Building Reserves: Performance in SPACE predicts size of the hippocampus (trainSPACE)

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Introduction:

- Decreases in hippocampal volume and thinner cortices are associated with age-related decline[1].
- Hippocampal volume is also associated with spatial ability[2].
- Previous research has shown that mental stimulation may induce morphological changes[3] and help to improve cognitive performance[4].
- Current cognitive training programs often focus on basic processing capacities like working memory and executive functions overlooking spatial ability.
- This study explores the association between performance in SPACE and imaging markers of neurodegeneration, while assessing the benefit of an intensive training program.

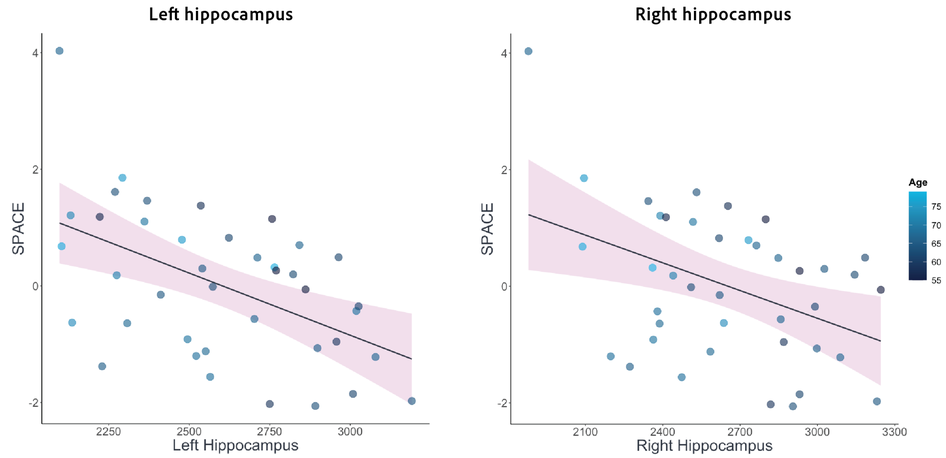
Methods:

- Baseline MRI, SPACE and neuropsychological data are collected from all 40 participants ($Age_{control}$= 65.20; $Age_{intervention}$= 68.10) .
- Participants in the intervention group complete a six-month training regime in which they play SPACE twice per week.
- All participants complete SPACE, a full neuropsychological assessment, and undergo a second MRI scan after six months.
- Eight participants in the intervention group and 12 participants in the control group have completed the entire protocol.

Conclusion:

- Performance in the path integration and in the mapping task predict the size of the hippocampus.
- The training program may have an effect on sustaining cognitive function.
- Participants that underwent the training outperform those in the control group for most tasks in SPACE.

SPACE significantly predicts hippocampal size



Left hippocampus

Model Fit Measures

Model	R	R^2	Overall Model Test F	df1	df2	p
1	0.38	0.15	6.54	1	38	0.015
2	0.64	0.41	8.48	3	36	<.001

Model Comparisons

Comparison Model	Model	ΔR^2	F	df1	df2	p
1	2	0.27	8.21	2	36	0.001

Model Coefficients - Left Hippocampus

Predictor	Estimate	SE	t	p
Intercept	4245.85	444.18	9.56	<.001
Age	−18.62	6.53	−2.85	0.007
PI distance error	−0.74	0.34	−2.19	0.035
Mapping performance	−481.58	128.05	−3.76	<.001

Right hippocampus

Model Fit Measures

Model	R	R^2	Overall Model Test F	df1	df2	p
1	0.51	0.26	13.44	1	38	<.001
2	0.65	0.42	8.62	3	36	<.001

Model Comparisons

Comparison Model	Model	ΔR^2	F	df1	df2	p
1	2	0.16	4.84	2	36	0.014

Model Coefficients - Right Hippocampus

Predictor	Estimate	SE	t	p
Intercept	4861.73	489.03	9.94	<.001
Age	−27.70	7.19	−3.85	<.001
PI distance error	−0.93	0.37	−2.49	0.017
Mapping performance	−323.93	140.98	−2.30	0.027

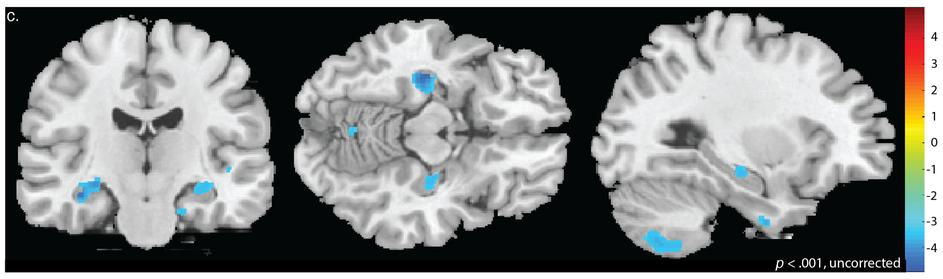


Figure 1: Results of the volumetry and VBM. The coloured dots in the graphs show the age of the participants. The table presents the results from the regressions. The VBM presents the inverse relationship between hippocampus size and error in the path integration task.

Results:

- Results of the regressions revealed that age, path integration distance error and mapping performance significantly predicted the size of the left (r^2 = .41, F(3, 36) = 8.48, p < .001) and right (r^2 = .42, F(3, 36) = 8.62, p < .001) hippocampus.
- Age accounted for 15% and 26% of the variance in the left and right hippocampus, respectively.
- As expected, we observed a negative relationship between errors in the path integration task and the size of the left (β = -0.74, p = 0.035) and right (β = -0.93, p = 0.017) hippocampus.
- Surprisingly, we observed a negative relationship between performance in the mapping task and the size of the left (β = -481.58, p < 0.001) and right (β = -323.93, p < 0.027) hippocampus.

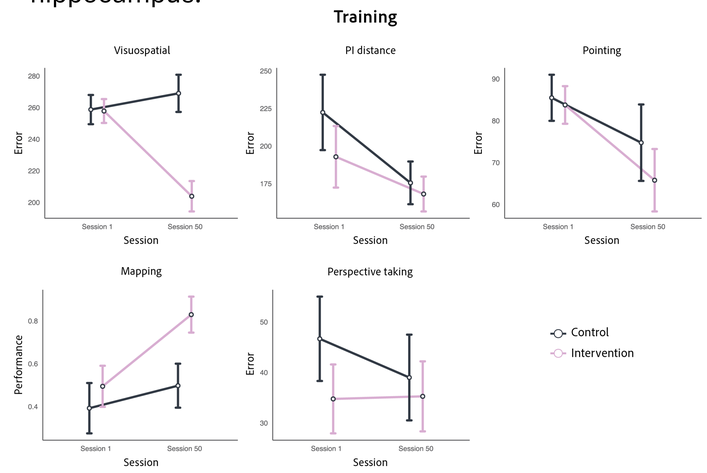


Figure 2: Performance of participants who completed the 6-month training either improved or remained stable for all tasks in SPACE.

References:

1. Erickson KI, Prakash RS, Voss MW, Chaddock L, Heo S, McLaren M, et al. Brain-derived neurotrophic factor is associated with age-related decline in hippocampal volume. J Neurosci. 2010;30(15):5368-75.
2. Maguire, E.A., Gadian, D.G., Johnsrude, I.S., Good, C.D., Ashburner, J., Frackowiak, R.S. and Frith, C.D., 2000. Navigation-related structural change in the hippocampi of taxi drivers. *Proceedings of the National Academy of Sciences*, *97*(8), pp.4398-4403
3. Nichols ES, Erez J, Stojanoski B, Lyons KM, Witt ST, Mace CA, et al. Longitudinal white matter changes associated with cognitive training. Hum Brain Mapp. 2021;42(14):4722-39.
4. Bonnechere B, Klass M, Langley C, Sahakian BJ. Brain training using cognitive apps can improve cognitive performance and processing speed in older adults. Sci Rep. 2021;11(1):12313.

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