

Supplementary Material

1) Changes to the Preregistration

In the preregistration, we state that, for the investigation of effects of PE on memory performance, we would analyze the number of correctly recalled words and compare the recall performance in pre and post. The effects of PE on inhibitory control are not analyzed in an exploratory fashion (as planned in the preregistration), but as an actual hypothesis, based on work by Kao et al. (2016), Aguirre-Loaiza et al. (2022), and Hillman et al. (2009). Inhibitory control is parametrized as the accuracy and reaction time in the Go/NoGo task. We decided on this procedure in order to enlarge the literature not only with regard to PE and memory, but also inhibitory control, complementing the work cited in the introduction. Importantly, we decided on this procedure before analyzing the data.

In the description of the statistical analysis and results sections of this paper, we report the implementation and results of repeated measures ANOVAs on values standardized to the pooled pretest SD and pre group-means. In the case of significant interaction effects, we applied t-test to track down if there was a significant difference in the pre to post change between the included groups. In the preregistration, we proposed variance-heterogeneous multilevel models and post hoc tests to implement the contrasts that we now integrated in the linear model. As we had large intergroup variances, we decided on the described standardizing procedure to better analyze and visualize the pre to post changes. The ANOVA was applied in the final analysis as it was more suitable for the data at hand.

A larger deviation from the preregistration consists in implementing a two step approach to the statistical analyses. As we got external advice to not consider the swim group in the main analyses due to considerable differences in participant recruiting and measuring conditions between the swim group and the other two groups. To still be able to use the data collected in the swim group, we decided to add this group in a second step for an exploratory analysis.

Finally, we compared the manuscript and the preregistration using a large language model based web app on the 28th October 2025 (<https://regcheck.app/>). When accounting for the non-reported analyses on the EEG data, we obtained the results displayed on the following page.

Hypothesis	Study Feature	Information in paper	Preregistered Protocol	Match
H1.1: Exercise enhances memory performance	Sample size before exclusions	97	Not specified	NA
	Sample size after exclusions	84	Not specified	NA
	Planned variable(s) to measure/test	Number of correctly recalled words	Number of correctly recalled words	TRUE
	Planned processing/scoring	Standardized to pooled pretest SD and pre-group means	Count of recalled words	FALSE
	Planned statistical model	Mixed ANOVA		
H1.2: Different exercise types have different effects	Sample size before exclusions	97	Not specified	NA
	Sample size after exclusions	84	Not specified	NA
	Planned variable(s) to measure/test	Number of correctly recalled words	Number of correctly recalled words	TRUE
	Planned processing/scoring	Standardized to pooled pretest SD and pre-group means	Count of recalled words	FALSE
	Planned statistical model	Mixed ANOVA		
H2.1: Exercise enhances electrophysiological markers of memory encoding	Sample size before exclusions	97	Not specified	NA
	Sample size after exclusions	84	Not specified	NA
	Planned variable(s) to measure/test	P300 amplitude (400–800 ms) for remembered vs. forgotten words, pre vs. post	P300 amplitude (400–800 ms) for remembered vs. forgotten words, pre vs. post	TRUE
	Planned processing/scoring	Mean amplitude in ROI (parietal electrodes), averaged across trials	Mean amplitude in ROI (parietal electrodes), averaged across trials	TRUE
	Planned statistical model	Mixed ANOVA		
H2.2: Different exercise types have different effects	Sample size before exclusions	97	Not specified	NA
	Sample size after exclusions	84	Not specified	NA
	Planned variable(s) to measure/test	P300 amplitude (400–800 ms) for remembered vs. forgotten words, pre vs. post	P300 amplitude (400–800 ms) for remembered vs. forgotten words, pre vs. post	TRUE
	Planned processing/scoring	Mean amplitude in ROI (parietal electrodes), averaged across trials	Mean amplitude in ROI (parietal electrodes), averaged across trials	TRUE
	Planned statistical model	Mixed ANOVA		

E2.1 Exercise enhances Inhibitory control	Sample size before exclusions	97	Not specified	NA
	Sample size after exclusions	84	Not specified	NA
	Planned variable(s) to measure/test	Accuracy and GO reaction times	Accuracy and GO reaction times	TRUE
	Planned processing/scoring	Standardized to pooled pretest SD and pre-group means	Accuracy and GO reaction times	FALSE
	Planned statistical model	Mixed ANOVA		
E2.1 Exercise enhances electrophysiological markers of Inhibitory control	Sample size before exclusions	97	Not specified	NA
	Sample size after exclusions	84	Not specified	NA
	Planned variable(s) to measure/test	NoGo N200 amplitude and latency (220–300 ms), pre vs. post, Group (sit, bike, swim)	NoGo N200 amplitude and latency (220–300 ms), pre vs. post, Group (sit, bike, swim)	TRUE
	Planned processing/scoring	Mean amplitude in frontal electrode, averaged across trials	Mean amplitude in frontal electrode, averaged across trials	TRUE
	Planned statistical model	Mixed ANOVA		

Source: www.regcheck.app (comparison of preregistration and manuscript done October 28th 2025)

Supplementary Table S2. Word lists used in the experiment and their English translations.

List 1 German	List 1 English	List 2 German	List 2 English
Amateur	Amateur	Abschied	Farewell
Aufgabe	Task	Angelegenheit	Matter
Austausch	Exchange	Armut	Poverty
Befehl	Command	Atom	Atom
Champion	Champion	Aufzug	Elevator
Debatte	Debate	Basis	Basis
Durchbruch	Breakthrough	Bergwerk	Mine
Einfluss	Influence	Beziehung	Relationship
Erfassung	Capture	Denker	Thinker
Gast	Guest	Einladung	Invitation
Gehalt	Salary	Einrichtung	Institution
Geliebte	Beloved	Entwurf	Draft
Genie	Genius	Fortsetzung	Continuation
Geruch	Smell	Fräulein	Miss
Geste	Gesture	Gebiet	Area
Halbkreis	Semicircle	Held	Hero
Harmonie	Harmony	Jugend	Youth
Hirte	Shepherd	Komponist	Composer
Karriere	Career	Konto	Account
Konferenz	Conference	Lösung	Solution
Lektion	Lesson	Maut	Toll
Muster	Pattern	Melodie	Melody
Phantom	Phantom	Mode	Fashion
Physik	Physics	Nachricht	Message
Raub	Robbery	Öffnung	Opening
Schicht	Layer	Patent	Patent
Seher	Seer	Rede	Speech
Sprache	Language	Reise	Journey
Standard	Standard	Rennen	Race
Steuer	Tax	Rückseite	Backside
Symbol	Symbol	Schuss	Shot
Täter	Perpetrator	Signal	Signal
Verarbeitung	Processing	Spur	Track
Verräter	Traitor	Unfall	Accident
Vertrag	Contract	Versuch	Attempt
Zustand	Condition	Vertreter	Representative

List 3 German	List 3 English	List 4 German	List 4 English
Absatz	Paragraph	Absolvent	Graduate
Abstimmung	Vote	Arbeiter	Worker
Agentur	Agency	Artikel	Article
Angriff	Attack	Ausländer	Foreigner
Ausflug	Excursion	Bekenntnis	Confession
Beruf	Profession	Belastung	Burden
Bootsmann	Boatswain	Besitz	Possession
Bündel	Bundle	Bewegung	Movement
Diät	Diet	Bindung	Bond
Einführung	Introduction	Eingang	Entrance
Grenze	Border	Empfänger	Recipient
Gruppe	Group	Ersatz	Replacement
Hemmung	Inhibition	Fehler	Error
Hitze	Heat	Gebühr	Fee
Inhaber	Owner	Gefährte	Companion
Kandidat	Candidate	Gegner	Opponent
Kontakt	Contact	Gerät	Device
Kultur	Culture	Gewicht	Weight
Lüge	Lie	Höhe	Height
Meile	Mile	Kaufmann	Merchant
Patient	Patient	Korrespondent	Correspondent
Portion	Portion	Luxus	Luxury
Prinzip	Principle	Minute	Minute
Rand	Edge	Mitglied	Member
Region	Region	Nation	Nation
Sammlung	Collection	Rätsel	Puzzle
Schneider	Tailor	Rebell	Rebel
Siedlung	Settlement	Reich	Empire
Strafe	Punishment	Scheibe	Disc
Tatsache	Fact	Schwerpunkt	Focus
Traum	Dream	Stiftung	Foundation
Untersuchung	Investigation	Titel	Title
Vermögen	Fortune	Unterkunft	Accommodation
Vision	Vision	Vorteil	Advantage
Wahl	Choice	Wetter	Weather
Zahlung	Payment	Zerfall	Decay

Supplementary Table S2. Results of the paired t-tests on the heart rate during the experiment. P-values are Bonferroni-corrected to account for multiple comparison.

Contrast	block	A	B	T	p-corr
Block	-	Intervention	Post	11.678	<.001***
Block	-	Intervention	Pre	10.181	<.001***
Block	-	Post	Pre	1.673	0.295
Group	-	Sit	Bike	-8.024	<.001***
Group	-	Sit	Swim	-7.417	<.001***
Group	-	Bike	Swim	-0.88	1
Block * Group	Intervention	Sit	Bike	-15.565	<.001***
Block * Group	Intervention	Sit	Swim	-14.229	<.001***
Block * Group	Intervention	Bike	Swim	-0.456	1
Block * Group	Post	Sit	Bike	-2.963	0.041*
Block * Group	Post	Sit	Swim	-3.157	0.029*
Block * Group	Post	Bike	Swim	-0.705	1
Block * Group	Pre	Sit	Bike	0.253	1
Block * Group	Pre	Sit	Swim	-1.232	1
Block * Group	Pre	Bike	Swim	-1.412	1

Note: *** $p < 0.001$, ** $p > 0.01$, * $p < 0.05$