Generalizability of Manual Control Skills between Control Tasks of Varying Difficulty

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Introduction

Long-duration space missions require more self reliance of crews:

1. Not everything can be trained before launch
2. No direct support from mission control
3. Loss of skills over duration of mission

Different training strategies are required:

1. Training of generalizable skills
2. In-mission training

Introduction

Research question:

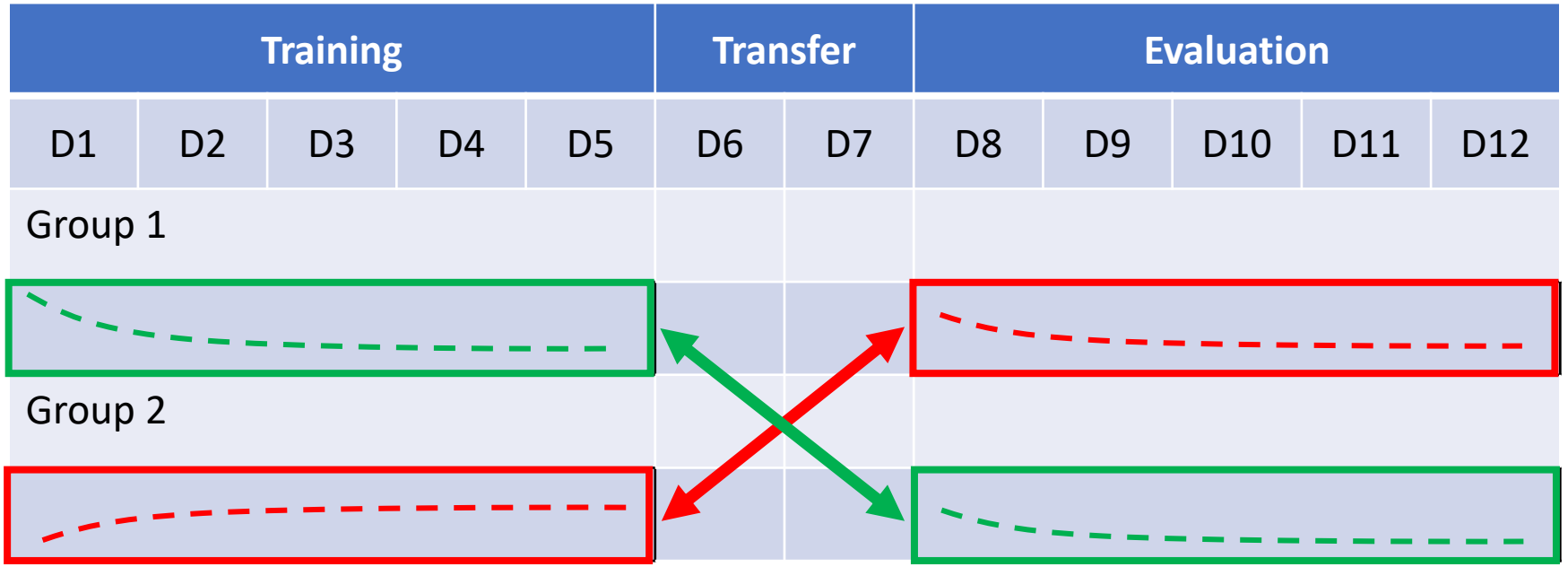
- Do manual control skills generalize between similar tasks of varying difficulty?

What is new:

- Manual control skills
- Cybernetic approach

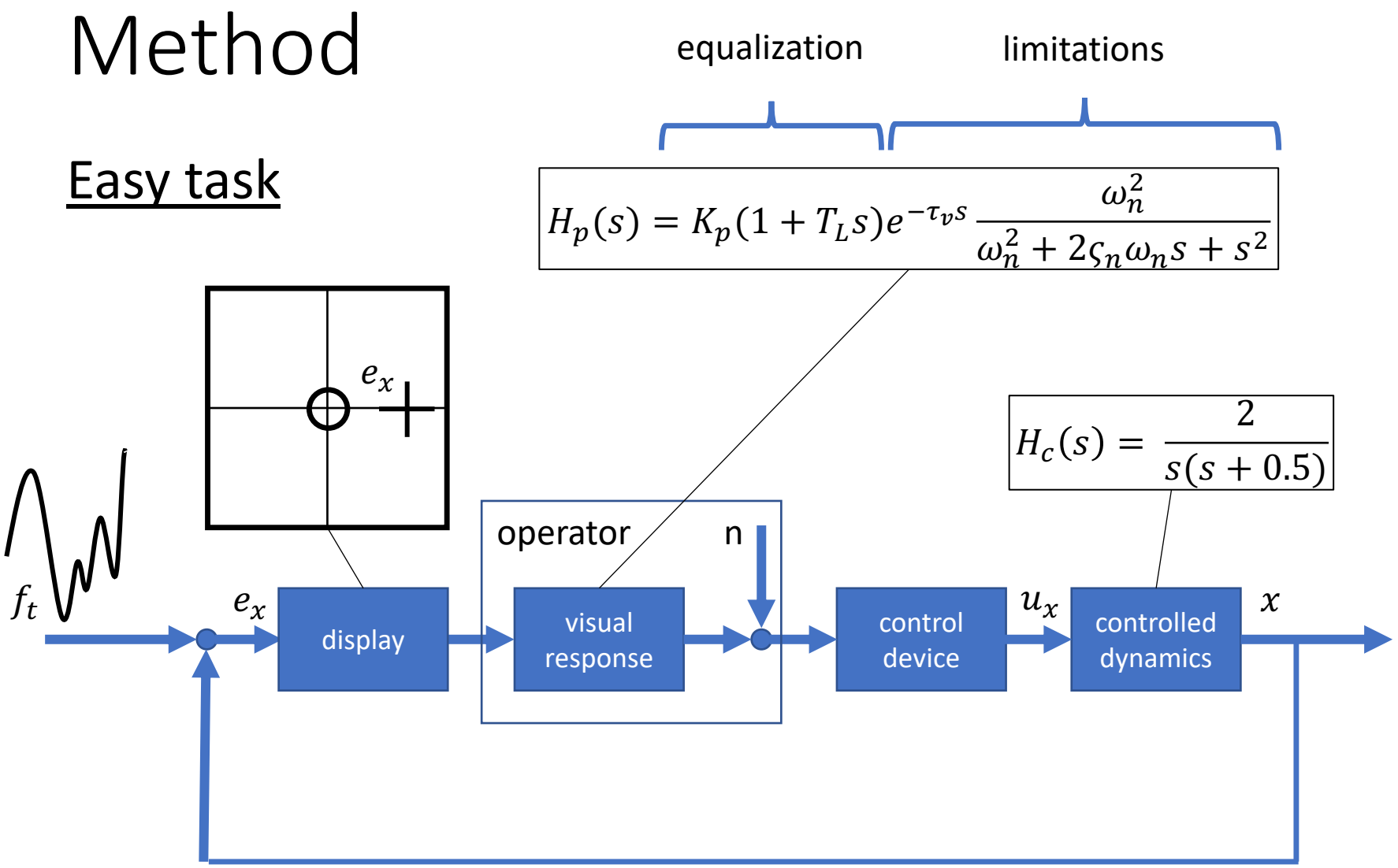
Method

- Between-subject design with two groups
- Ten days of testing



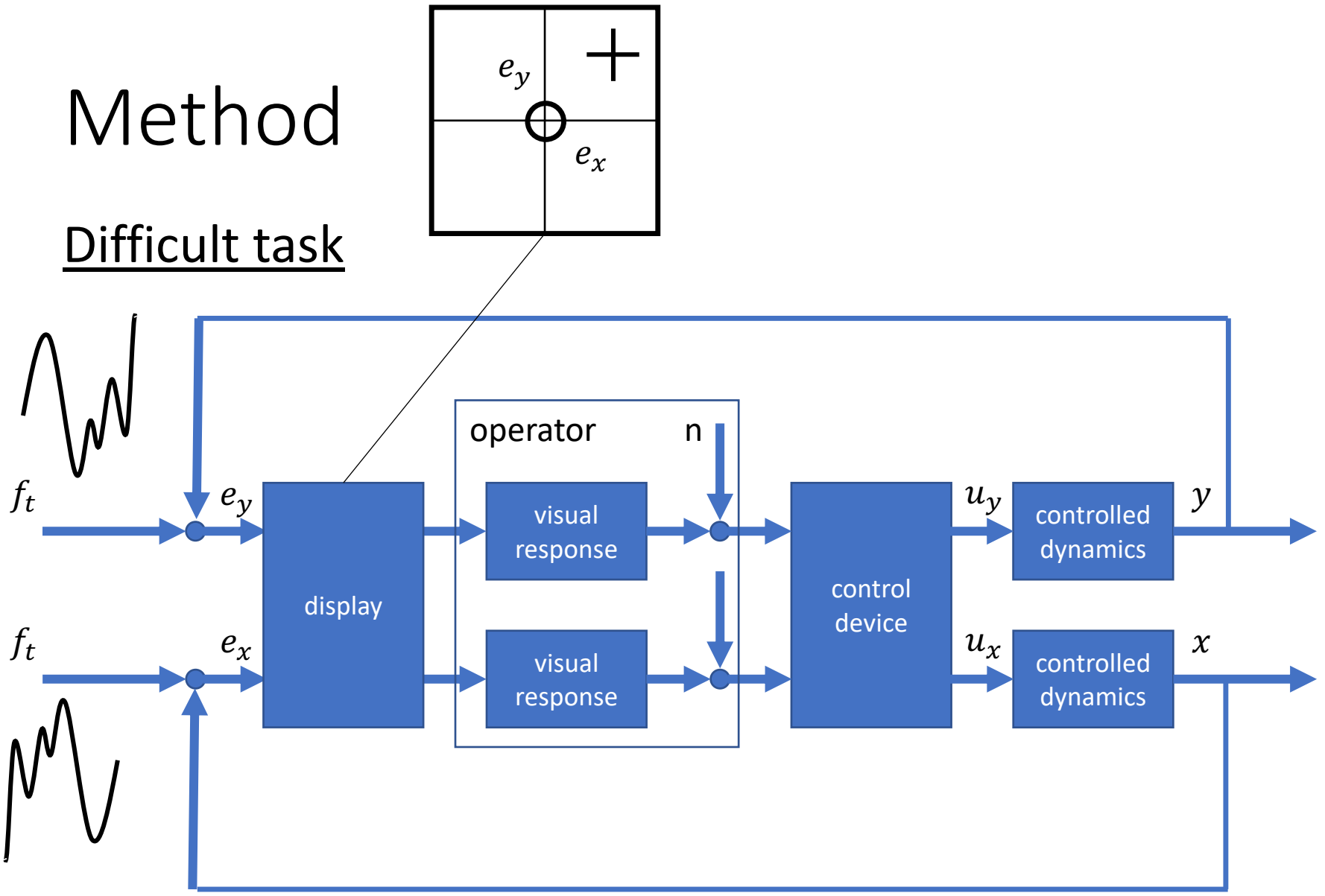
Method

Easy task



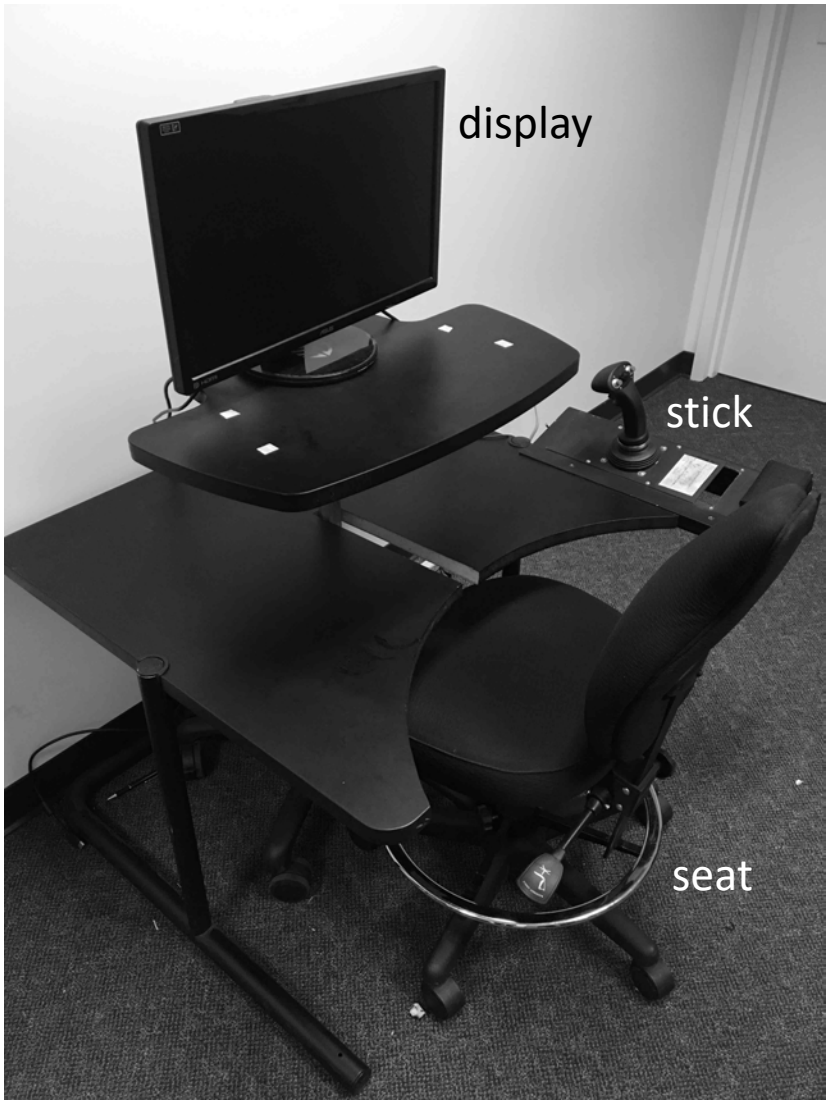
Method

Difficult task



Experiment Setup

- Desktop computer with BG Systems joystick
- Ten 90-second runs each day
- Nine task-naïve participants per group



Experiment Setup

Calculated variables for each axis:

1. Tracking performance (RMS_e)
2. Control effort (RMS_u)
3. Operator model parameters ($K_p, T_L, \tau_v, \zeta_m, \omega_m$)

$$y_{lc} = p_a + (p_0 - p_a)(1 - F)^x$$

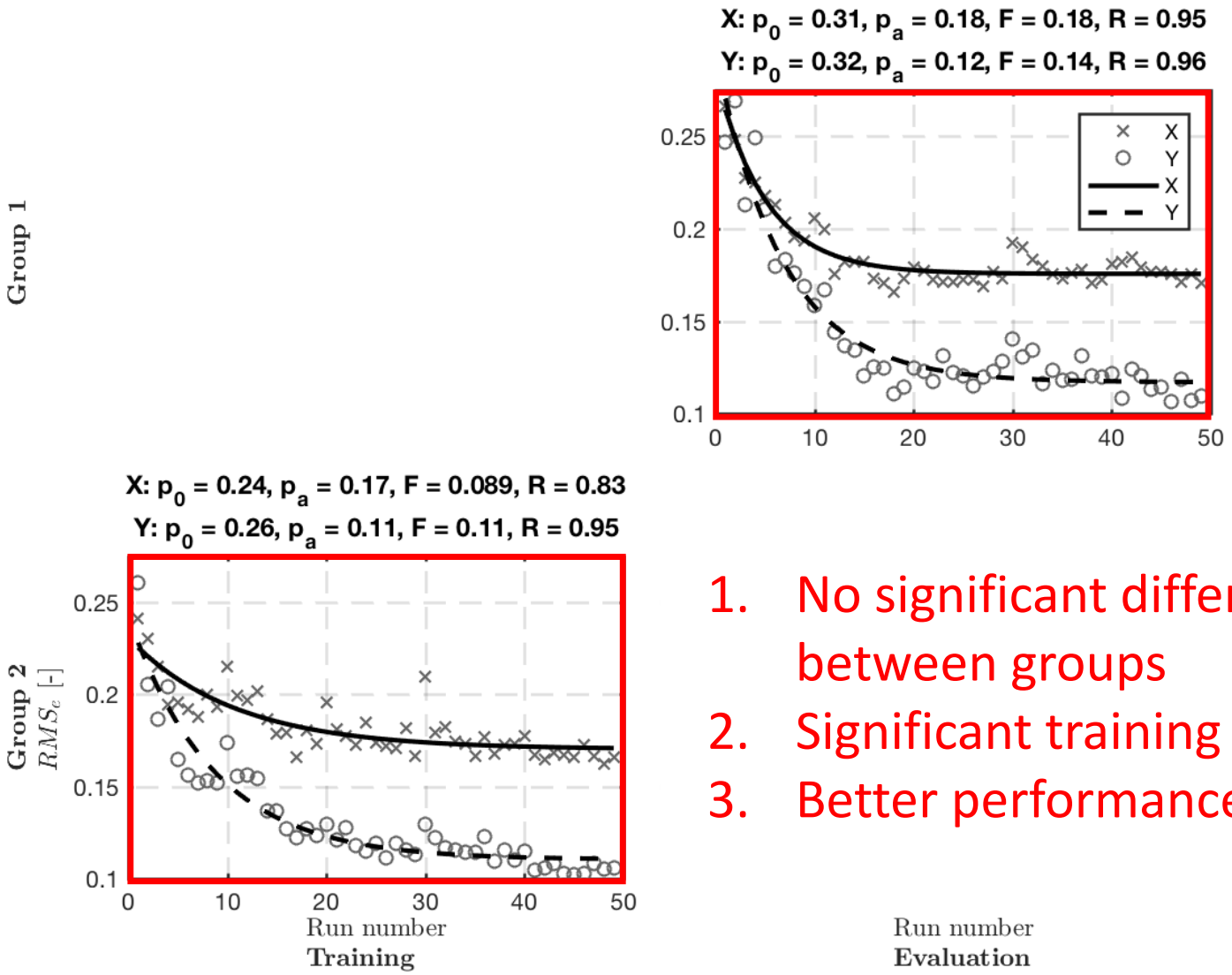
Dependent measures:

1. Learning curve parameters (p_0, p_a, F)

Results – Calculations

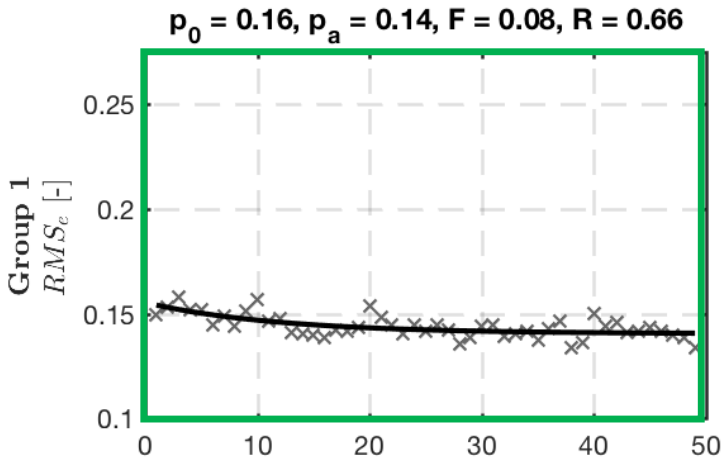
1. Data from six participants not used
2. Time-average of two runs
3. MLE for fitting operator models
4. Least squares for fitting learning curves on averaged data
5. Learning curve if Pearson's coefficient $R > 0.3$
6. Two-way mixed ANOVA (Group X Training)

Results – Tracking Performance

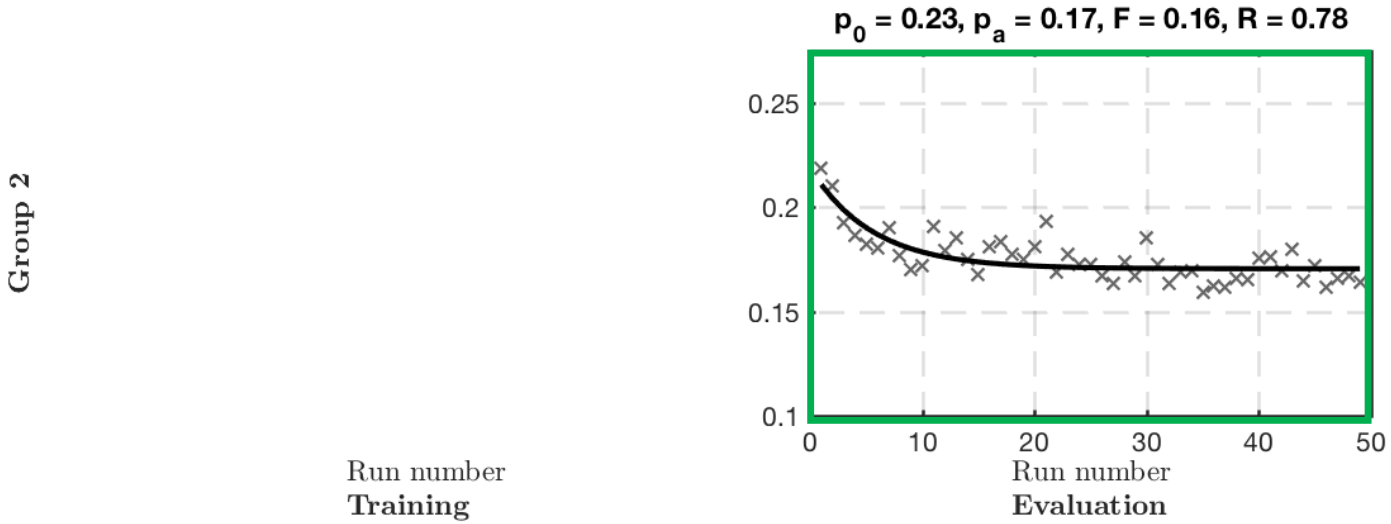


1. No significant difference between groups
2. Significant training effect
3. Better performance in y

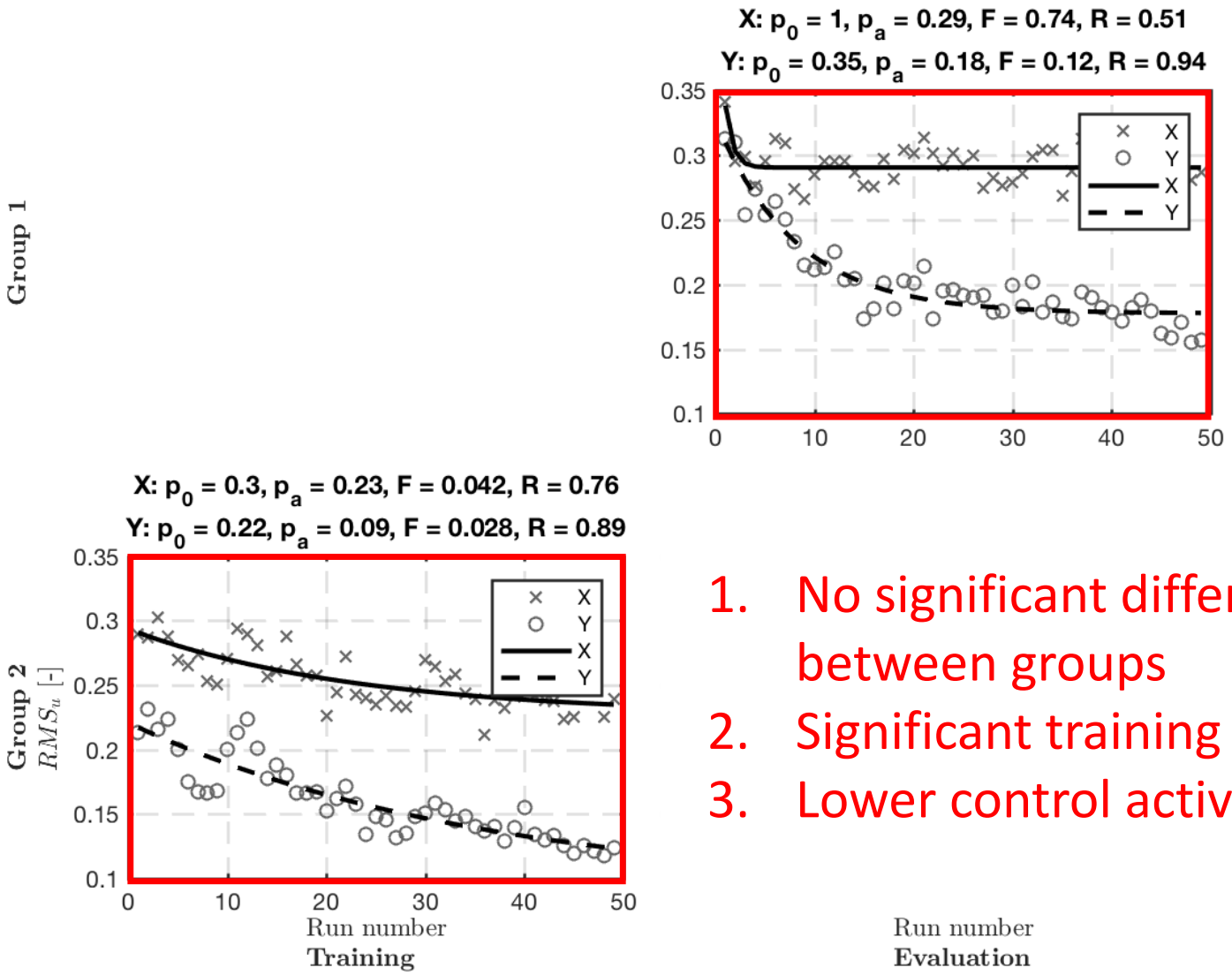
Results – Tracking Performance



1. Significantly better performance for group 1
2. Significant effect of training

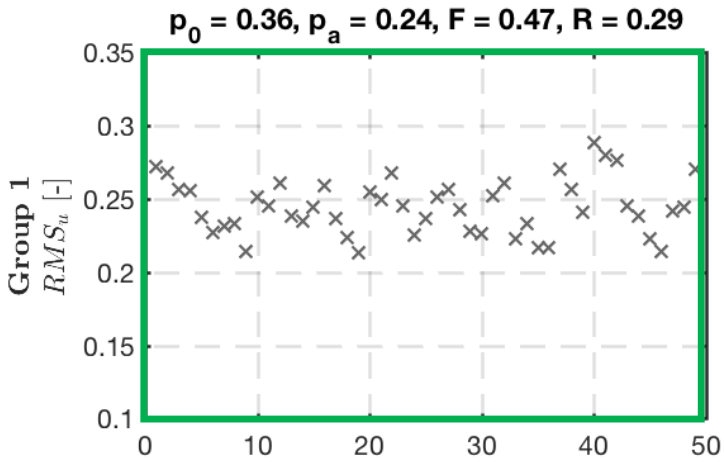


Results – Control Activity



1. No significant difference between groups
2. Significant training effect
3. Lower control activity in y

Results – Control Activity



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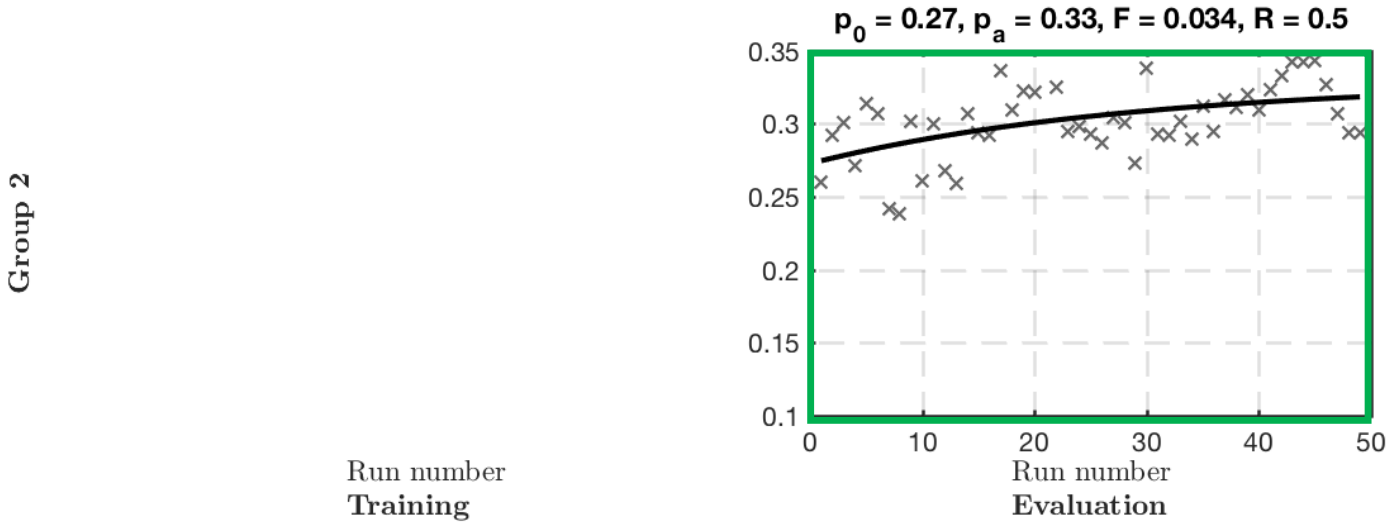
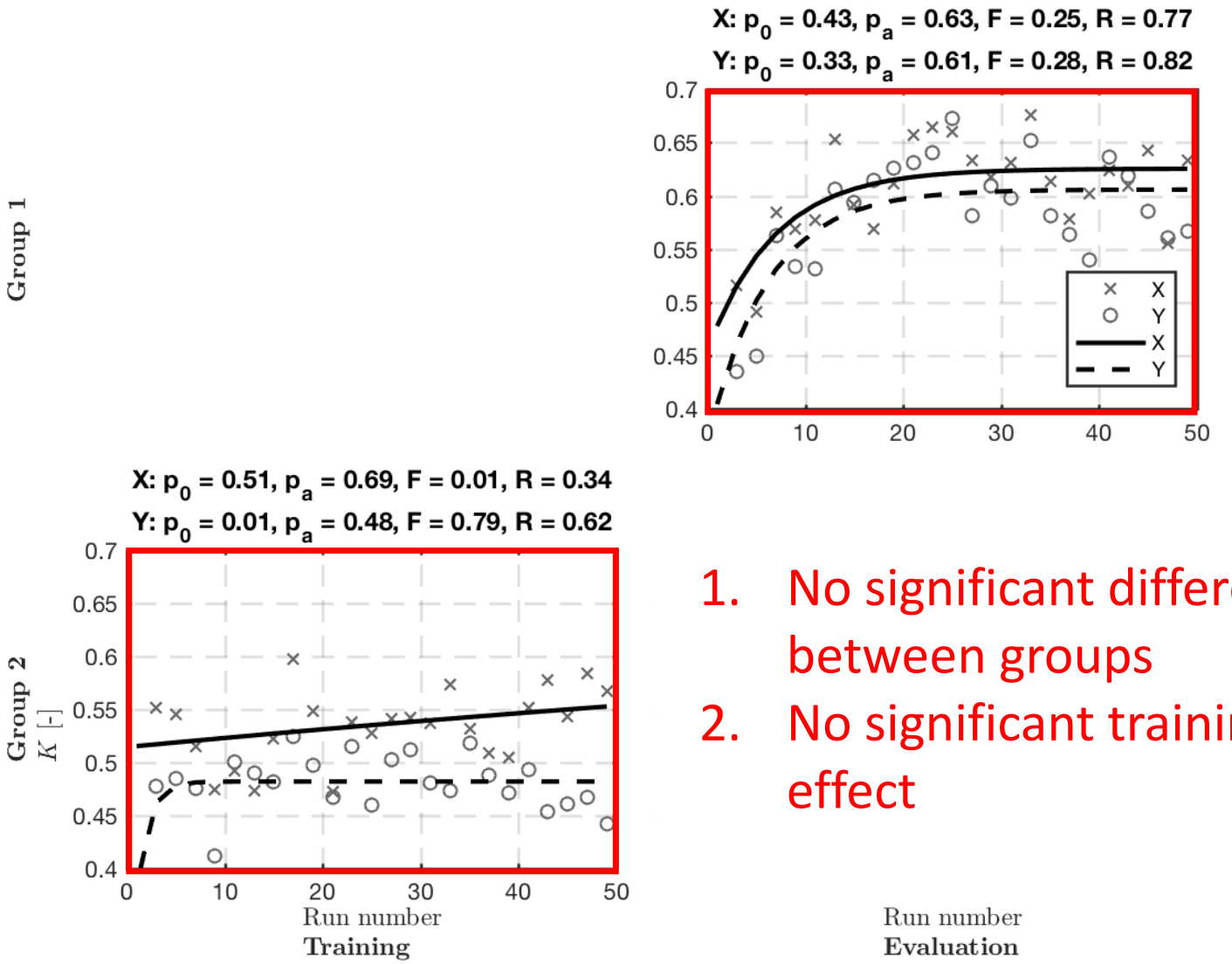


Results – Control Gain



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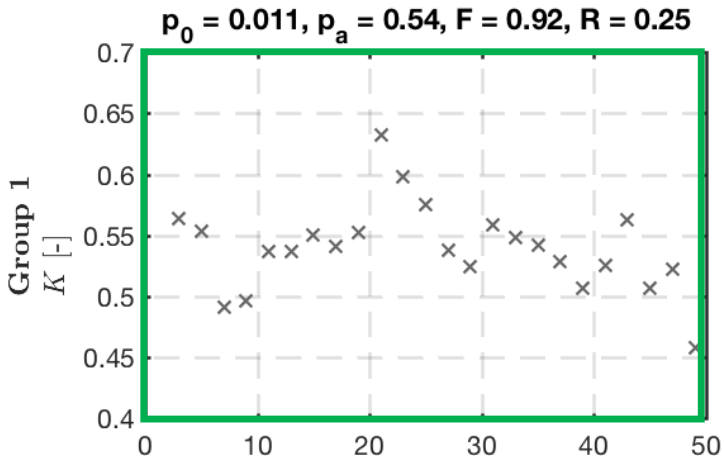
Results – Control Gain



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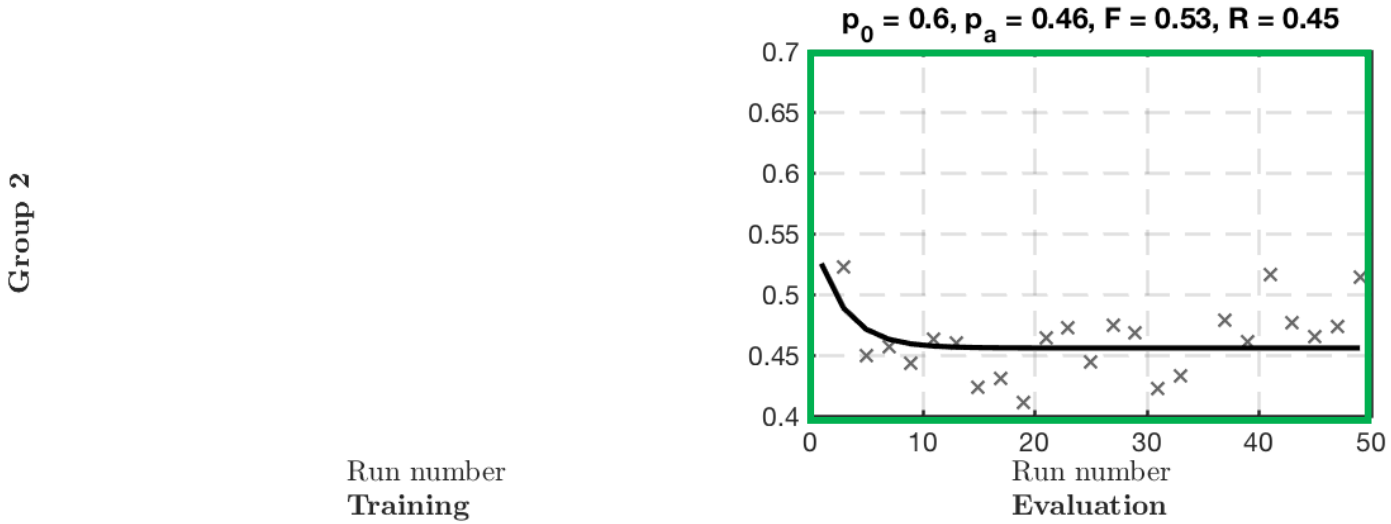
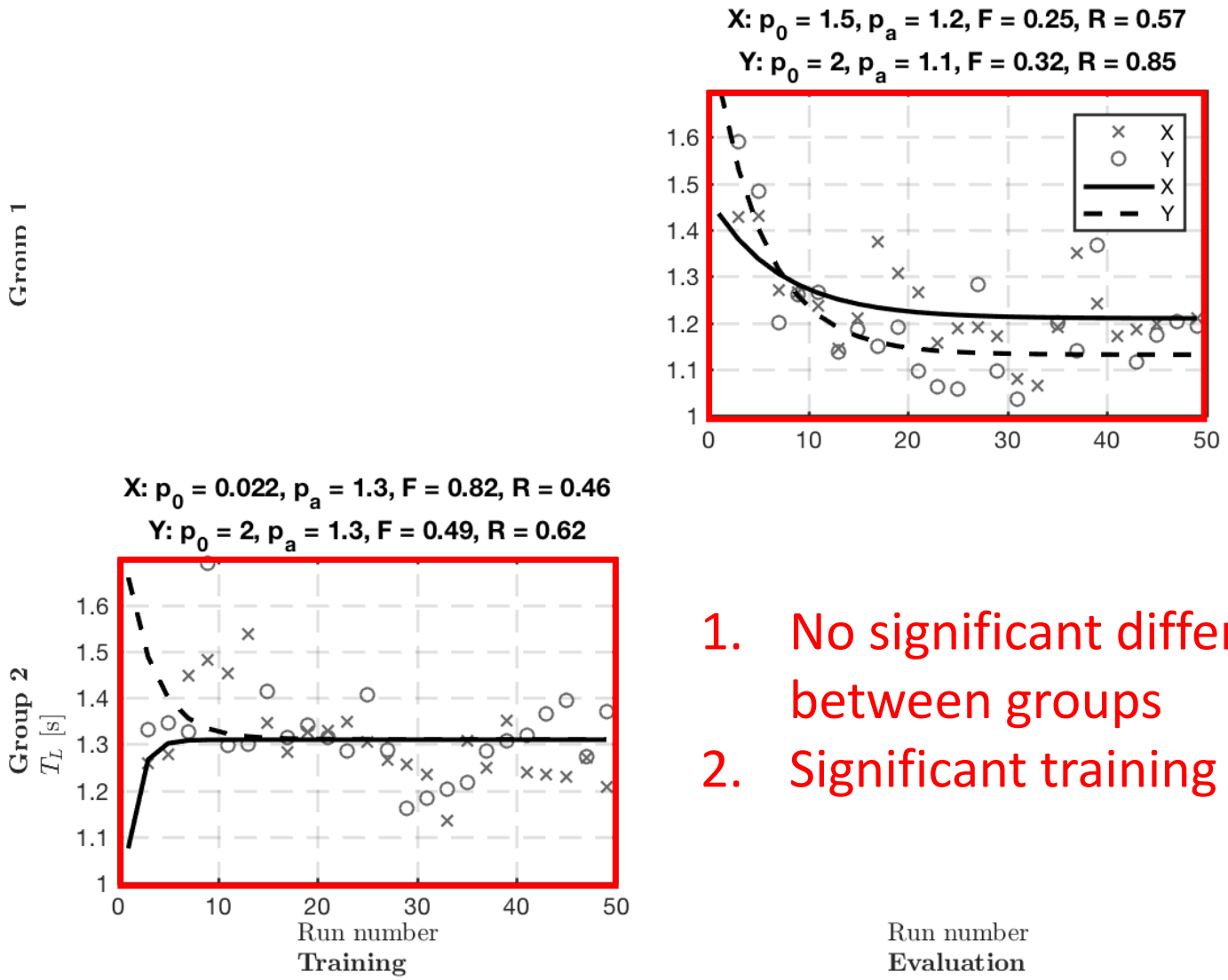
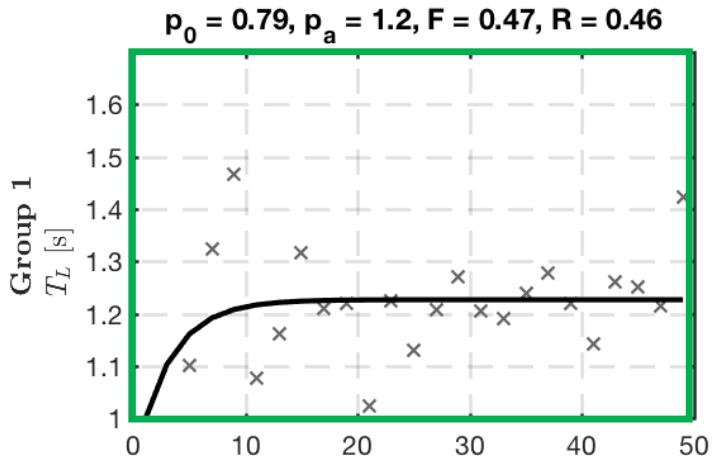


Results – Lead Time Constant



1. No significant difference between groups
2. Significant training effect

Results – Lead Time Constant



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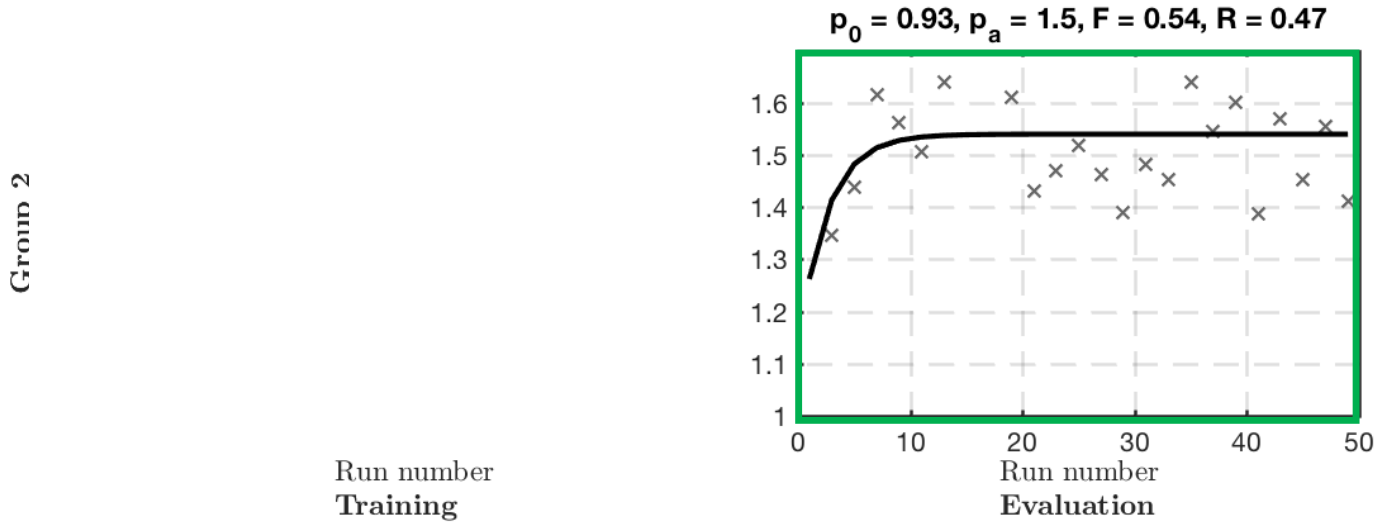

Conclusions

1. No significant difference between groups
2. Significant effect of training

Training with easy task – effects on hard task	Training with hard task – effects on easy task
Higher learning rates	Higher learning rates
No effect on performance	Better performance
Higher control activity	Higher control activity
Higher control gain	Lower control gain
Less visual lead	More visual lead

Thank you!

Questions?

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