Acute and Chronic Effects of Medium-Chain Triglyceride Supplementation on Metabolic Parameters and Working Memory in Rats

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[2] I. M. Sechenov Institute of Evolutionary Physiology and Biochemistry, Russian Academy of Sciences, 44 Prospekt Toreza, 194223, Saint Petersburg, Russia
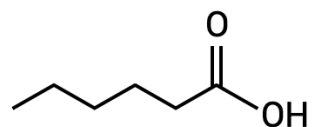
* Corresponding authors: KS: shcherbakova.ksenia.jp@gmail.com; AT: alexander.n.trofimov@gmail.com
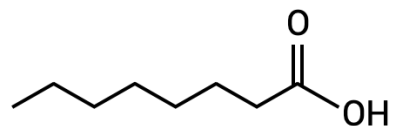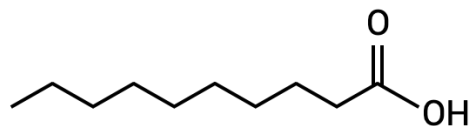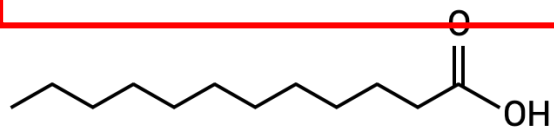
Medium-Chain Fatty Acids and Triglycerides
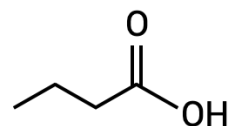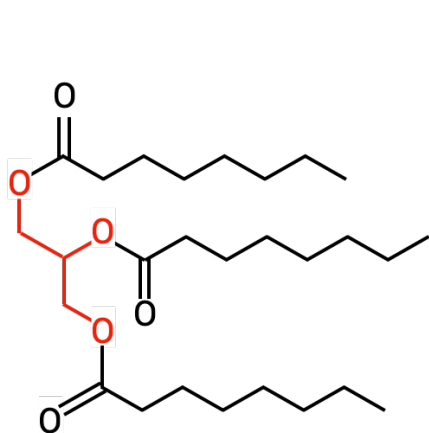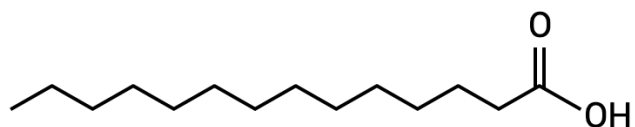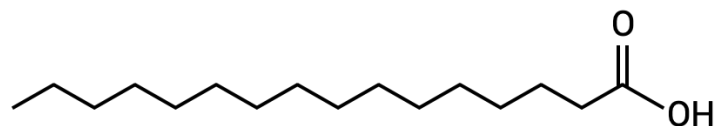
LCFA vs MCFA
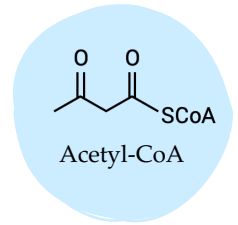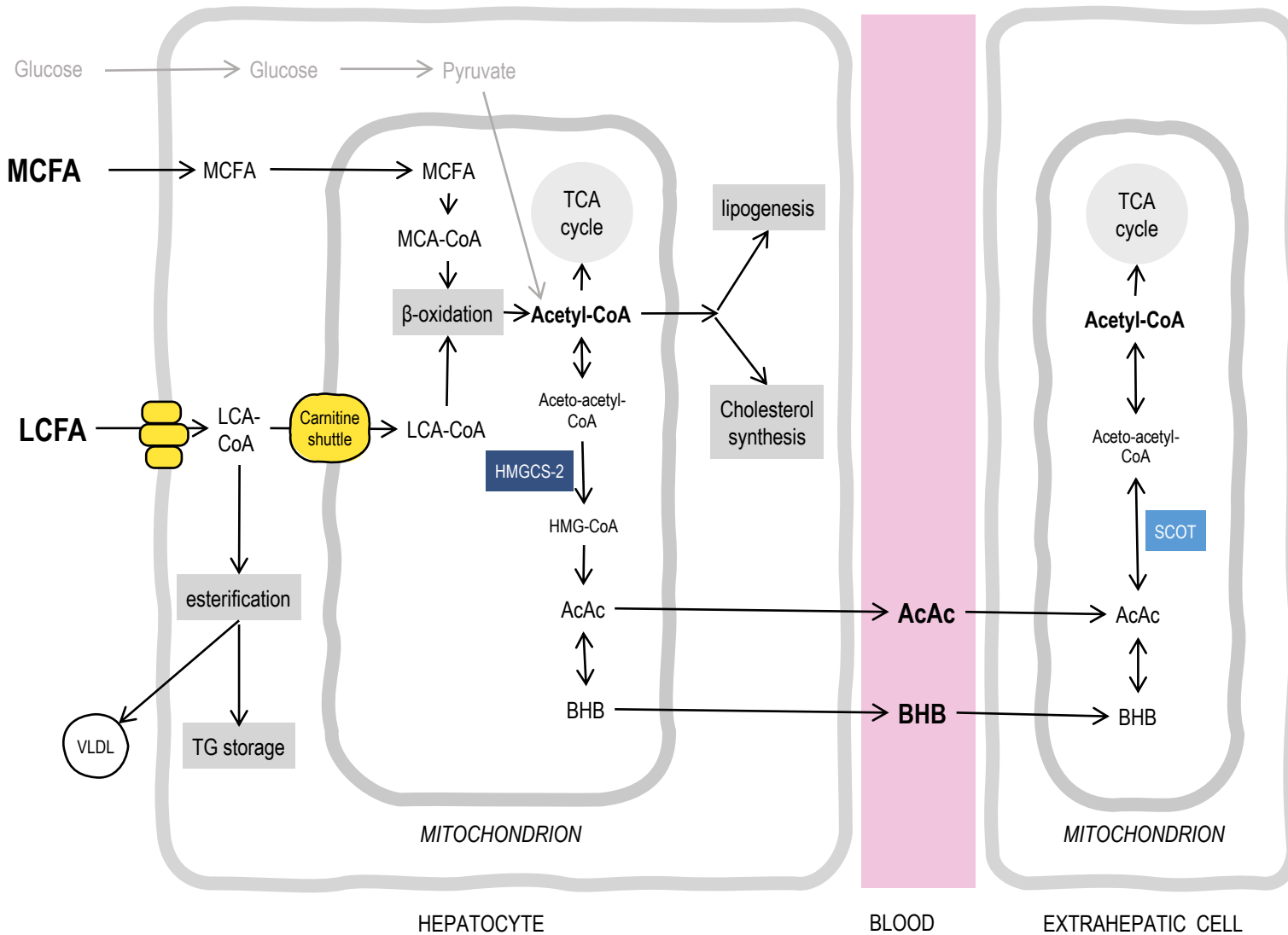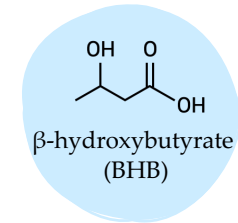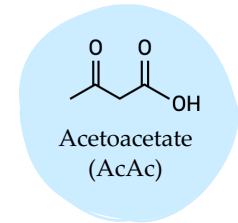
Neuroprotective Effects of Ketosis

↓ inflammation
↓ oxidative stress
↓ apoptosis

↑ energy metabolism
↑ GABA levels
↑ neuronal membrane repolarization

* changes in neuroplasticity gene expression

Ketone bodies:

Acetoacetate
(AcAc)

β-hydroxybutyrate
(BHB)

Strategies to induce ketosis:
- Ketogenic diet / Starvation (sustained ketosis)
- Ketogenic supplements (intermittent ketosis)
  - **MCT**
  - KB salts and esters

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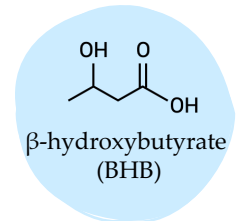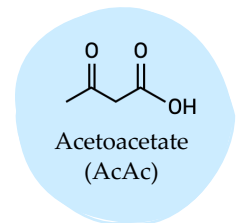
Documented MCFA Diet Effects on Metabolic Markers

Parameter	Effect	Reference
Liver TG accumulation	↑	Wein et al., 2009
	↓	Lieber et al., 2008
	no effect	Baba et al., 1982, Lieber et al., 2008
Fasting plasma TG levels	↑	Bray et al., 1980; Geelen et al., 1995; Hill et al., 1990; Tholstrup et al., 2004
	↓	Edens & Friedman, 1984; Jeffery et al., 1997; Wein et al., 2009
	no effect	Asakura et al., 2000
Fasting plasma total cholesterol	↑	Asakura et al., 2000; Hill et al., 1990; Tholstrup et al., 2004
	↓	Han et al., 2007
	no effect	Schwartz et al., 1989

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Experimental Design

MCT (C8+C10) Dose

Typical human dose:
     20-30 g (~0.3-0.5 g/kg)

Rat dose in out experiment (conversion coefficient: 6.1):
     3 g/kg

Experimental Design

2.5 m.o. male
Wistar rats

Chronic
MCT administration

Acute
MCT administration

MCT/
lard/
water

-1   0   1   2   3   4 weeks

Y maze

Y maze   sample
collection

MCT/
lard/
water

0   30   60   90   120 min

sample
collection

sample
collection

BHB + AcAc

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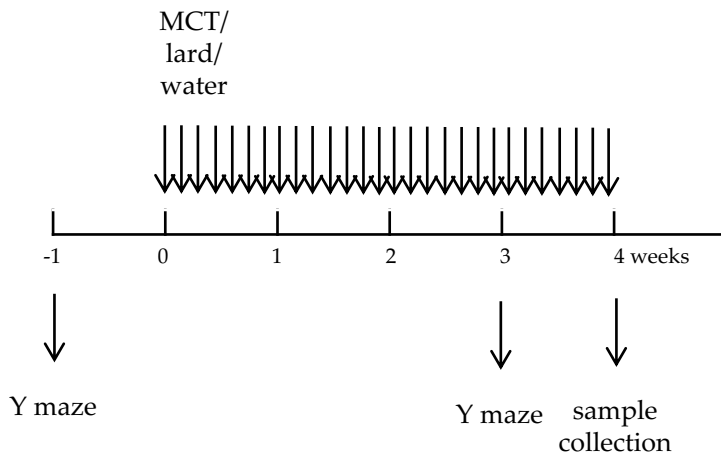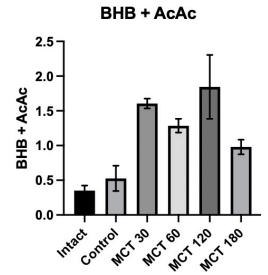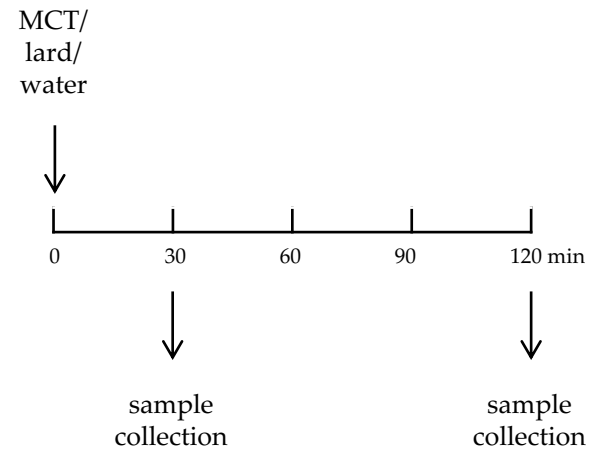
Results (Chronic Administration)
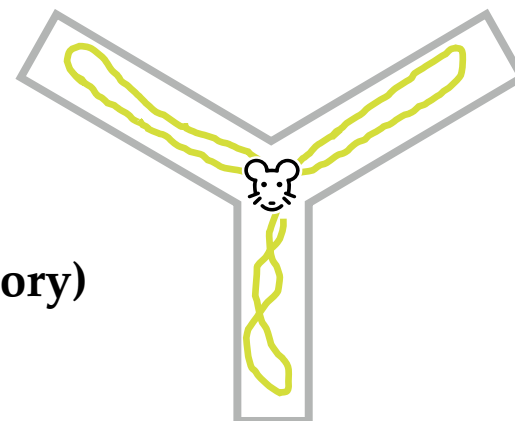
Y Maze: Spontaneous Alternations (Working Memory)

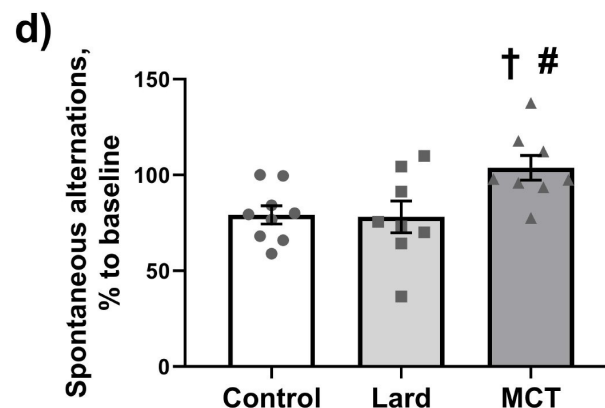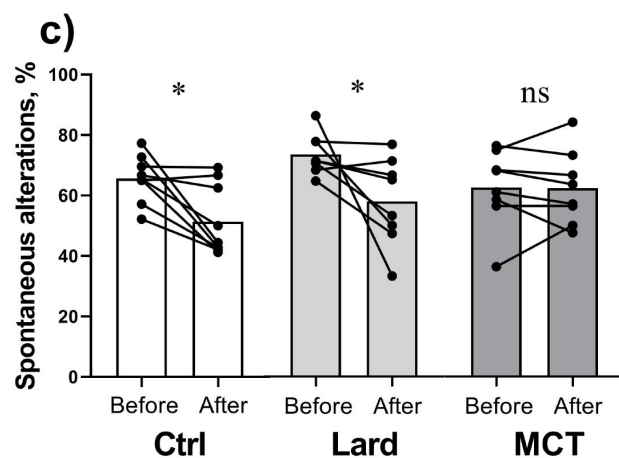∗ — MCT vs. Lard difference: linear regression
— fat vs. control difference: ANOVA and Tukey *post hoc*
† — MCT vs. the respective-time-point Lard difference: ANOVA and Tukey *post hoc*

∗, #, † — *P* < .05
∗∗, ##, †† — *P* < .01
∗∗∗, ###, ††† — *P* < .001
∗∗∗∗, ####, †††† — *P* < .0001

Results (Chronic Administration)

Y Maze: Arm Entries (Locomotive Activity)

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— fat vs. control difference: ANOVA and Tukey *post hoc*
† — MCT vs. the respective-time-point Lard difference: ANOVA and Tukey *post hoc*

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Results (Chronic Administration)

Markers of Metabolic Health

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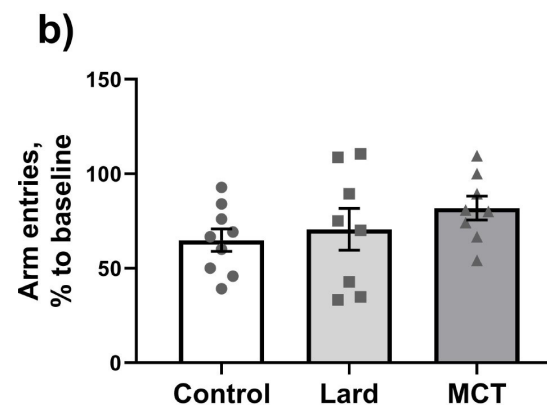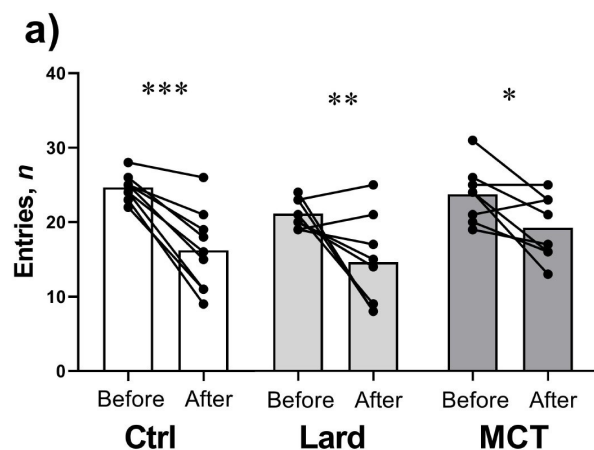
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Results (Chronic Administration)

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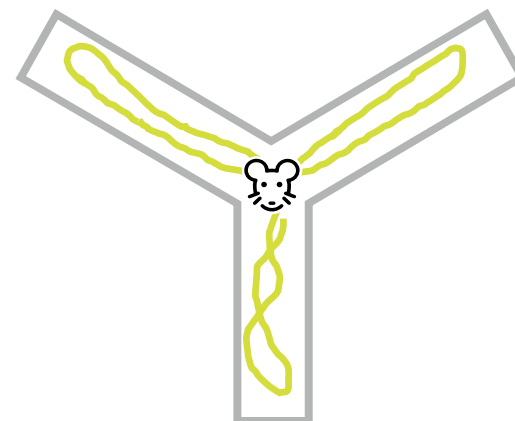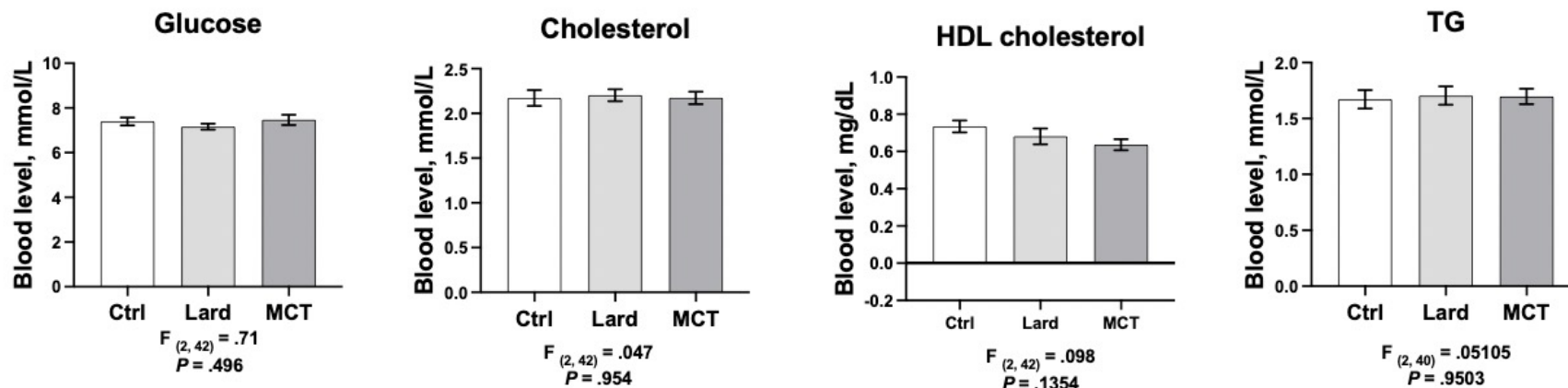
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Results (Acute Administration)

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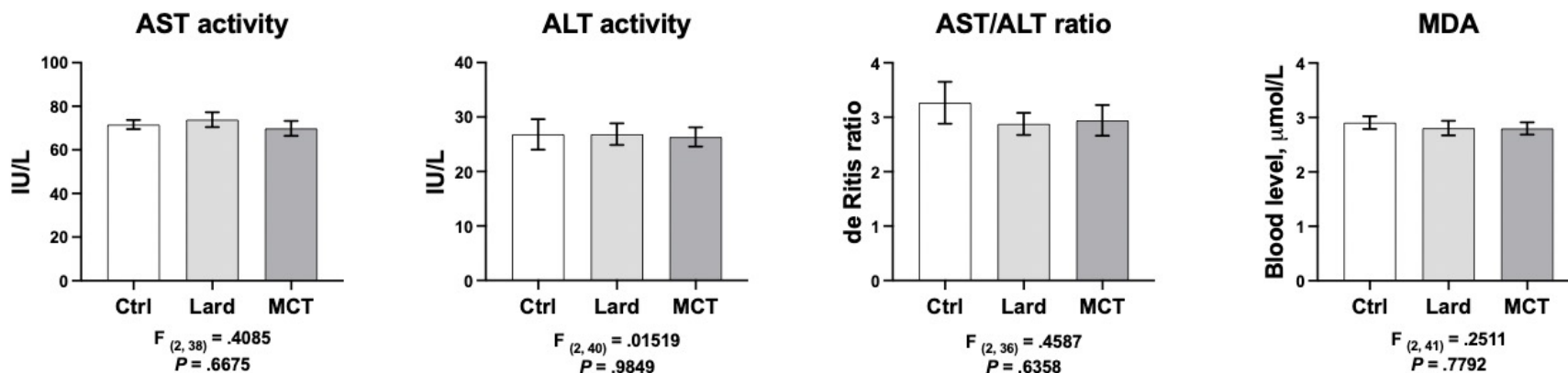
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Results (Acute Administration)

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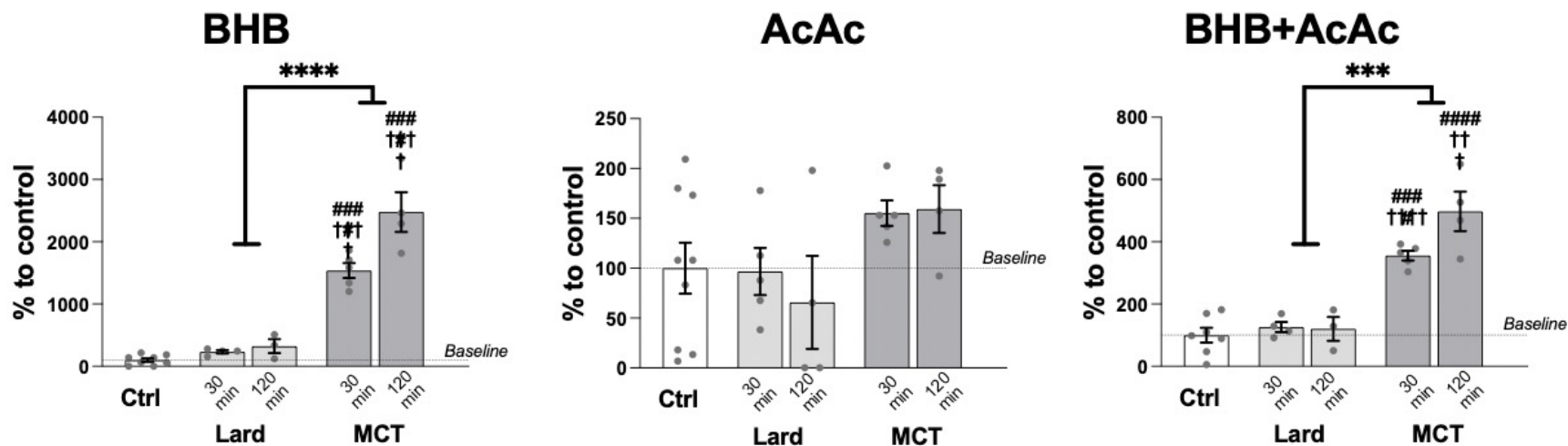
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Results (Acute Administration)

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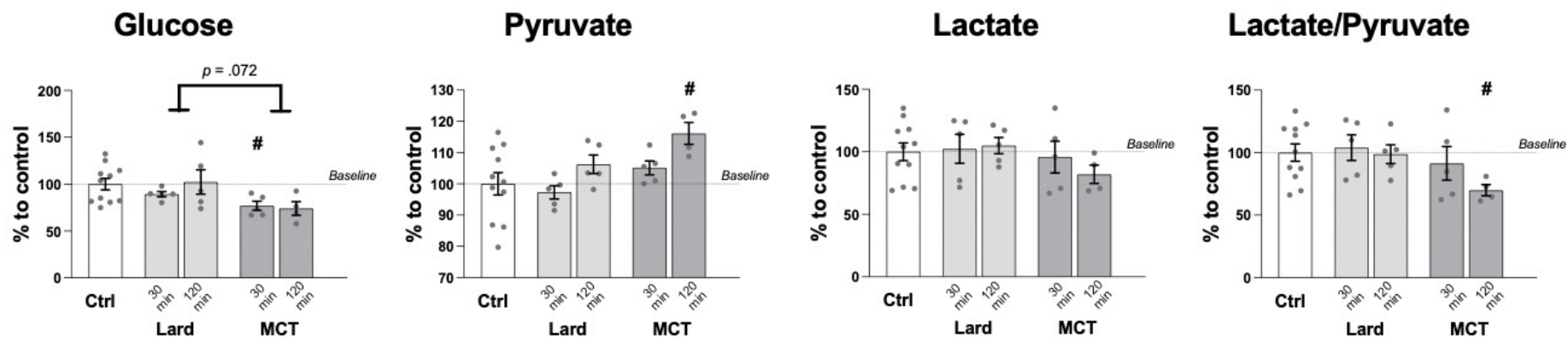
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Results (Acute Administration)

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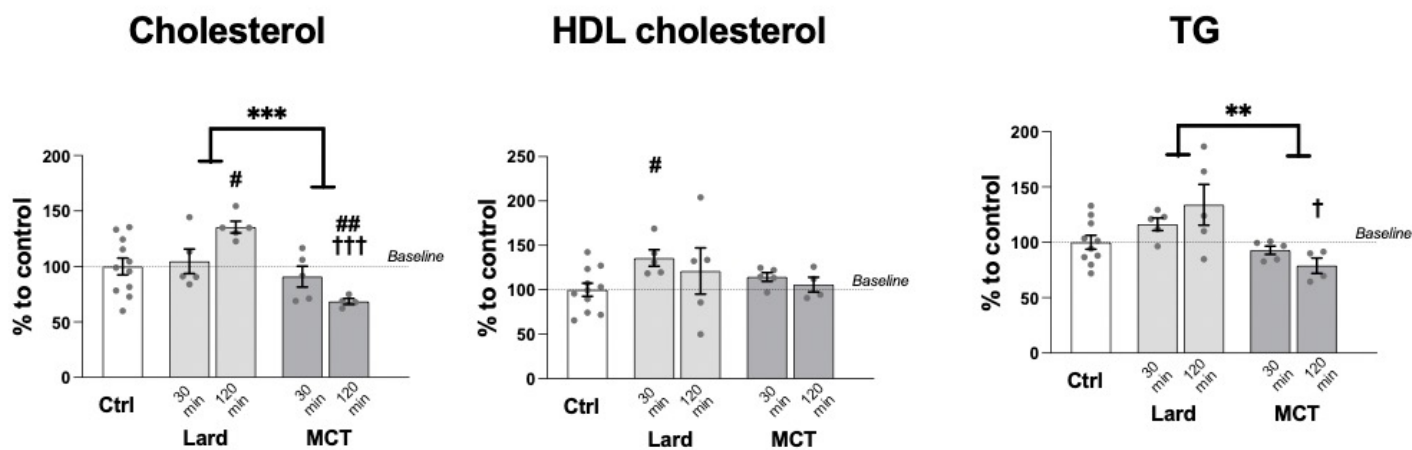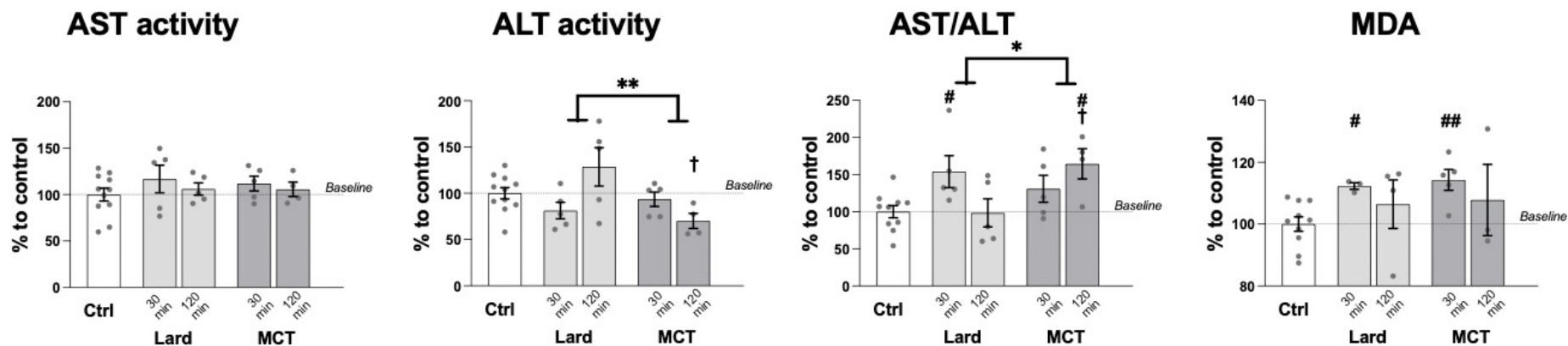
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Conclusions

MCT supplementation (3 g/kg) in young adult rats:

- established intermittent mild ketosis without dietary restrictions
- improved working memory
- had no effect on locomotive activity
- did not adversely affect metabolic health markers over 28 days

- acutely, MCT elevated blood MDA level to the same extend as lard
- more studies are needed to assess long-term effects

- the established administration protocol may be used to study the mechanisms of MCT-related effects on the brain

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Acknowledgments