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ACUTE IMPROVEMENTS IN QUADRICEPS RATE OF TORQUE DEVELOPMENT IN YOUNG ADULTS USING MOTOR LEARNING THEORY

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Disclosures

The authors have no conflicts of interest and nothing to disclose.

Introduction

- ❏ Rate of re-injury or contralateral injury following anterior cruciate ligament reconstruction (ACL-R) is as high as 33% [1,2]
- ❏ Quadricep re-education may be one reason for poor injury outcomes [1,2,3,4]
- ❏ RTD is key in restoring quadricep function in athletic populations
  - ❏ Proper gait (specifically athletics) [5]
  - ❏ 50-200 ms of goal directed activity [5]
- ❏ Rate of Torque Development (RTD)
  - ❏ RTD is primarily determined by the capacity to produce maximum voluntary activation in the early phase (0-200 ms) of an explosive contraction.[5]

Introduction

- OPTIMAL PREP[6,7]
  - Optimizing Performance Through Intrinsic Motivation and Attention for Learning
  - PREP- Performance, Rehabilitation, Exercise, Play
  - Motivational Pillars
    - Enhanced Expectancy- fostering a belief in the learner will succeed
    - Autonomy Support- allowing the participant choices in their learning environment
  - Attentional Pillar
    - External Focus- directing attention to their effects on the environment
  - Deliver all 3 simultaneously [9,10]

THE 3 PILLARS OF OPTIMAL PREP THEORY

01 Enhanced Expectancies

02 Autonomy Support

03 External Focus of Attention

Purpose Statement & Hypothesis

❑ In young adults, using an OPTIMAL-PREP intervention can increase quadricep RTD in the dominant kicking leg.[6,7,10]

❑ The use of OPTIMAL-PREP will lead to greater improvements in RTD (early: 0-100 ms; late: 100-200 ms) of the quadriceps, in comparison to the control condition.[6,7]

Participants

- ❏ Demographics
  - ❏ 6 males, 13 females
  - ❏ Age - 23.08 ± 4.5 y/o
  - ❏ Mass - 73.68 ± 10.27 kg
  - ❏ Height - 174.31 ± 8.17 cm
  - ❏ All right limb kicking dominant

- ❏ Inclusion Criteria:
  - ❏ At least 18 years old
- ❏ Exclusion Criteria:
 - ❏ Over the age of 35
  - ❏ History of ACL-R
- ❏ IRB written informed consent was obtained (#23-117)

Methods - Dynamometer

❑ Training- OPTIMAL-PREP using dynamometer
  ❑ Biodex hardware
  ❑ HUMAC Norm software
❑ Tested dominant kicking leg
❑ Kick out (isometric quadricep) at 45 degree knee flexion for 3 x 5 seconds and relax for 30 seconds following each condition
❑ 2 conditions
  ❑ Control: No OPTIMAL-PREP
 ❑ Experimental: OPTIMAL-PREP pillars introduc

Randomized Crossover Study

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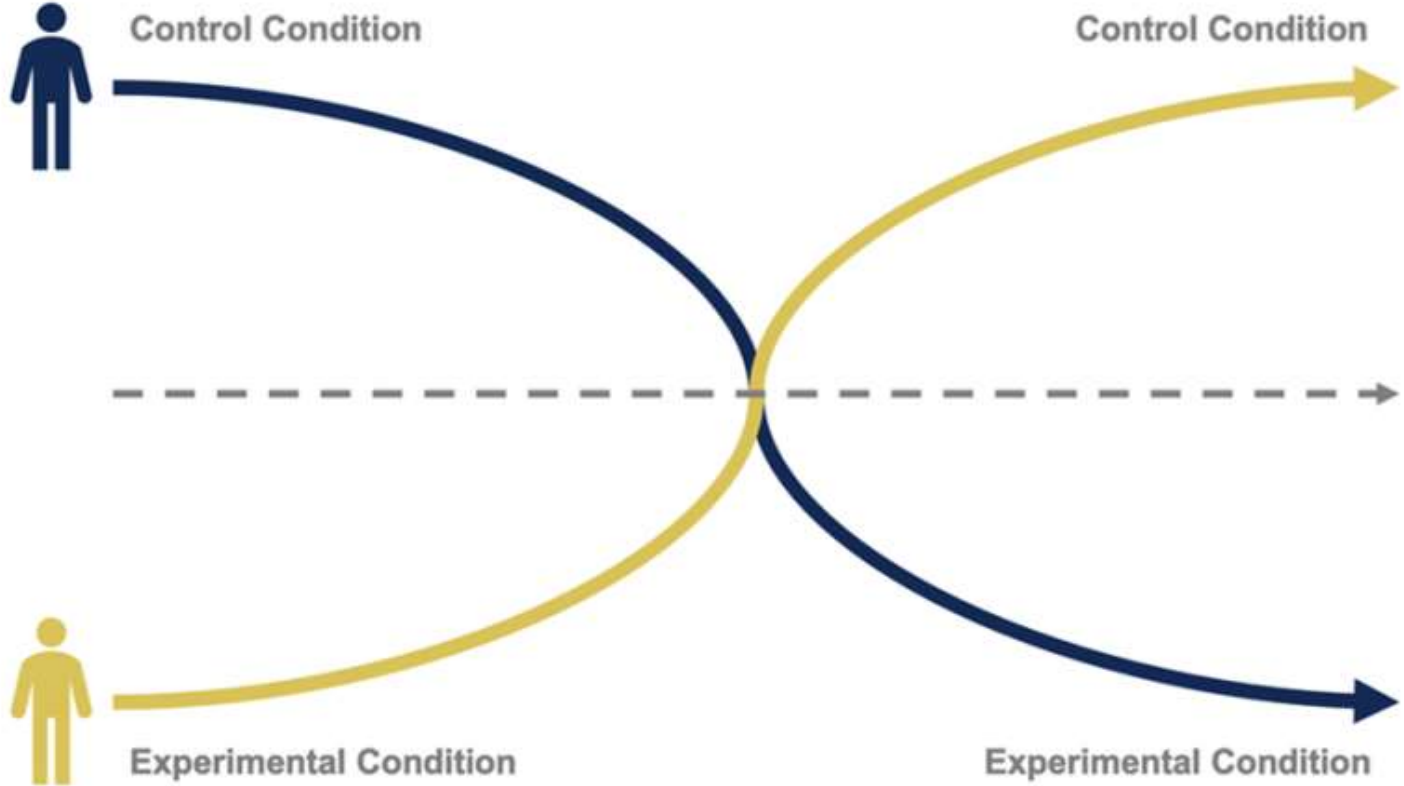
Methods - Motivational & Attentional

- Control - No motor learning manipulations
  - *"Kick your leg forward as hard as you can"*
- Experimental
- Motivational Pillars
  - Enhanced Expectancy- *"Watching the screen during your reps has been shown to increase your quadricep force production."*
  - Autonomy Support- choosing either the bar or line graph
- Attentional Pillar
  - External Focus- *"Kick your leg forward as hard as you can"**
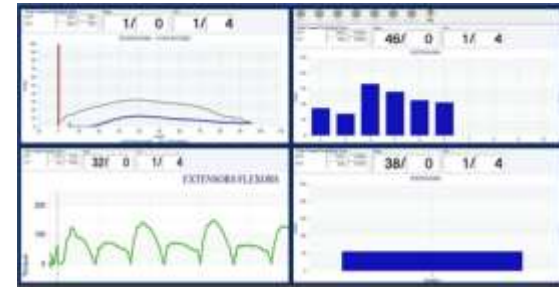
Data Handling and Statistical Analysis

❏ **Rate of Torque Development** was our primary outcome variable
  ❏ Early RTD = Torque (Nm) at 100ms / 0.1s/ mass
  ❏ Late RTD = (Torque (Nm) at 200ms - Torque (Nm) at 100ms) / 0.1s / mass

❏ We inspected histograms to assess data normality
❏ Two one-tailed paired T-tests to assess differences between conditions
  ❏ Early RTD
  ❏ Late RTD
❏ *A priori* Cohen's *d* of 0.5 (moderate)
❏ JASP 0.18.2 was used for all analyses

Descriptives

	N	Mean	SD	SE	Coefficient of variation
RTD_100ms_Con	19	8.429	5.097	1.169	0.605
RTD_100ms_Exp	19	8.608	4.911	1.127	0.571
RTD_200ms_Con	19	4.330	2.701	0.620	0.624
RTD_200ms_Exp	19	4.650	2.145	0.492	0.461

Paired Samples T-Test

| Measure 1		Measure 2	t	df	p	Cohen's d	SE Cohen's d	95% CI for Cohen's d Lower	95% CI for Cohen's d Upper
RTD_100ms_Con	-	RTD_100ms_Exp	−0.318	18	0.377	−0.073	0.113	-∞	0.306
RTD_200ms_Con	-	RTD_200ms_Exp	−0.662	18	0.258	−0.152	0.195	-∞	0.230

Note. For all tests, the alternative hypothesis specifies that Measure 1 is less than Measure 2. For example, RTD_100ms_Con is less than RTD_100ms_Exp.

Note. Student's t-test.

Results - Rate of Torque Development 0-100 ms
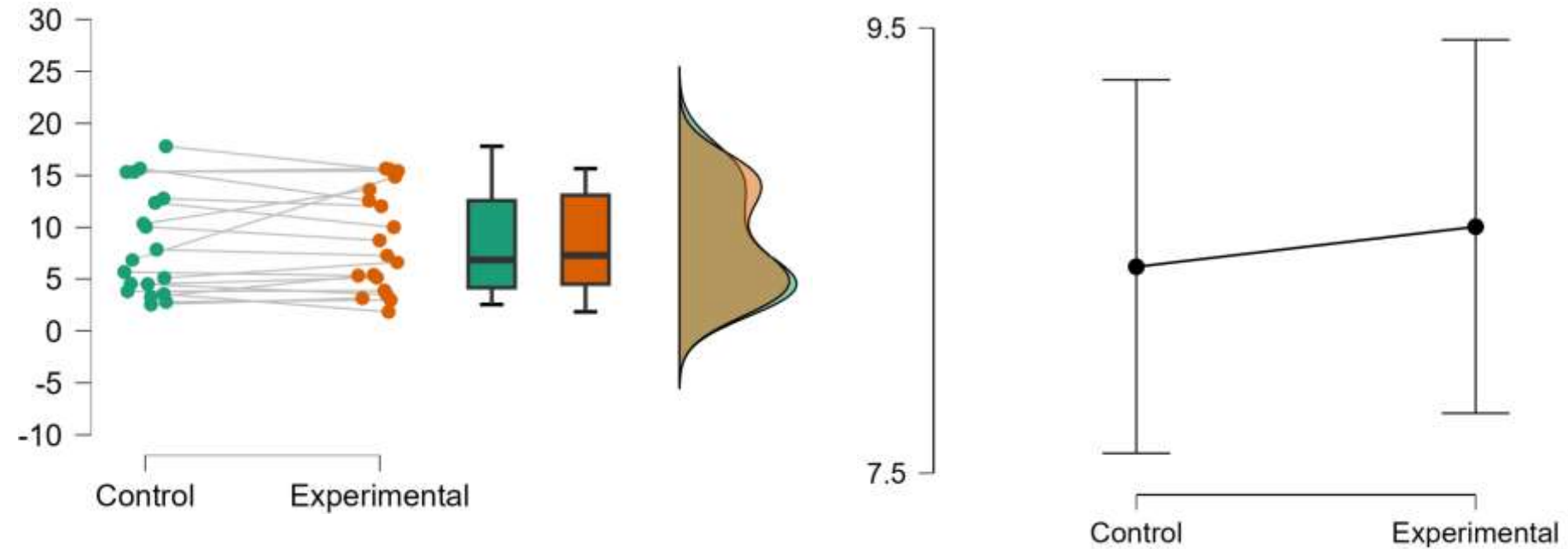
Results - Rate of Torque Development 100-200 ms
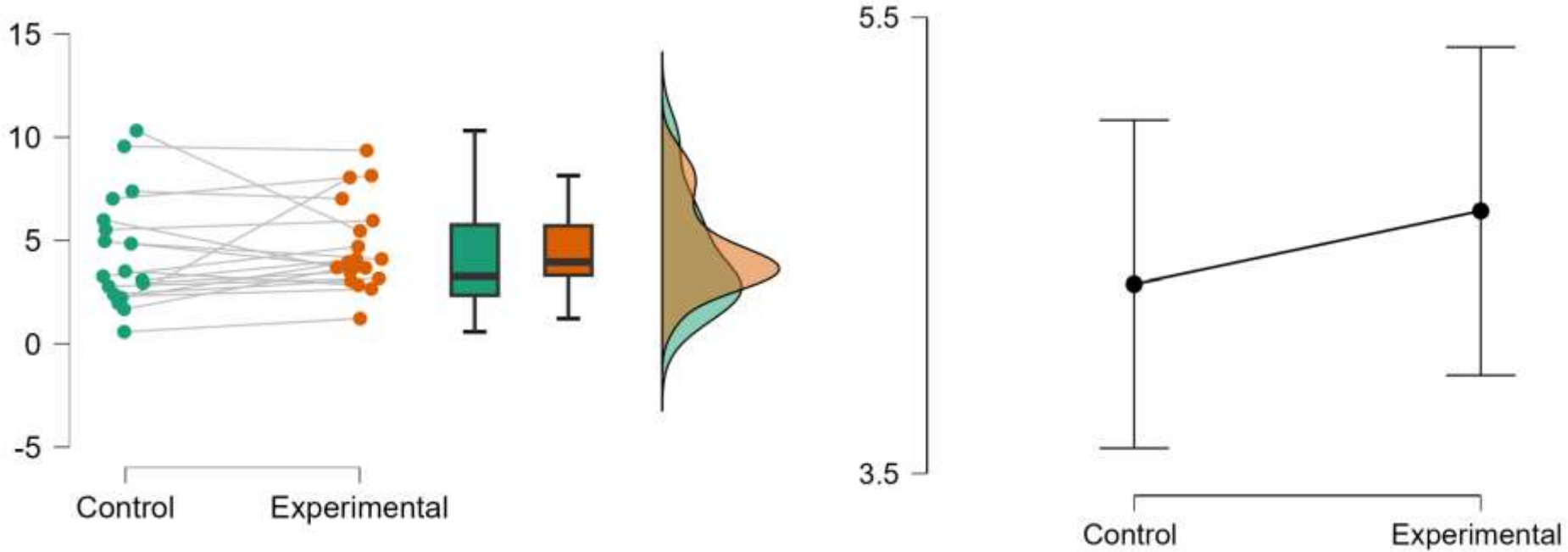
Discussion

❏ We observed negligible to small acute effects (Cohen's *d* of 0.07 for early RTD and 0.15 for late RTD)

❏ Early RTD - neural excitability [13,14]

❏ Late RTD - more voluntary [13, 14]

❏ We did not observe this

Population Differences

❏ Expansion of a previous project in ACL-r participants[11]
  ❏ Observed a moderate to large effect of peak torque and no effect for RTD
❏ Not tested on ACL-r participants
❏ The present study observed slightly stronger effects for RTD in a healthy population
❏ Motor learning principles are applicable to both populations

Limitations

- External Focus
  - "Focus on making the line go as high as you can."*
- Learning Effect
  - Second set was always better
  - Needed longer washout period

Clinical Relevance

❑ OPTIMAL-PREP should be used as a baseline and during rehab [5]

❑ Future research is looking at implementation of OPTIMAL-PREP 3-4 weeks post operation.[11,12,14]

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Peak Torque Bonus Slide

Pearson's Correlations

Variable		RTD_100ms_Con	RTD_200ms_Con	RTD_100ms_Exp	RTD_200ms_Exp
1. RTD_100ms_Con	Pearson's r	—			
	p-value	—			
2. RTD_200ms_Con	Pearson's r	0.601	—		
	p-value	0.006	—		
3. RTD_100ms_Exp	Pearson's r	0.880	0.487	—	
	p-value	< .001	0.034	—	
4. RTD_200ms_Exp	Pearson's r	0.480	0.643	0.410	—
	p-value	0.038	0.003	0.082	—

Pk_Trq_E_Norm_Nm/kg - Pk_Trq_C_Norm_Nm/kg

Experimental   Control