A Meta-Analysis of the Effects of Temporary Calorie Restriction on Cognitive Performance

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Why is a meta-analysis on this topic relevant?

- Some previous research found that skipping breakfast reduces different aspects of cognitive performance[1,2,3].
- However, this effect is not reliable and may be domain specific[4].
- Public interest in intermittent fasting[5] increases the importance of looking into the effects of skipping breakfast and longer fasts on cognition.
- A meta-analysis is helpful due to large differences in sample-size, study quality and measurement approach on this topic.

https://osf.io/nb5mj/

Preregistered | Open data | Open materials

Literature search & statistical model

- The protocol was preregistered at PROSPERO (ID: CRD42021272822)
- Searched 7 online databases (e.g. PsycINFO, PubMed, SCOPUS).
- With terms relating to fasting and cognition:

Fasting	cogniti*
"Time restricted feeding"	"Executive funct*"
"Food restriction"	Attention
Hunger	"Working memory"
Starvation	Fatigue
Hypoglycaemia	"Reaction time"
…	…

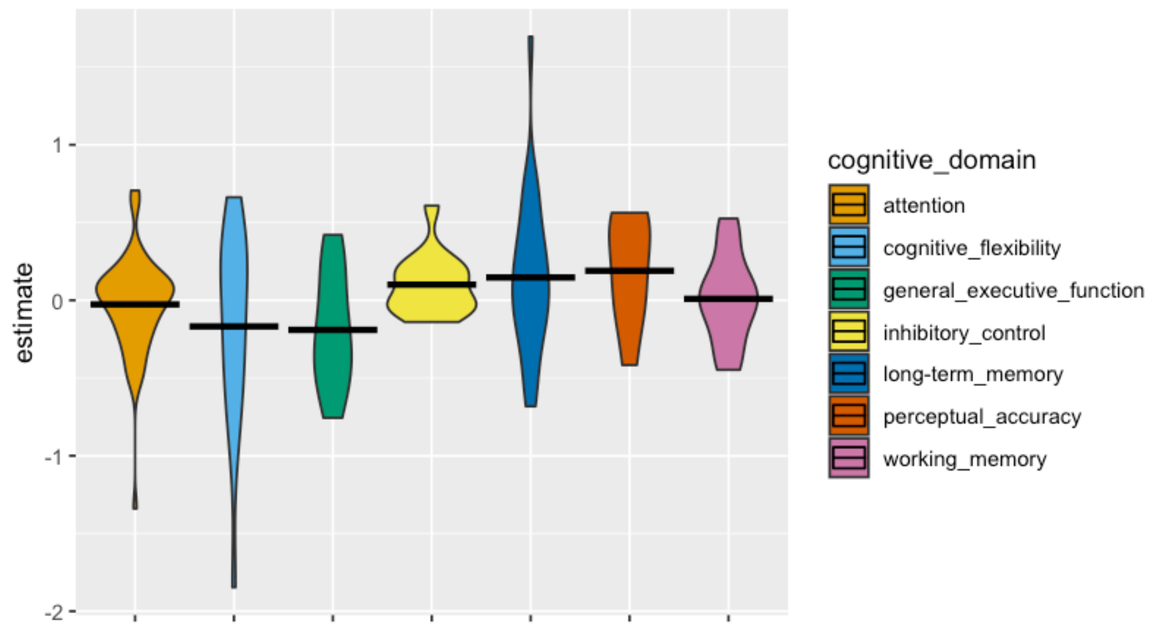
- Articles in previous systematic reviews, Google Scholar search results and references of included articles were considered.
- 17,465 articles were screened.
- Final sample includes 48 articles, 160 effect sizes, total sample size of N=2438.
- All included studies have a group/ condition with zero calorie intake for some time (median=12 h) and a control group/ condition with unrestricted food consumption, a cognitive performance measure, testing healthy participants.
- Calculated standardised mean differences (SMD) for the fasted group/ condition and the satiated group/condition as Hedge's g.
- A 3-level random intercept model with clusters for the tasks and studies was fit to the data with a linear model for the observed SMD:

$$\hat{\theta}_{i,j} = \theta + \epsilon_{i,j} + \zeta_{(s)\,i,j} + \zeta_{(p)\,j}$$

  - ($\epsilon_{i,j}$ = sampling variance, $\zeta_{(s)}$ = variance on study level, $\zeta_{(p)}$ = variance on population level)

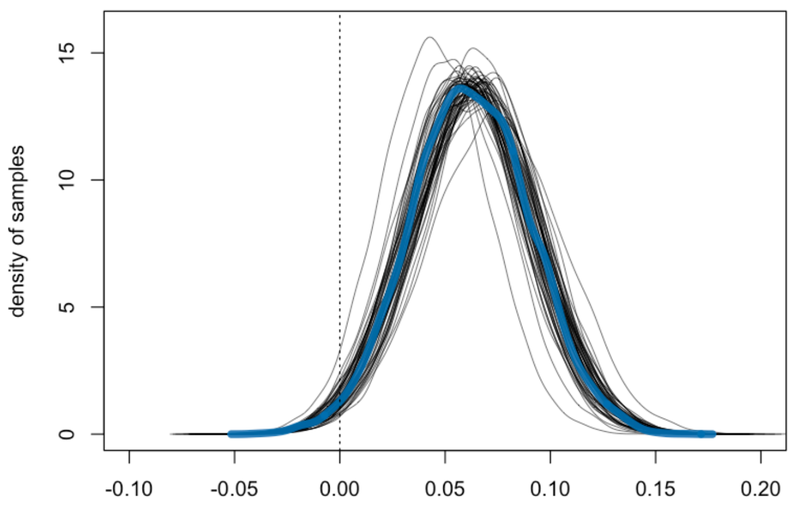
Main effect and moderators

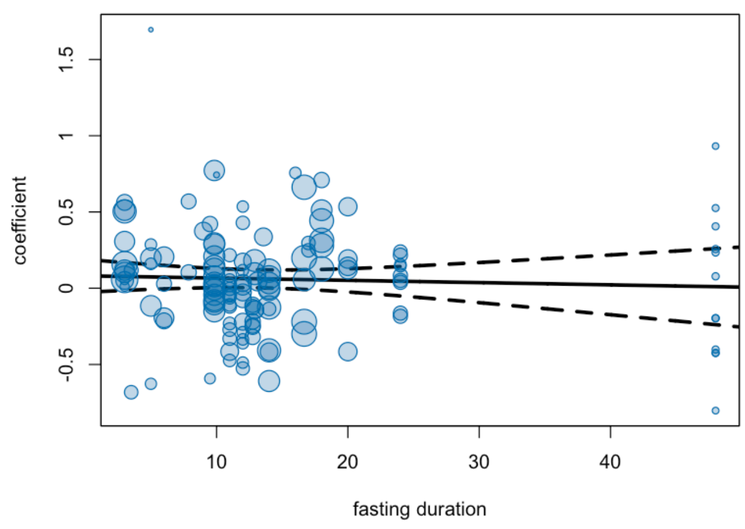
- The estimated SMD between the fasted condition and the satiated condition is g=0.06, *SE*=0.03, *95%CI*=[0.01, 0.12], *p*=0.03
- Heterogeneity (variance not explained by sampling variance) is I^2=26%.
- Categorising the estimates by the tested cognitive domain in a subgroup analysis reduces heterogeneity by 5% (Test of Moderators *QM*(*df*=7)=17.47, *p*=0.01).



- Adding the fasting duration as a fixed effect on the population level: There is no consistent effect of the duration of the calorie restriction on the difference between satiated and fasted state after removing studies with a Cook's D > 3 (*coeff*=-0.002, *SE*=0.004, *95%CI*=[-0.01, 0.01], *p*=n.s.).

- Leave-one-out analysis for the main effect of each study
- Plot shows samples from a normal distribution with the mean and SE from each reduced model
- Sample from complete model in blue





Take-aways & recommendations for future studies

- Averaging over different tasks and experiments, cognitive performance is reduced in fasted individuals compared to satiated subjects.
- This effect slightly differs between cognitive domains. There is no reliable dose-response relation between the duration of fasting and effects on cognitive performance.
- Most of the variance between effect sizes can be explained by sampling variance.
- All included articles only had one period of calorie restriction. The worse performance when fasted may be due to participants not being used to fasting. Future studies should follow participants over several fasting cycles.
- Some of the observed effect may be due to participants expecting to perform worse when fasted. An active control group, e.g. doing exercise or another diet should therefore be used.

Bibliography

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