The Effect of Drugs and Exercise on Memory

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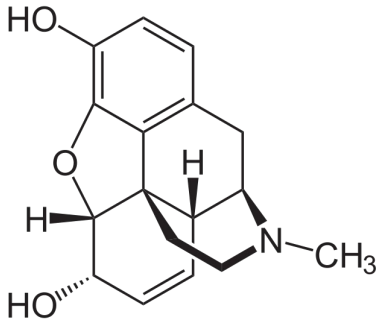


Research Questions & Motivations

- What effect will injection type and swim distance have on the cognitive ability of Islanders? Is it a significant effect?
- Is there a significant interaction between the distance and injection type on cognitive ability?

Medically speaking, methamphetamine is used to treat obesity and ADHD, and morphine for treat severe pain. Athletes or people who exercise often may be more prone to injuries or body conditions that require the uses of these drugs.

- How is cognitive ability affected by drug use? Does the extent of athleticism matter?
- What is the interaction between how much/far you swim and the amount of drugs administered?
- What are the ethical/moral impacts of administering these drugs, even in a medical setting?
- Help with considering this as a treatment if you are an athlete/concerned about cognitive ability

Literature

Cognitive Function Impairment in Meth Users

- Recreational methamphetamine use debated to cause severe cognitive deficits.
- Neuroimaging data examines acute and long-term cognitive effects of methamphetamine.
    - Acute methamphetamine use can improve cognitive functions (visuospatial perception, attention, and inhibition)
- Long-term effects show minimal significant differences from controls.
- Clinical significance of cognitive differences is overstated, impacting scientific research, treatment approaches, and public policy.

Morphine Effect on Cognitive Function

- Immediate-release (IR) morphine added to sustained-release (SR) opioids in palliative care for breakthrough pain, but effects on cognitive functioning not well-known.
- A study with 14 palliative care patients compared cognitive and subjective effects of IR morphine with placebo using a double-blind, placebo-controlled, cross-over design.
    - IR morphine significantly reduced pain but caused anterograde and retrograde memory impairments, and reduced performance on a complex tracking task, while improving performance on a simpler tracking task.
- These cognitive impairments from IR morphine may negatively affect patients' everyday functioning.

Literature

Exercise Training Improves Memory Performance in Adults

- As life expectancy increases, preventing and treating memory impairment is crucial for maintaining independence and quality of life.
- Exercise, particularly aerobic training, can prevent memory decline by improving overall health and cardiovascular and nervous system functions.
- The mechanisms by which exercise improves memory are not fully understood
    - But, include enhanced blood circulation, synaptic plasticity, and neurogenesis, influenced by molecular signals like neurotransmitters, neurotrophic factors, exerkines, and epigenetics.
- Irisin/BDNF signaling = key mediator of the beneficial effects of exercise on the brain,
    - Non-pharmacological way to improve cognitive function, especially in those at risk of neurodegenerative disorders.

Design

Treatment 1: (Drug Injection)

- Methamphetamine (50 mg)
- Morphine (20 mg)
- Saline (3 mL)

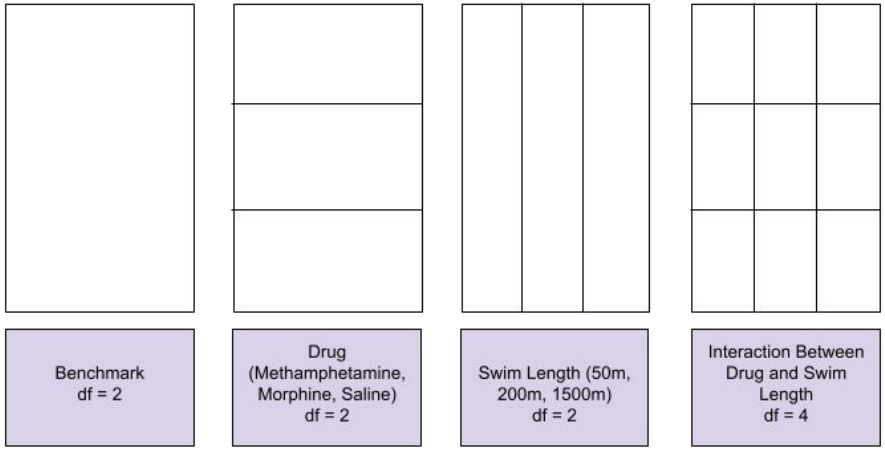
Treatment 2: (Swim Freestyle Length)

- 50m
- 200m
- 1500m

Response:

- Difference in score for memory test

We chose a Two-Factor ANOVA Design with interaction.



As a result, we have 9 total treatment groups.

Sampling Methods

Participants:

- We chose to sample men that are specifically in the age bracket 18-35, to reduce any effects due to differences accounted for by age and physicality

Methodology:

- Before applying any treatment, administer the memory test to every participant
- Then, apply the relevant treatments and administer the memory test again
- We “randomly” sampled men age 18-35 from 9 different regions and “randomly” assigned treatments

Sample Size Determination

Desired Power: 80%

Number of Groups: 9

Effect Size: 0.4 (Medium)

Significance Level: 0.05

Sample Size is 80 participants, round up to 81 since we have 9 treatment groups.

~ 9 participants per treatment

Response Variable

Y1 = Memory Test Score Before Treatments

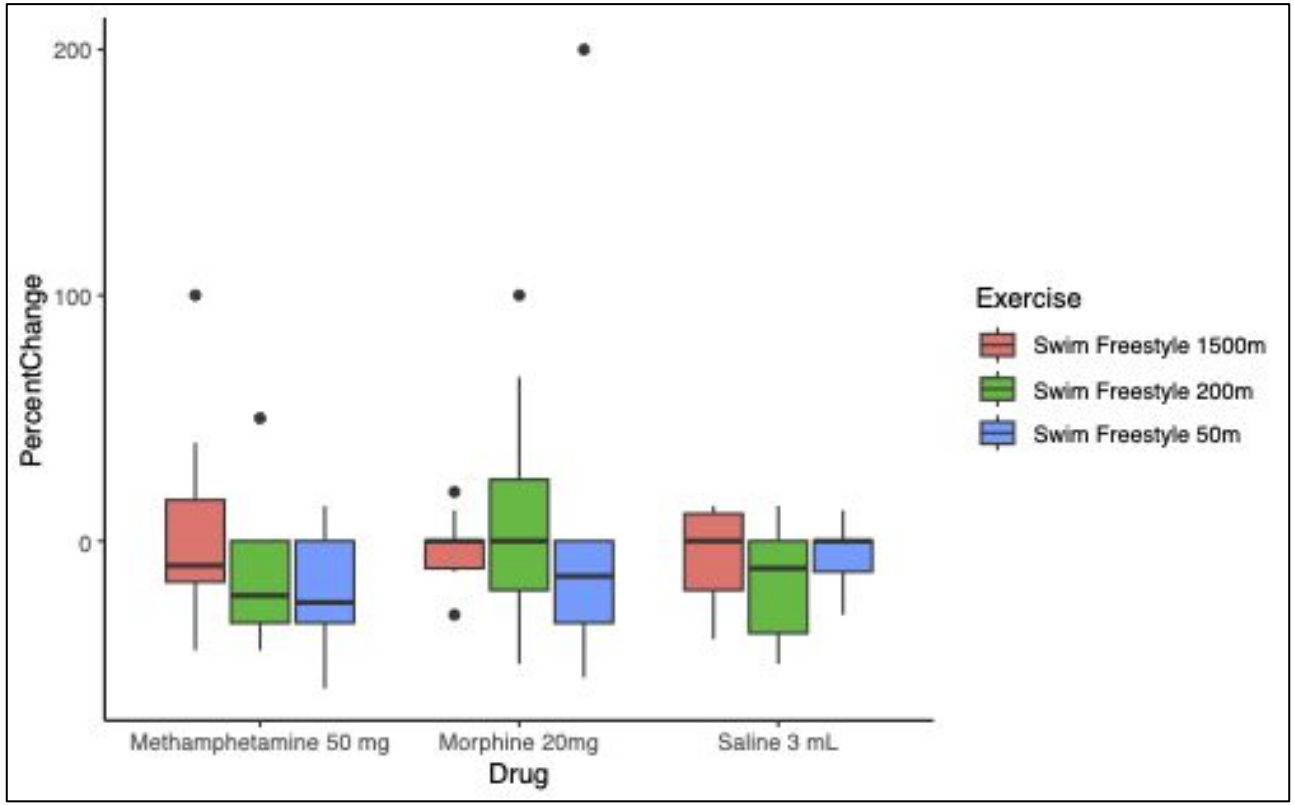
Y2 = Memory Test Score After Treatments

→ Response Variable = (Y2 - Y1)/Y1 * 100

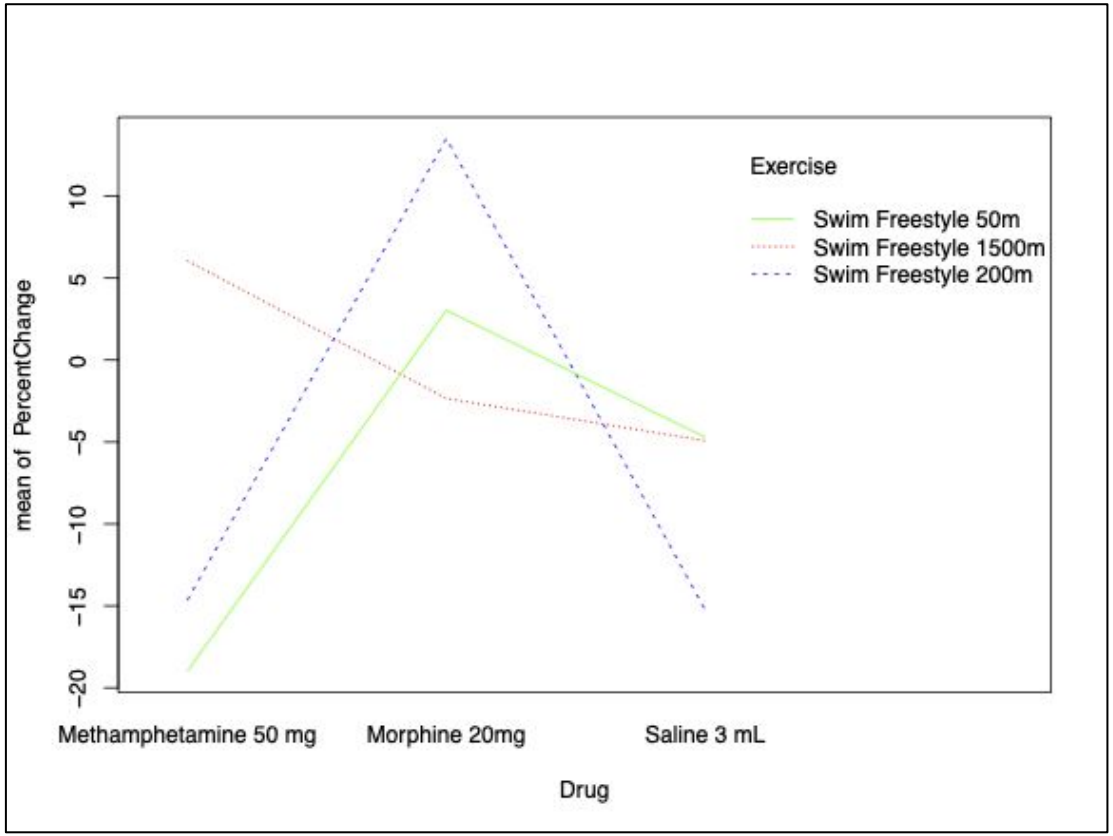
(percent change in memory test scores from before to after)

We want to compare the memory test scores after treatment relative to what they would score without treatment!

Boxplot


200
100
0
PercentChange
Methamphetamine 50 mg
Morphine 20mg
Saline 3 mL
Drug
Exercise
Swim Freestyle 1500m
Swim Freestyle 200m
Swim Freestyle 50m

Interaction Plot



ANOVA

	DF	Sum Sq	Mean Sq	F-value	p-value
Drug	2	3285	1642.3	1.174	0.315
Exercise	2	628	313.9	0.224	0.800
Drug: Exercise	4	4425	1106.4	0.791	0.535
Residuals	72	100721	1398.9		

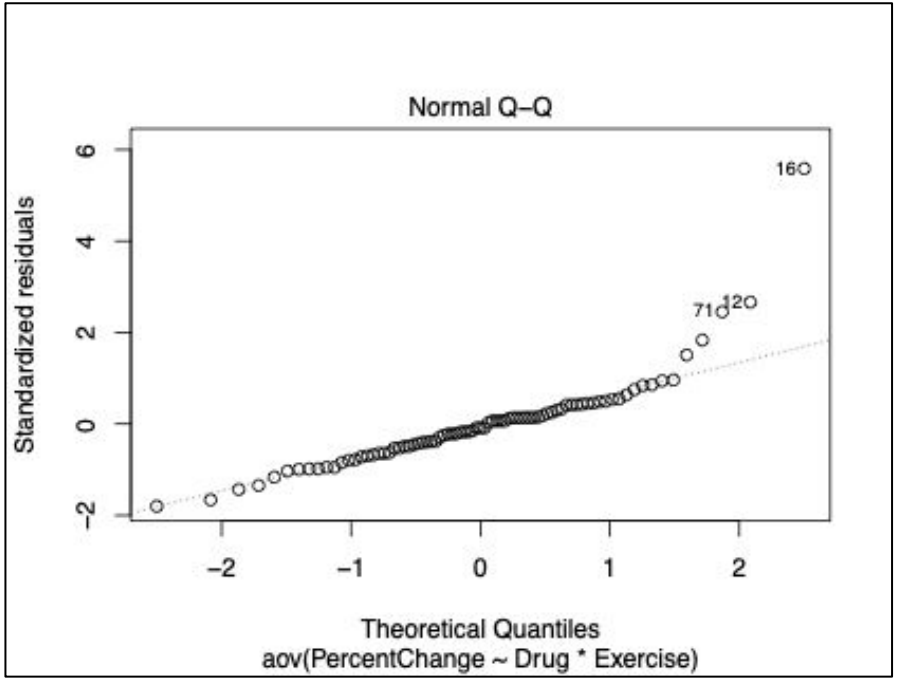
Tukey

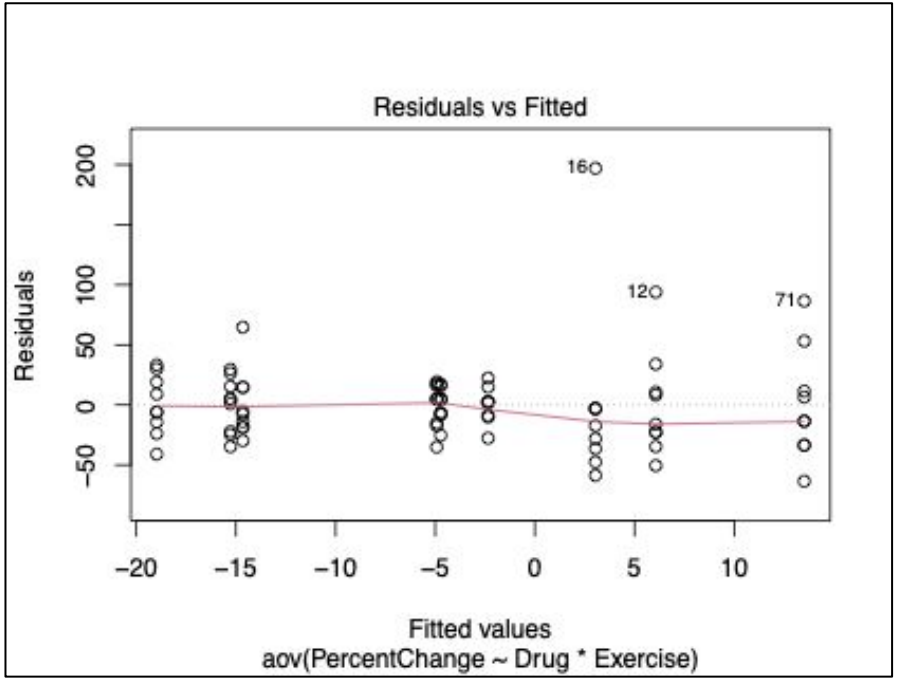
Drug	**diff**	**lwr**	**upr**	**p adj**
Morphine 20mg - Methamphetamine 50mg	13.9271017	-10.43374	38.28795	0.3629064
Saline 3mL - Methamphetamine 50 mg	0.8803645	-23.48048	25.24121	0.9958851
Saline 3mL - Morphine 20mg	-13.0467372	-37.40758	11.31411	0.4100666

Tukey

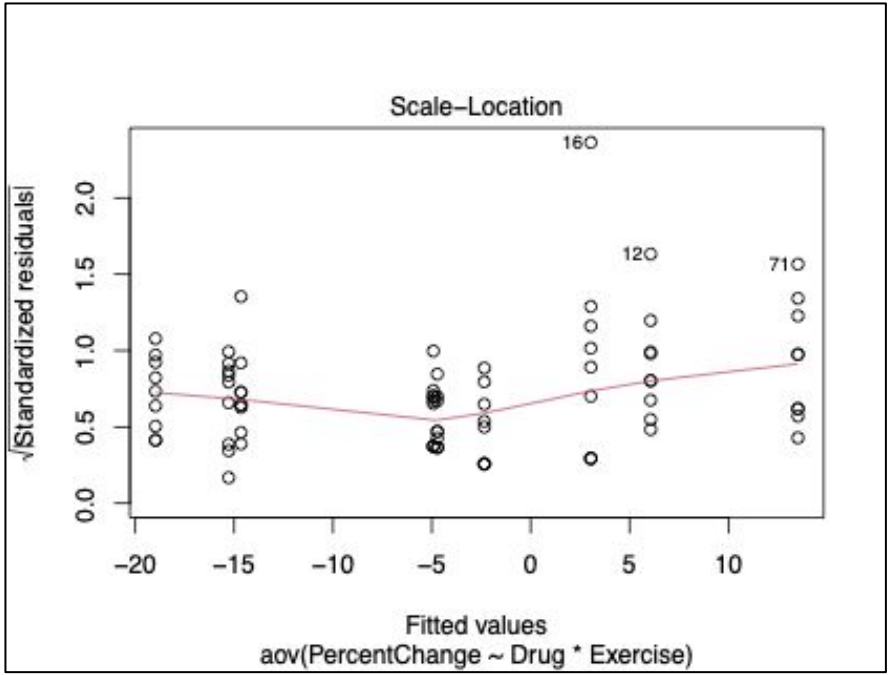
Exercise (Swim Freestyle)	**diff**	**lwr**	**upr**	**p adj**
200m - 1500m	-5.070547	-29.43139	19.29030	0.8724399
50m - 1500m	-6.484421	-30.84527	17.87642	0.8002501
50m - 200m	-1.413874	-25.77472	22.94697	0.9894224

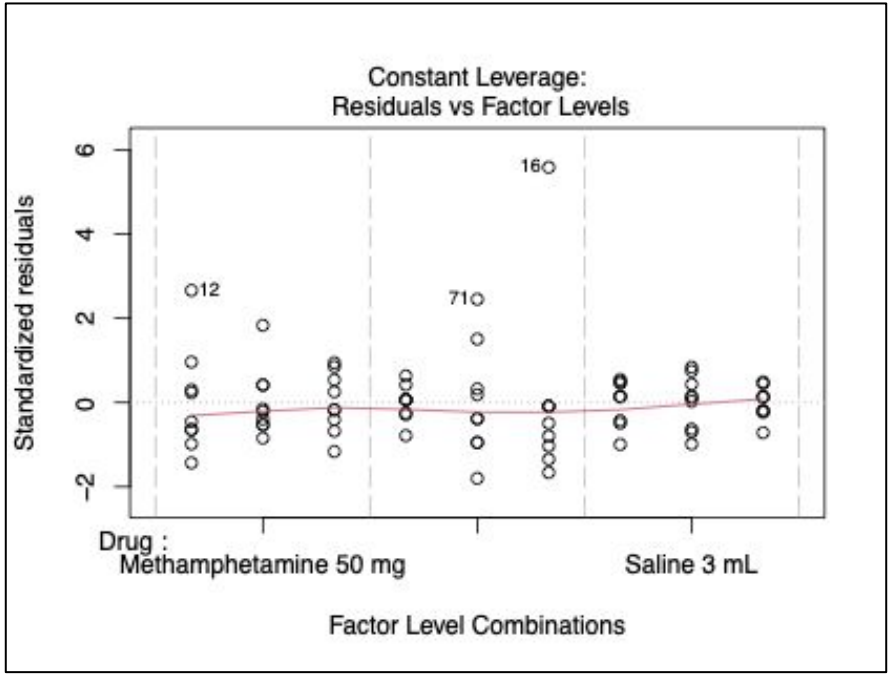
Model Assumptions





Model Assumptions





Conclusions

- There are **no significant factors**
  - Both type of drug and length of swim did not yield significant p-values (respectively 0.315 and 0.800, both > 0.05)
  - This is contrary to what we explored in literature - we could possibly improve the experimental design to span over a longer period of time or repeated drug/exercise use
  - Note that the p-value for the drug factor (0.315) was the smallest, and thus closest to being significant
- There is **no significant interaction between factors**
  - The p-value for drug:exercise = 0.515
- All diagnostic plots seem to fit all the criteria, so we can assume that our model is an **appropriate fit for the data**, despite showing no significance
- Our study implies that there is **no significant short term effect** on memory after drug use and exercise

Further Research Questions

What is the effect of drug use coupled with other types of exercise (other than swimming) on cognitive ability? What if it was coupled with strength training instead of cardiovascular exercise?

Does the existing physique of the Islander affect the results of this experiment? For example, what is the difference in results between a buff Islander who swims often versus a skinny Islander who never exercises?

What other drug combinations would be a greater/lesser effect (when coupled with swimming exercise treatments) on the change in cognitive ability?

We varied the drug factor by type. What if we kept the drug type constant but varied the dosage instead?

References

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