($F = 3.02$, $p < 0.01$, $\eta^2 = 0.004$), suggesting that age-related differences varied depending on the participant's specialization.

Regarding the total score, no significant main effect of sex was observed. However, significant effects of specialization ($F = 4.38$, $p < 0.05$, $\eta^2 = 0.001$) and age ($F = 2.59$, $p < 0.01$, $\eta^2 = 0.004$) were detected. Notably, a three-way interaction among sex, specialization, and age group was also significant ($F = 6.26$, $p < 0.001$, $\eta^2 = 0.007$), indicating a complex interplay of these factors in determining the overall performance.

Linear regression analyses (Table 3) revealed a progressive improvement in model fit with the inclusion of additional predictors. The base model, including age (scaled) and mean reaction time for correct responses as predictors, accounted for 18.3% of the variance in performance (adjusted $R^2 = 0.183$, AIC = 24363.4, BIC = 24390.1). Both predictors were statistically significant, with age negatively associated with performance ($\beta = -0.061$, $p = 0.015$) and mean RT showing a robust negative relationship ($\beta \approx 0.000$, $p < 0.001$).

Adding sex as a predictor improved model fit (adjusted $R^2 = 0.197$, AIC = 24265.3, BIC = 24298.7), with female participants performing significantly worse ($\beta = -0.522$, $p < 0.001$) than the male participants, while the effects of age and mean RT remained significant.

Further inclusion of academic specialization (STEM vs. non-STEM) led to additional improvement (adjusted $R^2 = 0.201$, AIC = 24231.7, BIC = 24265.1), with non-STEM participants exhibiting lower performance scores ($\beta = -0.616$, $p < 0.001$) than STEM participants. However, age and mean RT effects remained stable.

The full model, incorporating age, mean RT, sex, specialization, and their interaction, explained the largest proportion of variance (adjusted $R^2 = 0.205$, AIC = 24207.2, BIC = 24253.9). While age ($\beta = -0.081$, $p = 0.001$), mean RT ($\beta \approx 0.000$, $p < 0.001$), sex ($\beta = -0.345$, $p < 0.001$), and specialization ($\beta = -0.498$, $p < 0.001$) all remained significant predictors, the interaction between sex and specialization was not statistically significant ($\beta = 0.058$, $p = 0.625$), suggesting no evidence for a moderating effect.

Between the two demographic predictors, specialization (STEM vs. non-STEM) consistently showed a slightly stronger and more stable effect than sex on the total score, with larger absolute coefficients and better model fit when included alone. This suggests that educational specialization may be a somewhat more important predictor of performance than sex in this context.

4 Discussion

Using a large, homogeneous cohort of first-year Russian undergraduates, we observed that (a) academic specialization (STEM

 10.3389/feduc.2025.1639086

TABLE 3 Results of linear regression models for the prediction of the number of correct answers.

Model	Adjusted R^2	AIC	BIC	Predictor	Estimate	p-value
Base	0.183	24363.4	24390.1	Age (Scaled)	−0.061	0.015
				Mean RT (correct)	0.000	0.000
Sex	0.197	24265.3	24298.7	Age (Scaled)	−0.077	0.002
				Mean RT (correct)	0.000	0.000
				Sex (Female)	−0.522	0.000
Specialization	0.201	24231.7	24265.1	Age (Scaled)	−0.075	0.003
				Mean RT (correct)	0.000	0.000
				Specialization (non-STEM)	−0.616	0.000
Full	0.205	24207.2	24253.9	Age (Scaled)	−0.081	0.001
				Mean RT (correct)	0.000	0.000
				Sex (Female)	−0.345	0.000
				Specialization (non-STEM)	−0.498	0.000
				Sex x Specialization	0.058	0.625

vs. non-STEM) was a slightly stronger correlate of Corsi block-tapping task accuracy than biological sex, while (b) mean reaction time (RT) remained reliably faster in male students across specializations. Although several effects reached conventional statistical significance, all partial η^2 values were $\leq$0.005, and regression coefficients were modest, underscoring the fact that these practical differences are small and should be interpreted with caution.

Our data revealed an intriguing pattern, where participants who achieved higher Corsi span scores also exhibited longer average reaction times (RTs). This counterintuitive finding, despite the fact that the mean RT for correct trials was lower than the overall RT, suggests that high performers may have adopted more effortful and strategic processing during challenging sequences. In line with information processing theory (Baddeley, 2010), this could reflect engagement of modality-specific rehearsal mechanisms, such as subvocal or visuospatial chunking strategies, which increase cognitive load but ultimately enhance accuracy (Fischer, 2001; Turcotte and Oddson, 2022; McAteer et al., 2023; Soni and Frank, 2025). Thus, slower responses among top performers may reflect deeper processing rather than hesitation or inefficiency.

Complementing this interpretation is a domain-specific perspective grounded in Expertise Theory (Chi, 2006), which posits that frequent engagement in spatially demanding activities, such as coding, schematic visualization, or technical modeling, can refine the efficiency and robustness of rehearsal strategies. This may explain why female STEM students performed on par with or exceeded male non-STEM peers, despite well-documented average sex differences in spatial working memory (Pauls et al., 2013; Baddeley, 2010). In this context, educational specialization may serve not only as a proxy for prior spatial experience but also as a developmental scaffold that fosters domain-specific cognitive adaptations.

However, these interpretations remain correlational. It is unclear whether STEM environments causally enhance spatial working memory or whether individuals with pre-existing strengths in these domains disproportionately self-select into such fields. Disentangling these pathways requires longitudinal or experimental designs capable of tracing intra-individual change over time and isolating the effects of structured spatial training.

The absence of RT differences across academic specialization suggests that psychomotor speed is less influenced by educational experience than accuracy, consistent with prior findings that processing-speed measures contribute little beyond cognitive accuracy in predicting academic outcomes (Carretta and Ree, 2000). Despite modest effect sizes, our results indicate that academic context can reduce the typical male advantage in visuospatial accuracy, aligning with the evidence that targeted spatial training narrows sex differences and supports female retention in STEM (Moè, 2016). At the same time, persistent sex effects on both global and correct-trial RTs replicate established findings of faster psychomotor performance in male students than in female students (Ruff and Parker, 1993; Roivainen et al., 2021). Universities could therefore leverage curricular scaffolding of spatial reasoning, for instance, by embedding dynamic-visualization modules in introductory humanities courses, to foster more equitable cognitive skill specializations.

Our findings align with a growing body of research aimed at reducing sex-based disparities in STEM education by addressing not only structural barriers but also psychosocial dynamics. While access to STEM curricula is a necessary first step, recent reviews emphasize that it is insufficient on its own to ensure equitable outcomes. Factors such as motivational climate, perceived identity safety, and sustained academic belonging play a critical role in fostering long-term retention (Cheryan et al., 2025; Beroíza-Valenzuela and Salas-Guzmán, 2024). Evidence-based interventions, including utility-value writing tasks (Asher et al., 2023), ecological belonging cues (Bahnson et al., 2025), and exposure to relatable role models (Tal et al., 2024), have demonstrated measurable improvements in engagement and performance among underrepresented students. Notably, our results suggest that academic specialization itself could shape performance profiles in ways that partially offset or even obscure typical sex-based differences, particularly in visuospatial domains. This underscores the need for a more integrative framework, one that considers both biological predispositions and the formative influence of domain-specific training when interpreting sex-related performance gaps. Psychosocial strategies and curricular scaffolding should therefore be viewed not in isolation, but as components of a complex, dynamic system influencing cognitive outcomes.

Several limitations should be acknowledged.

First, the cross-sectional design precludes causal inference; future longitudinal research should track intra-individual change across semesters.

Second, cultural specificity limits generalizability: Russian educational structures, sex norms, and STEM pipelines differ from those in other regions (Ganley and Vasilyeva, 2014).

Third, the age homogeneity of the sample limits the generalizability to a broader student population.

Fourth, unmeasured covariates such as socioeconomic status or formal spatial-skills training could confound both specialization choice and task performance (Buckley et al., 2018).

Fifth, the computerized Corsi block task implementation may not fully map onto traditional board versions; device-related motor demands could interact with sex-linked hand-size or dexterity differences (Claessen et al., 2014).

Future directions include experimental manipulation of spatial strategy instruction across majors and sexes to probe malleability, incorporation of socioeconomic and motivational variables to parse layered influences on working-memory development, and replication in diverse cultural settings and with alternative spatial tasks (e.g., mental rotation) to verify domain-generality. Anchored in information-processing and expertise accounts, our results indicate that academic specialization is a meaningful, though small, predictor of visuospatial-memory accuracy, partly offsetting sex differences, while processing-speed disparities appear more biologically rooted. Appreciating these nuanced patterns can inform equitable curriculum design and targeted support for underrepresented groups in STEM.

5 Conclusion

In summary, our study shows that the CB task can be used to assess the visuospatial working memory span in university students. Sex differences in accuracy observed in the entire sample disappeared when male and female students were compared within the STEM and non-STEM educational specializations. Unlike accuracy, the RT was associated with sex but not with educational specialization. Future studies focusing on the causal relationship between STEM education and visuospatial working memory could provide a basis for interventions aimed at reducing the underrepresentation of women in STEM education.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors without undue reservation.

Ethics statement

The studies involving humans were approved by the Ethics Committee of the Psychological Institute of the Russian Academy of Education. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

SM: Conceptualization, Funding acquisition, Methodology, Supervision, Writing – review & editing. AP: Data curation, Formal analysis, Investigation, Writing – original draft. AM: Data curation, Investigation, Validation, Writing – original draft. TA: Data curation, Formal analysis, Investigation, Validation, Writing – original draft. TT: Data curation, Investigation, Project administration, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The authors declare that no Gen AI was used in the creation of this manuscript.

Publisher's note

References

Arce, T., and McMullen, K. (2021). The Corsi block-tapping test: evaluating methodological practices with an eye towards modern digital frameworks. *Comput. Hum. Behav. Rep.* 4:100099. doi: 10.1016/j.chbr.2021.100099

Asher, M. W., Harackiewicz, J. M., Beymer, P. N., Hecht, C. A., Lamont, L. B., Else-Quest, N. M., et al. (2023). Utility-value intervention promotes persistence and diversity in STEM. *PNAS* 120:e2300463120. doi: 10.1073/pnas.2300463120

Baddeley, A. (2010). Working memory. *Curr. Biol.* 20, R136–R140. doi: 10.1016/j.cub.2009.12.014

Bahnson, M., Godwin, A., Schunn, C., McChesney, E., and DeAngelo, L. (2025). Retention in engineering pathways: an ecological belonging intervention supports help-seeking and continued enrollment. *Int. J. STEM Educ.* 12:6. doi: 10.1186/s40594-025-00530-w

Berch, D. B., Krikorian, R., and Huha, E. M. (1998). The corsi block-tapping task: methodological and theoretical considerations. *Brain Cogn.* 38, 317–338. doi: 10.1006/brcg.1998.1039

Beroíza-Valenzuela, F., and Salas-Guzmán, N. (2024). STEM and gender gap: a systematic review in WoS, Scopus, and ERIC databases (2012–2022). *Front. Educ.* 9:1378640. doi: 10.3389/feduc.2024.1378640

Brunetti, R., Del Gatto, C., and Delogu, F. (2014). eCorsi: implementation and testing of the Corsi block-tapping task for digital tablets. *Front. Psychol.* 5:939. doi: 10.3389/fpsyg.2014.00939

Buckley, J., Seery, N., and Canty, D. (2018). A heuristic framework of spatial ability: a review and synthesis of spatial factor literature to support its translation into STEM education. *Educ. Psychol. Rev.* 30, 947–972. doi: 10.1007/s10648-018-9432-z

Carretta, T. R., and Ree, M. J. (2000). General and specific cognitive and psychomotor abilities in personnel selection. *Int. J. Sel. Assess.* 8, 227–236. doi: 10.1111/1468-2389.00152

Cheryan, S., Lombard, E. J., Hailu, F., Pham, L. N. H., and Weltzien, K. (2025). Global patterns of gender disparities in STEM and explanations for their persistence. *Nat. Rev. Psychol.* 4, 6–19. doi: 10.1038/s44159-024-00380-3

Chi, M. T. (2006). "Two approaches to the study of experts' characteristics," in *The Cambridge handbook of expertise and expert performance*. eds. K. A. Ericsson, N. Charness, P. J. Feltovich, and R. R. Hoffman (Cambridge University Press), p. 21–30.

Claessen, M. H. G., van der Ham, I. J. M., and van Zandvoort, M. J. E. (2014). Computerization of the standard corsi block-tapping task affects its underlying cognitive concepts: a pilot study. *Appl. Neuropsychol. Adult* 22, 180–188. doi: 10.1080/23279095.2014.892488

Facchin, A., Pegoraro, S., Rigoli, M., Rizzi, E., Strina, V., Barera, S., et al. (2024). Regression-based normative data for Corsi span and Supraspan learning and recall among Italian adults. *Neurol. Sci.* 45, 5707–5718. doi: 10.1007/s10072-024-07756-6

Fanari, R., Meloni, C., and Massidda, D. (2019). Visual and spatial working memory abilities predict early math skills: a longitudinal study. *Front. Psychol.* 10:2460. doi: 10.3389/fpsyg.2019.02460

Farrell Pagulayan, K., Busch, R. M., Medina, K. L., Bartok, J. A., and Krikorian, R. (2006). Developmental normative data for the Corsi block-tapping task. *J. Clin. Exp. Neuropsychol.* 28, 1043–1052. doi: 10.1080/13803390500350977

Fischer, M. H. (2001). Probing spatial working memory with the Corsi blocks task. *Brain Cogn.* 45, 143–154. doi: 10.1006/brcg.2000.1221

Ganley, C. M., and Vasilyeva, M. (2014). The role of anxiety and working memory in gender differences in mathematics. *J. Educ. Psychol.* 106, 105–120. doi: 10.1037/a0034099

Gountas, J., and Moraes, M. (2024). Analogical visuospatial matrix reasoning, verbal relational reasoning, verbal IQ and memory relationships with maths and science: a behavioural and fMRI study. *Qeios.* doi: 10.32388/SZ5ZYZ

Jirout, J. J., & Newcombe, N. S. (2015). Building blocks for developing spatial skills: evidence from a large, representative U.S. sample. Psychol. Sci., 26, 302–310. doi: 10.1177/0956797614563338

Kessels, R. P. C., van Zandvoort, M. J. E., Postma, A., Kappelle, L. J., and de Haan, E. H. F. (2000). The corsi block-tapping task: standardization and normative data. *Appl. Neuropsychol.* 7, 252–258. doi: 10.1207/s15324826an0704_8

McAteer, S. M., McGregor, A., and Smith, D. T. (2023). Oculomotor rehearsal in visuospatial working memory. *Atten. Percept. Psychophys.* 85, 261–275. doi: 10.3758/s13414-022-02601-4

Moè, A. (2016). Does experience with spatial school subjects favour girls' mental rotation performance? *Learn. Individ. Differ.* 47, 11–16. doi: 10.1016/j.lindif.2015.12.007

Nori, R., Piccardi, L., Migliori, M., Guidazzoli, A., Frasca, F., De Luca, D., et al. (2015). The virtual reality walking Corsi test. *Comput. Hum. Behav.* 48, 72–77. doi: 10.1016/j.chb.2015.01.035

Pauls, F., Petermann, F., and Lepach, A. C. (2013). Gender differences in episodic memory and visual working memory including the effects of age. *Memory* 21, 857–874. doi: 10.1080/09658211.2013.765892

Piccardi, L., Iaria, G., Ricci, M., Bianchini, F., Zompanti, L., and Guariglia, C. (2008). Walking in the Corsi test: which type of memory do you need? *Neurosci. Lett.* 432, 127–131. doi: 10.1016/j.neulet.2007.12.044

Roivainen, E., Suokas, F., and Saari, A. (2021). An examination of factors that may contribute to gender differences in psychomotor processing speed. *BMC Psychol.* 9:190. doi: 10.1186/s40359-021-00698-0

Ruff, R. M., and Parker, S. B. (1993). Gender-and age-specific changes in motor speed and eye-hand coordination in adults: normative values for the finger tapping and grooved pegboard tests. *Percept. Mot. Skills* 76, 1219–1230. doi: 10.2466/pms.1993.76.3c.1219

Soni, A., and Frank, M. J. (2025). Adaptive chunking improves effective working memory capacity in a prefrontal cortex and basal ganglia circuit. *eLife* 13:RP97894. doi: 10.7554/eLife.97894

Tal, M., Lavi, R., Reiss, S., and Dori, Y. J. (2024). Gender perspectives on role models: insights from STEM students and professionals. *J. Sci. Educ. Technol.* 33, 699–717. doi: 10.1007/s10956-024-10114-y

Turcotte, J., and Oddson, B. (2022). Managing increased cognitive load in a guided search. *Percept. Mot. Skills* 129, 378–398. doi: 10.1177/00315125221076440

Williams, C. L., and Meck, W. H. (1991). The organizational effects of gonadal steroids on sexually dimorphic spatial ability. *Psychoneuroendocrinology* 16, 155–176. doi: 10.1016/0306-4530(91)90076-6

Zilles, D., Lewandowski, M., Vieker, H., Henseler, I., Diekhof, E., Melcher, T., et al. (2016). Gender differences in verbal and visuospatial working memory performance and networks. *Neuropsychobiology* 73, 52–63. doi: 10.1159/000443174