



# Combining Physical and Mental Practices of a Dart-throwing Task Enhances Motor Learning and Impacts Psychological Skills

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## Background

In sports and performance, it is important that motor skills are learned effectively and can be reproduced in different demanding circumstances that can arise. Not only should motor skills be learned as quickly and efficiently as possible, but their performance should be durable and resilient to the potentially debilitating effects of performance anxiety caused by competitive pressure (Vine et al.2013).

The significance of practicing under different conditions to enhance motor learning depends on whether the learning benefits are transferred to novel situations (Schmidt & Lee, 2019), particularly those likely to be encountered while performing the skill and those with high importance. For example, a practice condition may improve a learner's encoding and consolidation of a skill, however, the efficacy of the individual during practice conditions is limited if the skill cannot be successfully retrieved and performed in high-stakes environments, under psychological pressure.

As many skills must be performed in high stakes environments, such as sports competitions, it is crucial to determine practice conditions that enhance learning and preserve learning benefits under psychological pressure. Normally, when performers are required to execute a skill under high-pressure conditions individuals have a tendency to choke (Baumeister,1984; Hardy, Mullen, & Jones, 1996; Beilock & Carr, 2001; Lewis & Linder, 1997; Masters, 1992). Therefore, practicing skills to prevent this phenomenon is crucial for better performance.

The application of visualization techniques combined with the physical practice of a skill may benefit skill learning and performance under pressure. The more visualization techniques are practiced, the more robust a motor program will be "created" in the brain. The psychological benefits of the practice of Visualization in skill performance are that the (1) learner will "anticipate" potential scenarios and outcomes of future actions, therefore minimizing anxiety; (2) the learner's motivation will be increased because they will be "experiencing" the skill being performed with a positive outcome. (Weinberg and Gould, 2017).

## Research Question and Hypothesis

Based on the background provided, this study aimed to examine whether the combination of physical and mental (visualization) practices of a dart-throwing task enhanced motor learning and Psychological skills and ultimately benefited skill performance under a high-pressure situation.

Our hypotheses were:

- (1) Combination of physical and mental practices of dart-throwing skills would enhance motor learning relative to participants who only physically practiced the skill;
- (2) Combination of physical and mental practices of dart-throwing skills would benefit skill performance under high-pressure relative to its counterparts;
- (3) Combination of physical and mental practices of dart-throwing skills would enhance psychological skills, such as motivation, perceived competence, and positive thinking in addition to minimizing anxiety. Visualization would benefit skill performance under high-pressure when compared to the group who only physically practiced the skill.

## Subject Characteristics

### Groups

53 Total Participants  
27 in Visualization + Dart Group  
26 in Dart Group

### Age

Mean age (in years): 21.8 ± 3.4

### Played Darts in Lifetime

Never: 57.3%  
1-5 Times: 33.2%  
6-10 Times: 9.5%

### Played Darts within the Last Year

Never: 69.2%  
1-5 Times: 30.8%

## Purpose

Examine whether the combination of physical and mental (Visualization) practices of a dart throwing task enhanced motor learning and Psychological Skills benefiting skill performance under high-pressure

## Methods

### Participants

Fifty-Three (53) physically active and beginner subjects of dart-throwing skills completed the experiment (one visit - 75 minutes). Participants were distributed into two groups (Dart + Visualization (DV); and Dart (D)). Participants were recruited from undergraduate courses, e-mails, and word of mouth.

### Task

Participants were required to learn a dart throwing task in reference to a target located 1.73 m off the ground and 2.37 m from the throwing line (pretest phase, learning phase, retention and pressure posttests), and 3.37 m on the transfer posttest. The center of the board ("bullseye") was treated as the origin (point 0,0). To analyze performance and learning, we assessed Radial Error (RE) for Accuracy and Bivariate Variable Error (BVE) for precision.

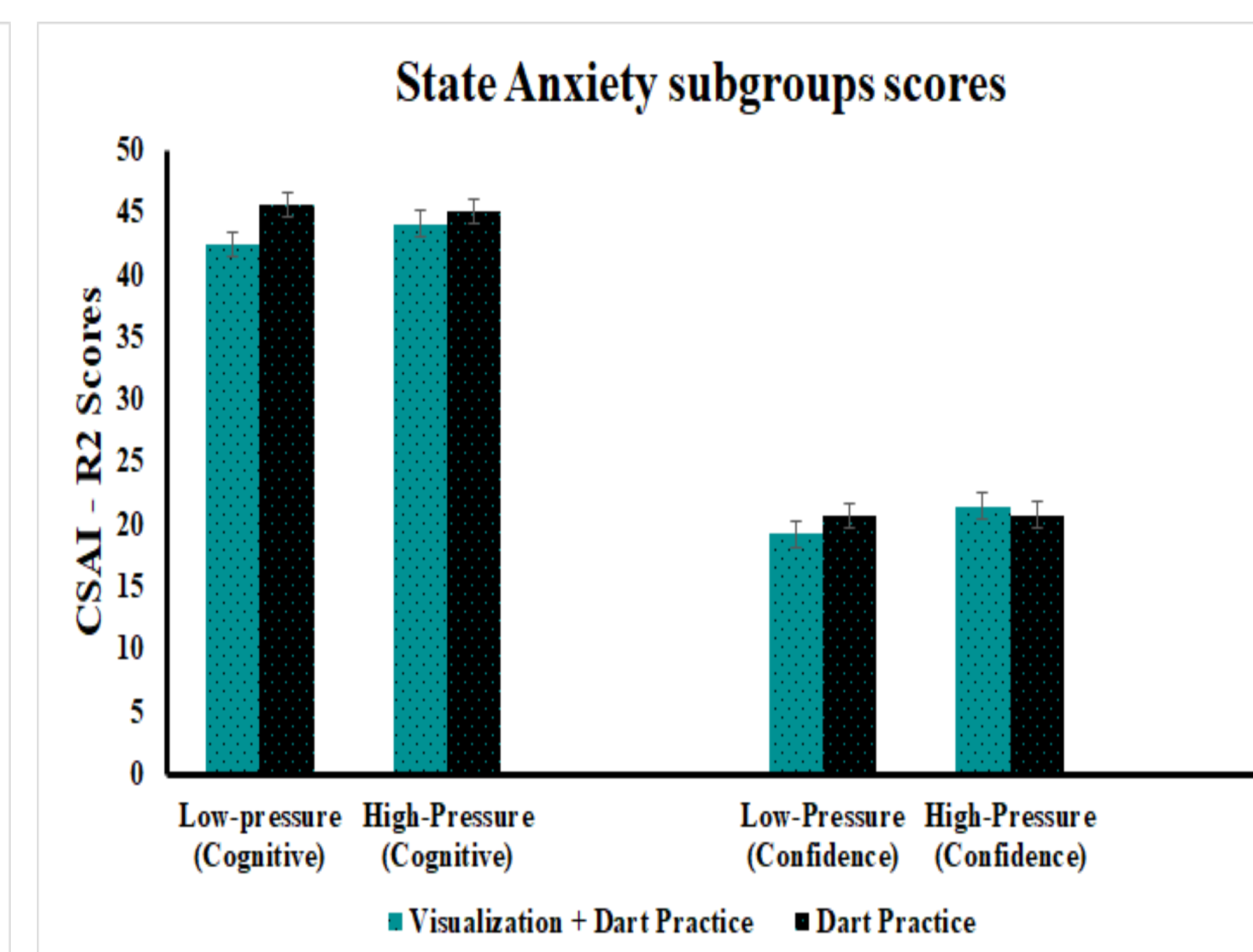
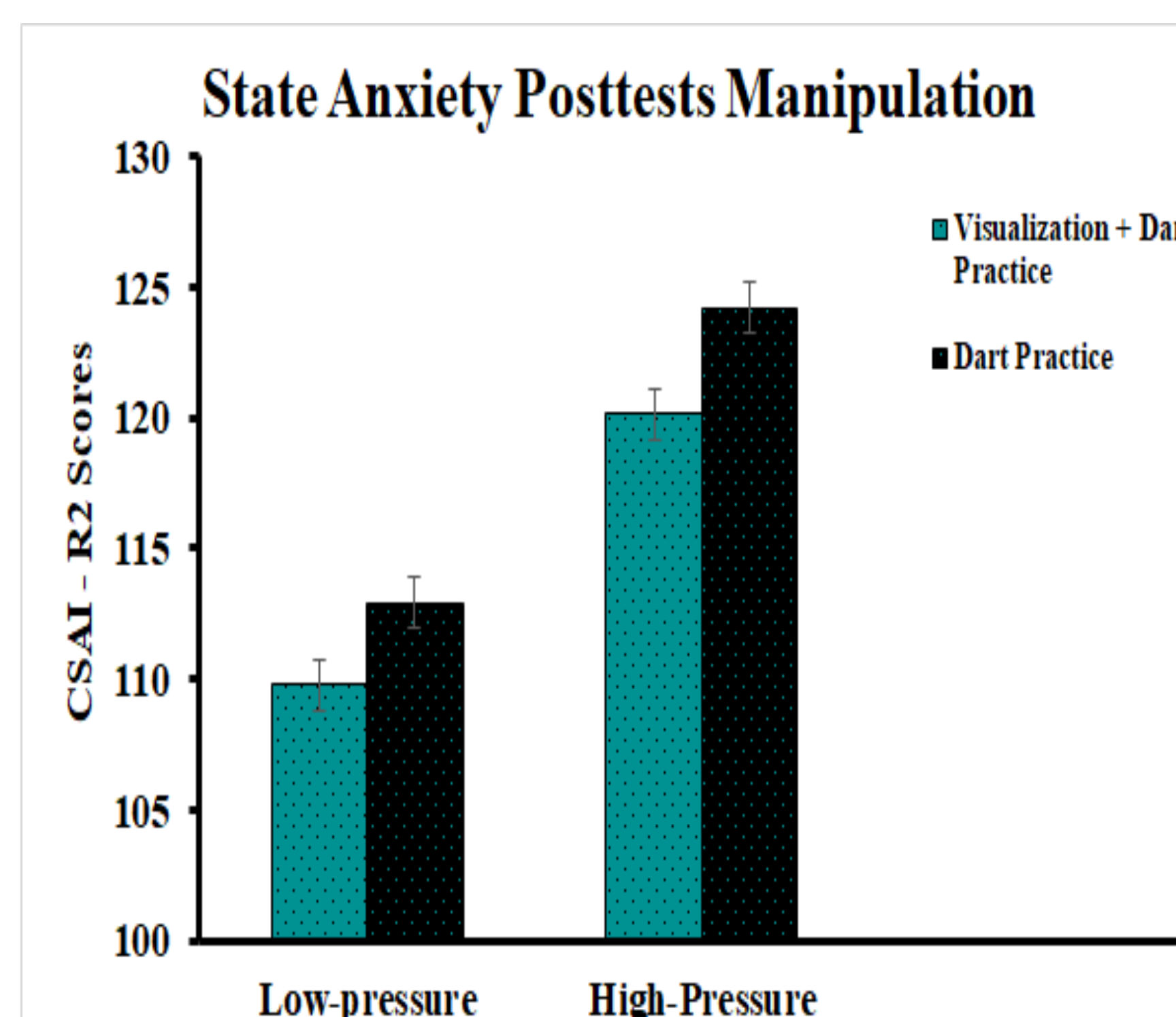
### Statistical Analysis

- To assess practice performance, a 2 (group) x 6 (block) mixed-factor ANOVA with repeated-measures on the last factor separate for radial error and bivariate variable error were utilized.
- To assess learning, a 2 (group) x 3 (posttest) mixed-factor ANOVA with repeated-measures on the last factor, and radial error/variable error serving as the dependent variables were utilized.
- Separate ANOVAs for Motivation, Self-Efficacy, Positive Thinking, and Anxiety were utilized.

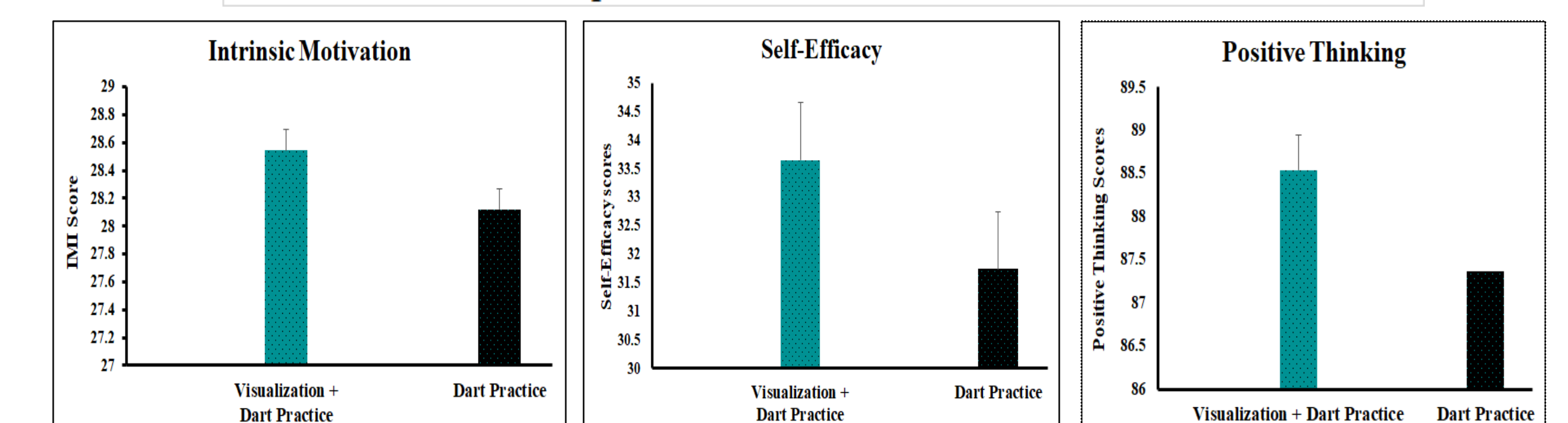
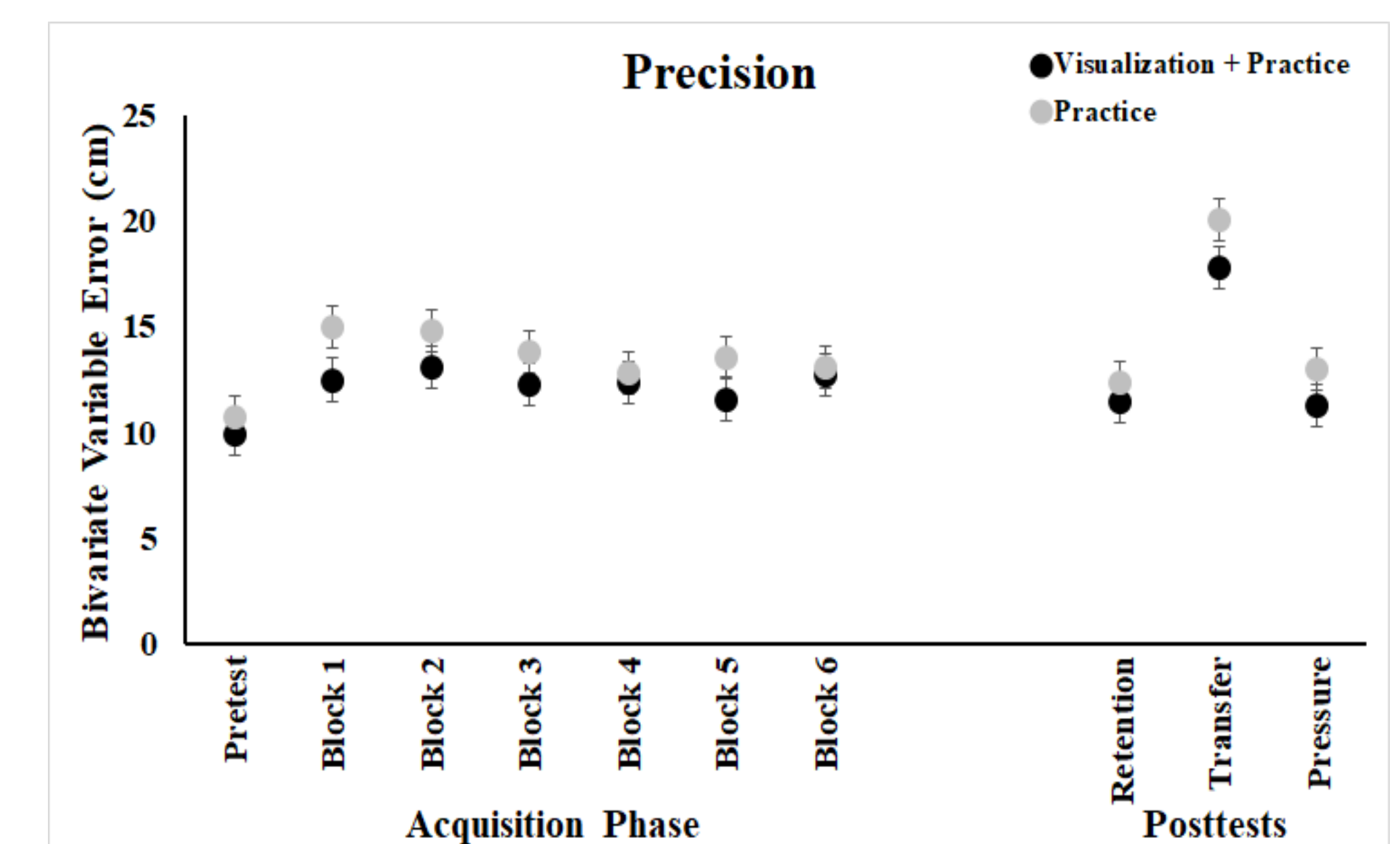
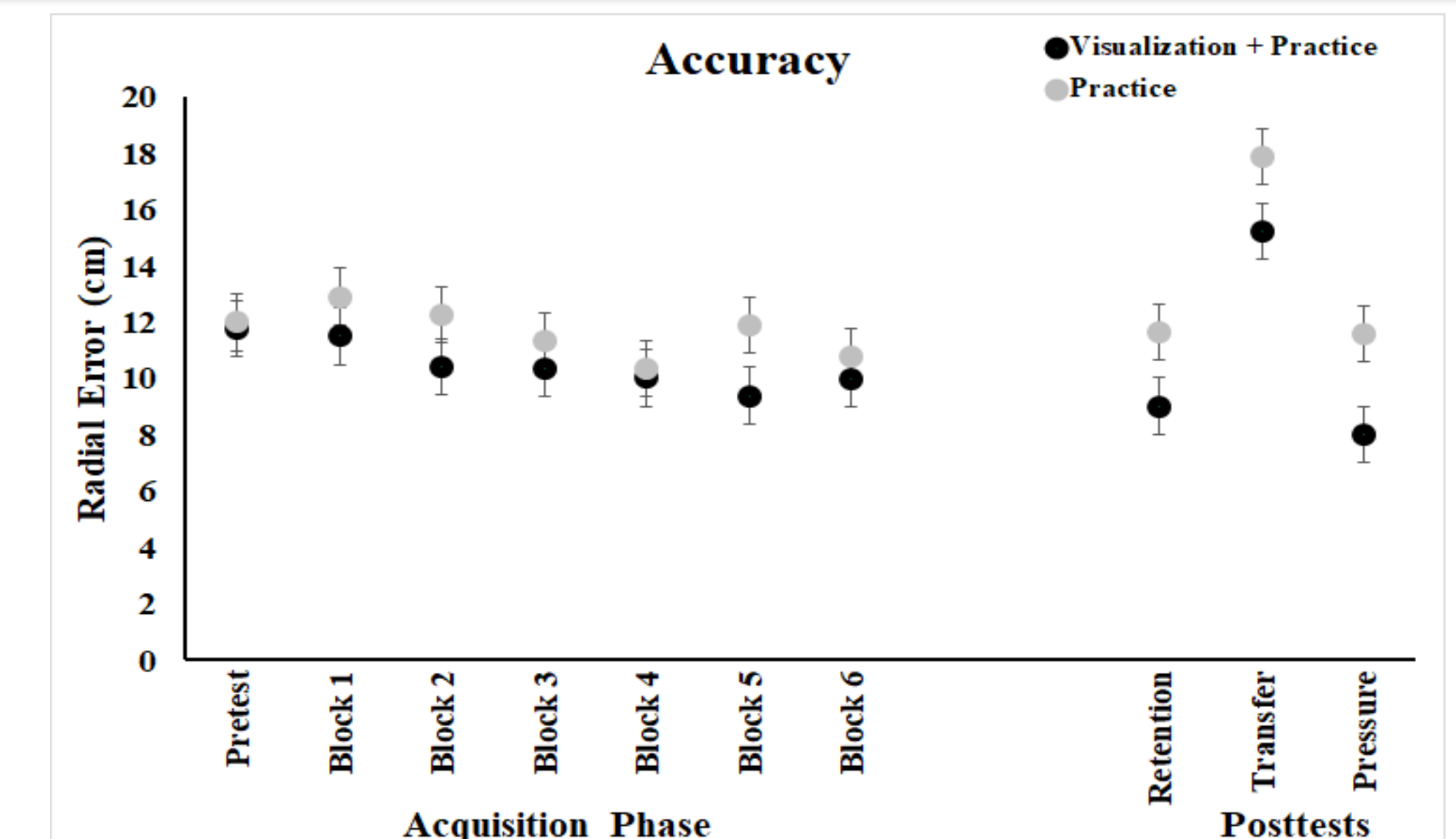
## Experiment Design

| Pretest (Baseline)   | Learning Phase  | Posttests (immediate)   |
|--|---|---|
| <ul style="list-style-type: none"> <li>10 Trials</li> </ul>  | <ul style="list-style-type: none"> <li>2-min studying dart-throwing booklet</li> <li>6 blocks of 10 trials (60 total)</li> <li>Same distance as pretest</li> </ul>  | <b>Retention test</b> <ul style="list-style-type: none"> <li>10 trials</li> <li>Low pressure</li> <li>Same distance as pretest</li> <li>CSAI-R2 (Anxiety)</li> </ul>              |
| <b>Target</b> <ul style="list-style-type: none"> <li>1.73 m off the ground</li> <li>2.37 m from the throwing line</li> </ul> | <ul style="list-style-type: none"> <li>1-minute break between blocks</li> <li>DV group (visualization - Breaks)</li> <li>D group (read a paper - Breaks)</li> </ul> | <b>Transfer test</b> <ul style="list-style-type: none"> <li>10 trials</li> <li>3.37 m from the throwing line</li> </ul>   |
|  | <b>Psychological assessments</b> <ul style="list-style-type: none"> <li>IMI (Intrinsic Motivation)</li> <li>Self-Efficacy</li> <li>Positive Thinking</li> </ul>     | <b>High-Pressure test</b> <ul style="list-style-type: none"> <li>10 trials</li> <li>Same distance as pretest</li> <li>Pressure manipulation</li> <li>CSAI-R2 (Anxiety)</li> </ul> |

## State Anxiety Results



## Motor Learning Results



## Conclusion

- While learning a new motor skill, combining physical practice and visualization techniques enhanced motor learning
- Combining physical practice of a dart-throwing task and visualization benefited skill performance under pressure
- Psychological manipulation of posttests condition (low and high pressure) altered participants perceptions of pressure, and led the V+D group to feel less pressure
- Even though results showed differences on psychological skills, scores did not reach statistical significance

## References

- Baumeister, R. F. (1984). Choking under pressure: Self-consciousness and paradoxical effects of incentives on skillful performance. *Journal of Personality and Social Psychology*, 46, 610–620. <http://dx.doi.org/10.1037/0022-3514.46.4.610>
- Beilock, S. L., & Carr, T. H. (2005). When high-powered people fail: Working memory and "choking under pressure" in math. *Psychological Science*, 16, 101–105. <http://dx.doi.org/10.1111/j.0956-7976.2005.00789.x>
- Masters, R. S. W. (1992). Knowledge nerves and know-how: The role of explicit versus implicit knowledge in the breakdown of a complex motorskill under pressure. *British Journal of Psychology*, 83, 343–358. <http://dx.doi.org/10.1111/j.2044-8295.1992.tb02446.x>
- Vine, S. J., Moore, L. J., Cooke, A., Ring, C., & Wilson, M. R. (2013). Quiet eye training: A means to implicit motor learning. *International Journal of Sport Psychology*, 44, 367–386. <http://dx.doi.org/10.7352/IJSP2013.00.000>
- Weinberg, R., & Gould D. (2017). *Foundations of Sport and Exercise Psychology*. 7ed, Human Kinetics.