

1-1-2021

## Skilled Throwing Performance: A Test of the OPTIMAL Theory

Jacquelyn V.L. Sertic  
*University of Nevada, Las Vegas*

Jason M. Avedesian  
*University of Nevada, Las Vegas*

James W. Navalta  
*University of Nevada, Las Vegas, james.navalta@unlv.edu*

Follow this and additional works at: [https://digitalscholarship.unlv.edu/kns\\_fac\\_articles](https://digitalscholarship.unlv.edu/kns_fac_articles)



Part of the [Exercise Science Commons](#)

---

### Repository Citation

Sertic, J., Avedesian, J., Navalta, J. (2021). Skilled Throwing Performance: A Test of the OPTIMAL Theory. *International Journal of Exercise Science*, 14(5), 358-368.  
[https://digitalscholarship.unlv.edu/kns\\_fac\\_articles/385](https://digitalscholarship.unlv.edu/kns_fac_articles/385)

This Article is protected by copyright and/or related rights. It has been brought to you by Digital Scholarship@UNLV with permission from the rights-holder(s). You are free to use this Article in any way that is permitted by the copyright and related rights legislation that applies to your use. For other uses you need to obtain permission from the rights-holder(s) directly, unless additional rights are indicated by a Creative Commons license in the record and/or on the work itself.

This Article has been accepted for inclusion in Kinesiology and Nutrition Sciences Faculty Publications by an authorized administrator of Digital Scholarship@UNLV. For more information, please contact [digitalscholarship@unlv.edu](mailto:digitalscholarship@unlv.edu).



*Original Research*

---

## **Skilled Throwing Performance: A Test of the OPTIMAL Theory**

JACQUELYN V. L. SERTIC<sup>†1</sup>, JASON M. AVEDESIAN<sup>†1</sup>, and JAMES W. NAVALTA<sup>‡</sup>

Department of Kinesiology and Nutrition Sciences, University of Nevada, Las Vegas, Las Vegas, NV, USA

<sup>†</sup>Denotes graduate student author, <sup>‡</sup>Denotes professional author

---

### ABSTRACT

*International Journal of Exercise Science* 14(5): 358-368, 2021. The OPTIMAL theory of motor learning postulates that autonomy support (AS), enhanced expectancies (EE), and an external focus of attention (EF) facilitate improved motor learning and performance. However, its applicability to elite-level throwing athletes has not been investigated by previous literature. The primary purpose of this study was to investigate the successive implementation of AS, EE, and EF factors on overhand throwing performance in elite collegiate softball athletes ( $14.44 \pm 2.75$  years of softball experience). The secondary purpose was to determine whether self-efficacy beliefs would be augmented by factor manipulation. Twenty-four participants threw softballs at a bullseye target during five blocks. The Baseline test (Block 1) was used to subsequently assign participants to either the OPTIMAL or control group. Three middle blocks (Block 2 to 4) followed with successive factor implementation for the OPTIMAL group and without instruction for the control group. The final block (Block 5) served as the Transfer test, at which time throwing distance was increased. During Blocks 2 to 4, the OPTIMAL group was given the choice between softballs (AS), a liberal definition of successful throwing performance (EE), and instructed to focus on the bullseye (EF). Self-efficacy beliefs were assessed after applying the factors and before all blocks. There were no significant differences between the groups in throwing accuracy or self-efficacy scores across all blocks. The results suggest that the OPTIMAL theory does not augment skilled throwing performance or alter self-efficacy in elite softball throwing, potentially attributed to a natural adoption of EF and previously high self-efficacy.

**KEY WORDS:** Autonomy, external focus, enhanced expectancies, self-efficacy, motivation, attentional focus

### INTRODUCTION

The OPTIMAL theory of motor learning (34) identifies three key motivational and attentional factors for optimizing motor learning and performance: autonomy support (AS), enhanced expectancies (EE), and external focus (EF) of attention. Historically, research has focused on the effects of each individual factor, with prior experiments demonstrating that a single OPTIMAL factor facilitates motor skill acquisition and performance improvements in both novices (5, 13, 40) and skilled athletes (4, 12, 15, 17, 31, 37).

More recently, a series of investigations combined two of the OPTIMAL factors and found results suggesting additive beneficial effects in learning to throw with the non-dominant arm (26, 32, 33). In those studies, factor implementation included participant attentional focus to the throwing target (EF) (26, 33), providing participants bogus social-comparative feedback (EE) (26, 32), and allowing participants to choose certain blocks to use their dominant arm to throw (33) or choice of ball color (AS) (32). While research demonstrates that one or two OPTIMAL factors facilitate learning in novices and skilled athletes, few studies have tested the OPTIMAL theory as presently constructed by Wulf and Lewthwaite (2016) (34) with all three factors in combination (2, 6, 7, 29, 35). Only two studies focused on overhand throwing. Specifically, Amoozezaie et al. (2019) (2) and Wulf et al. (2018) (35) demonstrated that novice throwing performance of darts and beach tennis balls, respectively, was greater under all three manipulations compared to two. These studies focused on the motor skills of novices, indicating that the three factors of the OPTIMAL theory serve to augment learning and performance.

Self-efficacy is an individual's confidence to perform a specific task (3). The OPTIMAL theory is believed to enhance a performer's self-efficacy by utilizing the factors in isolation or in combination. This increase in self-efficacy is potentially attributed to dopamine release (34). Self-efficacy results from past experiences (3) and therefore, self-efficacy may predict motor performance (28). This is supported through recent research demonstrating a predictive association between self-efficacy and performance during an overhand throwing task in novices (26, 32, 33). These studies suggest that influencing performers through factor implementation also enhances self-efficacy and subsequently improves performance.

The OPTIMAL theory has been well studied in novice level performers and generally demonstrates positive motor performance with the aforementioned motivational and attentional focus factors. However, it is yet to be fully elucidated whether similar factor implementations can augment elite level athletic performance during similar motor tasks. Therefore, the primary aim of the present study was to determine whether the successive addition of the OPTIMAL factors during a throwing task could additively improve accuracy in elite performers. Participants were divided into two groups: the OPTIMAL group, that incorporated all three OPTIMAL factors, and a control group. We hypothesized that compared to the control group, the OPTIMAL group would exhibit significant improvements after each factor was added. The secondary aim of the current investigation was to determine whether self-efficacy would be enhanced through OPTIMAL factor implementation. We therefore also hypothesized that the OPTIMAL group would report higher self-efficacy than the controls as a result of the factor implementation.

## **METHODS**

### *Participants*

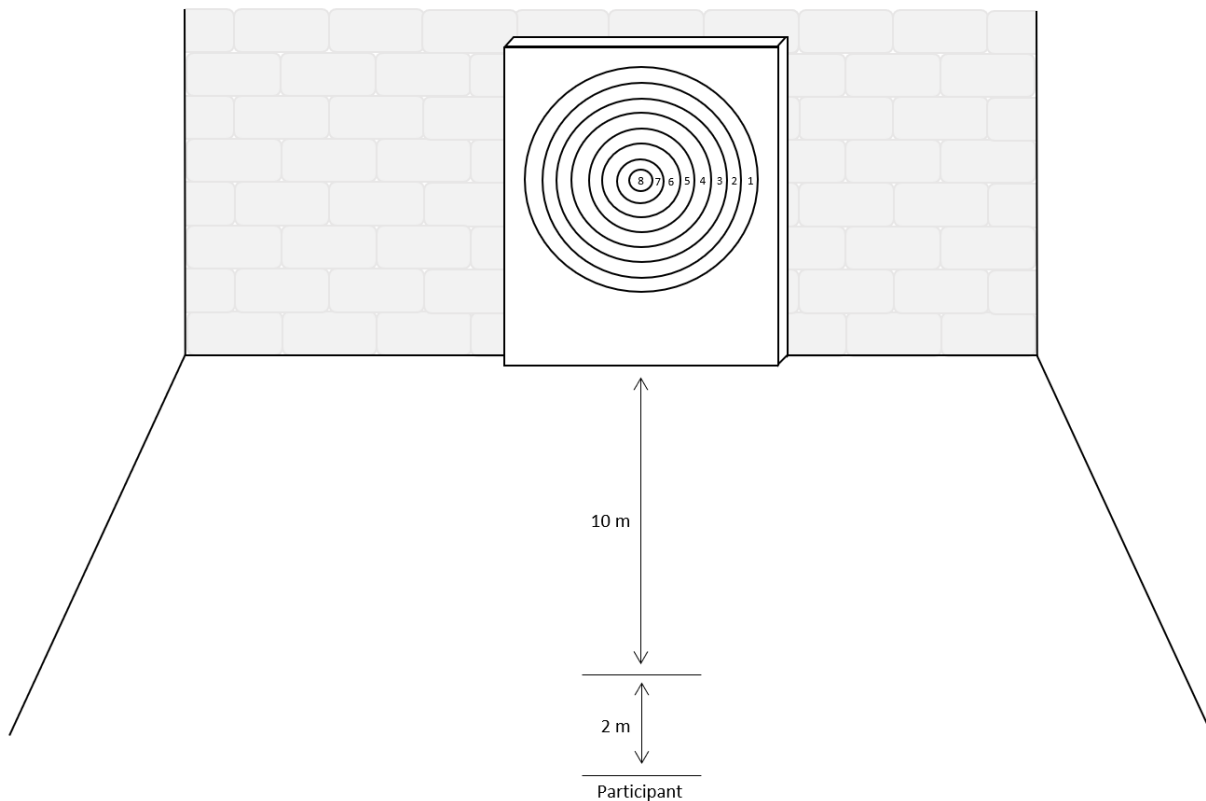
Participants were recruited on the basis that they had at least ten years of competitive softball experience and play(ed) collegiate softball. Athletes were excluded if they experienced the yips, which is a form of performance inhibition (25). Assuming an effect size of 0.7, an alpha level set at 0.05, and a power value of 90% (6), a G\*Power analysis estimated a sample size of 24

participants (G\*Power 3.1.9.4 Universität Düsseldorf) (8, 9). Twenty-four healthy, female softball players with a mean age of 21.36 years ( $SD = 1.58$ ) and a mean softball experience of 14.44 years ( $SD = 2.75$ ) were recruited to participate in this study. At the time of data collection, all but two participants were either retired or current Division I softball athletes; the other two participants were former Division II softball athletes. All participants were naïve to the specific purpose of the experiment and all provided written informed consent before study participation, which was approved by the University of Nevada, Las Vegas Institutional Review Board and in accordance with the ethical standards of the Helsinki Declaration. This research was carried out fully in accordance to the ethical standards of the International Journal of Exercise Science (23).

### *Protocol*

The experimental methodology of the present study closely resembled previous investigations (2, 26, 32, 33, 35). In contrast, it was believed that the 7.5 m used previously (26, 32, 33, 35) was not challenging enough for the present cohort of elite softball athletes. Instead, participants threw standard NCAA softballs towards a bullseye located 10 meters (Blocks 1 to 4) or 12 meters (Block 5) away using an overhand throw with the dominant arm (Figure 1). These distances were chosen to be inclusive of all softball positions on the field. Anecdotally, during a practice or game, softball players throw anywhere from 3 m to 75 m, with most throws occurring within the range of 5 m and 15 m. The bullseye target and scoring methods to assess throwing performance emulated previous studies (2, 26, 32, 33, 35). The bullseye was composed of 8 concentric rings and spaced 10 cm apart. The center of the bullseye was 1.26 m above the ground, which is approximately where the player would throw the ball during a practice or game. In order to accurately score the throws, the bullseye was videotaped in slow-motion with a video camera and scores were recorded afterwards by the experimenter. Throws were scored based on where they hit the bullseye target. Each ring was assigned a number and the corresponding number was the given score. Hitting the center of the bullseye resulted in a score of 8, hitting the 7-ring resulted in a score of 7, and so on. Completely missing the bullseye resulted in a score of 0. If the softball hit the line separating two rings, the score awarded was the ring hosting most of the softball.

Self-efficacy was assessed by questionnaire before each block. As OPTIMAL group participants prepared to throw Blocks 2 to 4, they were first instructed of the factor, next given the self-efficacy questionnaire, and then performed the throwing task. When there was no factor application (i.e. for the Baseline test, the Transfer test, and all blocks for the control group), participants reported their self-efficacy immediately before the throwing task. The questionnaire asked participants to report confidence in their ability to achieve an average score of at least 3, 4, 5 or 6 on the upcoming block. Participants responded on a 10-point scale with anchors 1 (not confident at all) and 10 (extremely confident) (26).



**Figure 1.** Experimental set-up. The video camera was placed on the ground, in front and to the right side of the bullseye target. During pilot testing, this placement of the camera was found to be of optimal placement to (1) capture the softballs hitting the target and (2) to not be hit by the rebounding softballs.

Participants performed a self-selected warm-up of the throwing arm and lower limbs, followed by overhand throws with the experimenter until the participant felt comfortable to begin the test session. Baseline throwing scores allowed the investigator to quasi-randomly assign participants to one of two groups: the OPTIMAL group and the control group. The first twelve participants were assigned to groups randomly and the remaining twelve participants were assigned to groups according to their Baseline scores in order to ensure no group difference in throwing scores at Baseline.

Participants performed five blocks of twelve throwing trials with three minutes rest between blocks. Each throw to the wall represented one trial. Before every block, participants filled out a questionnaire evaluating their self-efficacy towards the upcoming block and were told the task goal: to be as accurate as possible. Block 1 served as the Baseline test; the optimal factors were individually introduced before Blocks 2-4; Block 5 served as the Transfer test. Participants were allotted one unscored warm-up throw to the target before each block. No instructions other than the task goal were provided during the Transfer test.

In the OPTIMAL group, AS, EE, and EF were assigned in a counterbalanced fashion (6). The order of AS, EE, and EF conditions was different across participants to control for possible order effects (6). Therefore, there were six possible combinations of factor implementation. AS was

introduced by allowing participants to choose between two nearly identical softballs. Participants were told that one was new and the other had been used in competition. Although they were the same brand, the perception to the participant was that one softball looked new and one had been scuffed and made to look like it had been used in competition. EE was introduced by informing participants that hitting the 4 or better on the bullseye is considered good (24, 40). Participants in the OPTIMAL group were instructed to focus on the bullseye (EF). During each block, AS, EE, and EF were implemented every three trials in the OPTIMAL group (1, 33), whereas the control group received no further feedback (6, 29). Although the control group completed all five blocks without further instruction, they, along with the OPTIMAL group, received veridical feedback from the task itself.

### *Statistical Analysis*

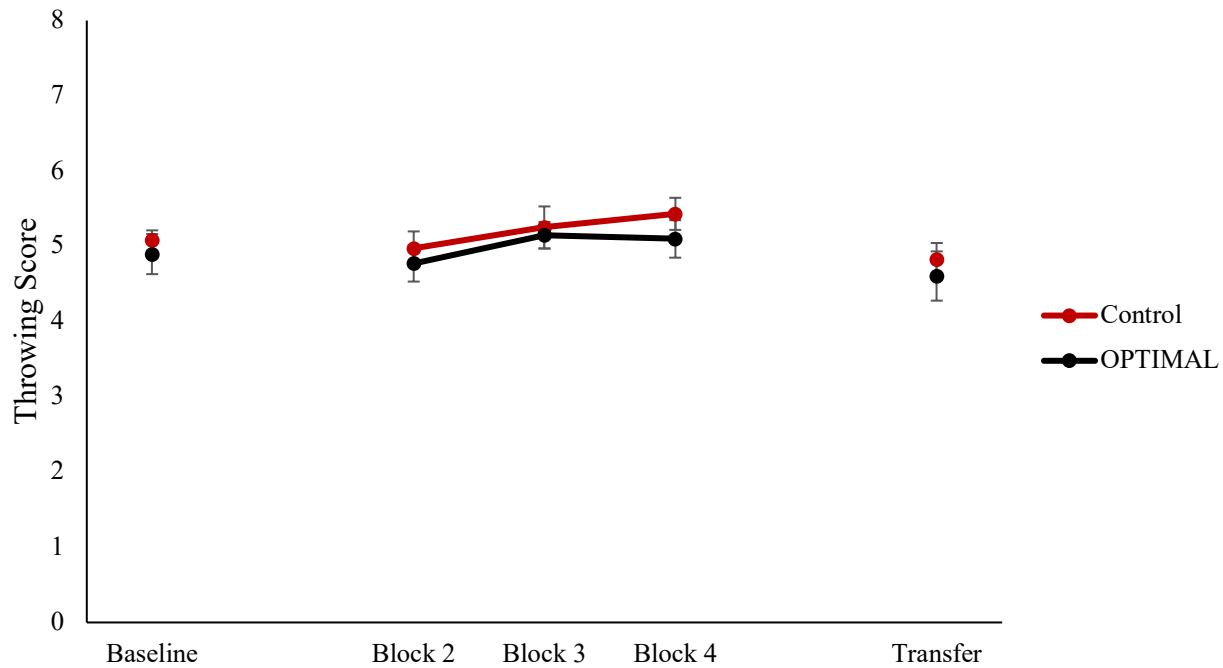
The throwing accuracy scores were averaged across all 12 trials in each block. The Baseline data were analyzed with a univariate analysis of variance (ANOVA). Blocks 2-4 were analyzed in a 2 (group: OPTIMAL, control)  $\times$  3 (block) repeated-measures ANOVA. The Transfer test data were analyzed with a univariate ANOVA. The self-efficacy ratings were averaged across the 4 questions and analyzed in a univariate ANOVA for the Baseline test, a 2 (group)  $\times$  3 (block) repeated-measures ANOVA for Blocks 2-4, and a univariate ANOVA for the Transfer test. Follow up pairwise comparisons were performed to locate specific differences in significant interactions and main effects. Effect sizes are reported as partial eta squared and statistical significance was accepted at 0.05. Statistical analyses were conducted using IBM SPSS Statistics for Windows, Version 26.0.

## **RESULTS**

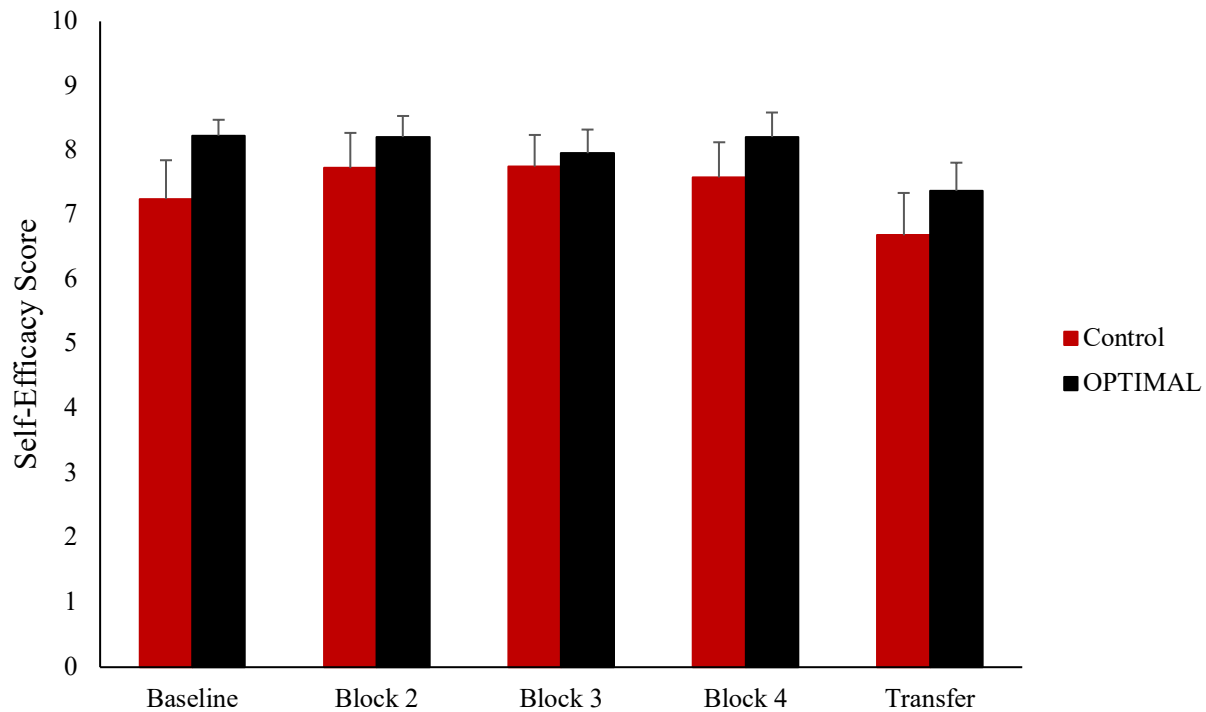
At Baseline, throwing scores did not significantly differ between groups ( $p = 0.551$ ). During Blocks 2 to 4, there was no significant Group  $\times$  Block interaction in throwing scores ( $p = 0.798$ ), as well as no significant main effect of Group ( $p = 0.428$ ,  $\eta_p^2 = 0.029$ ) or Block ( $p = 0.058$ ,  $\eta_p^2 = 0.121$ ). The Transfer test was conducted from 12 m. There were no significant differences in throwing scores between groups ( $p = 0.557$ ). Throwing accuracy across blocks is shown in Figure 2.

In addition, the OPTIMAL and Control group were successful in scoring a 4 or better on their trials. The OPTIMAL group scored a 4 or better 77.5% of their throws while the Control group achieved this 79.2% of the time.

Reported self-efficacy was not significantly different between groups at Baseline ( $p = 0.145$ , see Figure 3). In Blocks 2 to 4, there was no significant interaction of Group  $\times$  Block ( $p = 0.488$ ) as well as no main effect of Group ( $p = 0.472$ ,  $\eta_p^2 = 0.024$ ) or Block ( $p = 0.747$ ,  $\eta_p^2 = 0.008$ ). Control and OPTIMAL groups showed no difference in self-efficacy scores at the Transfer test ( $p = 0.392$ ).



**Figure 2.** Mean throwing scores of OPTIMAL and control groups across Baseline, Blocks 2 to 4, and the Transfer test. Error bars represent standard error.



**Figure 3.** Reported mean self-efficacy scores of the OPTIMAL and control groups across Baseline, Blocks 2 to 4, and the Transfer test. Error bars represent the standard error.

## DISCUSSION

Most prior literature has assessed the efficacy of a single OPTIMAL factor, with researchers generally finding that individually implementing AS, EE, or EF to improve task performance. Recent studies found that combining two or more of the OPTIMAL factors improves performance in children (1), novices (2, 7, 18, 26, 32, 33, 35), moderately skilled athletes (16), and during maximal force exertion (6, 28). The present study was the first study, to our knowledge, to assess whether the successive addition of the OPTIMAL factors improves performance in a sample of skilled athletes, and the second, to our knowledge, to consecutively add all three factors across blocks (6). The results are twofold: there were no throwing performance benefits or change in self-efficacy in this sample of elite softball athletes. Both the OPTIMAL and control groups produced similar throwing scores (Figure 2), achieved a score of 4 or more on the bullseye target on 78.6% of the trials, and reported similar self-efficacy scores (Figure 3) during the Baseline test, across Blocks 2 to 4, and during the Transfer test.

Learning a novel throwing task has been demonstrated to be augmented by a single OPTIMAL factor (14, 19, 21, 22, 38) as well as under a combination of motivational and attentional focus factors (2, 26, 32, 33, 35). Previous studies combining two OPTIMAL factors have demonstrated similar throwing results in the retention and transfer tests: the group provided both factors showed the highest accuracy, the groups provided one factor produced intermediate scores, and the control group with no factors scored lowest (26, 32, 33). When provided all three OPTIMAL factors, throwing accuracy was higher than when given two factors (2, 35). These results collectively suggest that learning a novel task, such as throwing with the non-dominant arm, is facilitated with each addition of an OPTIMAL factor.

The present study did not align with these previous studies' findings and we suggest skill level as the primary reason for differential results. The present study measured throwing accuracy of softball players with an average of 14.44 years of softball experience and demonstrated that successively applying AS, EE, and EF did not acutely influence throwing performance in this cohort. We identify possible reasons for these results. The EE manipulation informed participants that scoring a 4 or better is considered good, however participants (in both groups) scored a 4 or better on more than three-quarters of the trials. It is possible that the task was relatively simple for these high-level throwing athletes. The challenge point framework, originally proposed by Guadagnoli & Lee (2004), suggests that the nominal task difficulty predicts performance based on an individual's skill level: the same throwing task is likely to be much more challenging for a novice than for the skilled athlete (11). Still, it is possible to improve at simple tasks and we would anticipate the OPTIMAL group to demonstrate performance benefits from OPTIMAL factor implementation. An additional consideration is the possibility that the control group was focusing externally as a function of the throwing task goal: throwing accurately to the target. While the research generally supports an EF over IF, it is speculated that when not given specific attentional focus cues, performers naturally adopt an EF. This is supported through research demonstrating that control conditions produce similar performance results as EF conditions, such as when performing a muscular endurance test (20). Moreover, body-movements and ball-flight kinematics of novice jugglers under the no attentional-guided



instructions performed similarly to the group instructed to focus externally on the juggled balls (39). Furthermore, in the study by Wulf, Shea, & Park (2001), 70.6% and 80% of participants preferred to focus externally (on the markers) rather than internally (on their feet) as they balanced on a stabilometer (36). These results suggest that the natural adoption of focus creates fluid movements similar to an instructed external attentional focus. There is an exception to this as elite track athletes tended to focus internally during a running task (27). However, running and throwing accurately to a target are different tasks that may encourage different focuses of attention. Therefore, in the context of a softball throwing task, an EF may predominate.

Although the present study observed no performance improvements in skilled softball players, other studies have shown improvements in skilled athletes with OPTIMAL factor instruction (4, 12, 15, 17, 37). However, unlike the present investigation, previous studies of elite performers have not reported self-efficacy scores during OPTIMAL factor implementation. In previous research, it is possible that if self-efficacy were initially lower at Baseline then subsequent factor implementation served to raise self-efficacy across blocks, providing additional motivational benefits and thus augmenting improvements in performance (30).

In previous throwing experiments with novice performers, increased self-efficacy partially mediated throwing performance improvements: the self-efficacy scores at the end of the practice phase predicted throwing performance in retention and transfer tests (26, 32, 33). The increased confidence in participants' abilities to perform acted to relieve motor constraints and allowed participants to produce movements with greater automaticity than those with lower self-efficacy (26). In contrast, our elite cohort demonstrated high confidence levels regardless of factor implementation (Figure 3). The high level of self-efficacy in these athletes may exist from previous successes in their softball careers (3, 10) and suggests that there was no additional motivation to augment athlete throwing scores.

The present study is not without limitations. We recognize that while this study has a small sample size, our study was restricted to elite softball players, a relatively understudied population within the motor learning literature. We also acknowledge that previous motor learning studies have utilized similar or smaller sample sizes and achieved significant results in accuracy-specific tasks (4, 37). Golfers were found to be significantly more accurate under an individual OPTIMAL factor (EF) in groups of 11 (4) and 6 (37). Additionally, although our effect sizes are small, they are similar to and larger than studies that have demonstrated statistical significance in throwing performance (32, 33). Lastly, the results of this study may not be generalizable to novice throwing performers or elite performers in sports other than softball.

The present results suggest that successively applying OPTIMAL factors to skilled throwers does not improve throwing accuracy or alter self-efficacy. It is possible that these combined factors are more effective at improving performance in tasks with more capacity for improvement, such as during a novel throwing task (2, 35). Elite-level athletes spend years developing their skills and may not easily improve from simple manipulations. Although it is possible that skilled performers can benefit from OPTIMAL factors, the present results demonstrate a skill and level of expertise unaffected by the OPTIMAL theory.

## REFERENCES

1. Abdollahipour R, Nieto MP, Psotta R, Wulf G. External focus of attention and autonomy support have additive benefits for motor performance in children. *Psychol Sport Exerc*, 32: 17-24, 2017.
2. Amoorezaie P, Arabamerib E, Boroujenic ST. Contributions of external attentional focus, enhanced expectancies and autonomy support to enhance learning skills of throwing darts. *Int J Mot Contr Learn*, 2(2): 42-53, 2019.
3. Bandura A. Self-efficacy: Toward a unifying theory of behavioural change. *Psychol Rev*, 84(2): 191-215, 1977.
4. Bell JJ, Hardy J. Effects of attentional focus on skilled performance in golf. *J Sport Exerc Psychol* 21(2): 163-177, 2009.
5. Bodasińska, A, Zieliński, J, Makaruk, H. Influence of attentional instructions on football juggling performance in children. *J Phys Educ Sport* 19(3): 1560-1564, 2019.
6. Chua L-K, Wulf G, Lewthwaite R. Onward and upward: Optimizing motor performance. *Hum Mov Sci* 60: 107-114, 2018.
7. Chua L-K, Wulf G, Lewthwaite R. Choose your words wisely: Optimizing impacts on standardized performance testing. *Gait Posture* 79: 210-216, 2020.
8. Faul F, Erdfelder E, Lang A-G, Buchner A. G\*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behav Res Methods* 39: 175-191, 2007
9. Faul F, Erdfelder E, Buchner A, Lang A-G. Statistical power analyses using G\*Power 3.1: Tests for correlation and regression analyses. *Behav Res Methods* 41, 1149-1160, 2009
10. Gernigon C, Delloye J-B. Self-efficacy, casual attribution, and track athletic performance following unexpected success or failure among elite sprinters. *Sport Psychol* 17: 55-76, 2003.
11. Guadagnoli MA, Lee TD. Challenge point: A framework for conceptualizing the effects of various practice conditions in motor learning. *J Mot Behav* 36(2): 212-224, 2004.
12. Halperin I, Chapman DW, Martin DT, Lewthwaite R, Wulf G. Choices enhance punching performance of competitive kickboxers. *Psychol Res* 81: 1051-1058, 2017.
13. Hartman JM. Self-controlled use of a perceived physical assistance device during a balancing task. *Percept Mot Skills* 104: 1005-1016, 2007.
14. Hooyman A, Wulf G, Lewthwaite R. Impacts of autonomy-supportive versus controlling instructional language on motor learning. *Hum Mov Sci* 36: 190-198, 2014.
15. Hosseiny SH, Ghasemi A, Shakeri N. Comparing the effects of internal, external and prefer focus of attention on the elite shooters' performance. *Adv Environ Biol* 8(5): 1245-1250, 2014.
16. Makaruk H, Porter JM, Bodasińska A, Palmer S. Optimizing the penalty kick under external focus of attention and autonomy support instructions. *Eur J Sport Sci*: 1-9, 2020.
17. Makaruk H, Porter, JM, Makaruk B. Acute effects of attentional focus on shot put performance in elite athletes. *Kinesiology* 45(1): 55-62, 2013.

18. Marchant DC, Carnegie E, Wood G, Ellison P. Influence of visual illusion and attentional focusing instruction in motor performance. *J Sport Exerc Psychol* 17(6): 659-669, 2019.
19. Marchant DC, Clough PJ, Crawshaw M. The effects of attentional focusing strategies on novice dart throwing performance and their task experiences. *Int J Sport Exerc Psychol* 5(3): 291-303, 2007.
20. Marchant DC, Greig M, Bullough J, Hitchen D. Instructions to adopt an external focus enhance muscular endurance. *Res Q Exerc Sport* 82(3): 466-473, 2011.
21. McKay B, Lewthwaite R, Wulf G. Enhanced expectancies improve performance under pressure. *Front Psychol* 3(8): 1-5, 2012.
22. McKay B, Wulf G. A distal external focus enhances novice dart throwing performance. *Int J Sport Exerc Psychol* 10(2): 149-156, 2012.
23. Navalta JW, Stone WJ, Lyons TS. Ethical Issues Relating to Scientific Discovery in Exercise Science. *Int J Exerc Sci* 12(1): 1-8, 2019
24. Palmar K, Chiviacowsky S, Wulf G. Enhanced expectancies facilitate golf putting. *Psychol of Sport and Exerc* 22: 229-232, 2016
25. Papineau D. Choking and the yips. *Phenom Cogn Sci* 14: 295-308, 2015
26. Pascua LAM, Wulf G, Lewthwaite R. Additive benefits of external focus and enhanced performance expectancy for motor learning. *J Sports Sci* 33(1): 58-66, 2015.
27. Porter J, Wu W, Partridge J. Focus of attention and verbal instructions: Strategies of elite track and field coaches and athletes. *Sport Sci Rev* 19(3-4): 77-89, 2010
28. Rosenqvist O, Skans OD. Confidence enhanced performance? – The causal effects of success on future performance in professional golf tournaments. *J Econ Behav Organ* 117: 281-295, 2015.
29. Singh H, Hockwald A, Drake N, Avedesian J, Lee S-P, Wulf G. Maximal force production requires OPTIMAL conditions. *Hum Mov Sci* 73: 2020.
30. Sklett VH, Lorås HW, Sigmundsson H. Self-efficacy, flow, affect, worry and performance in elite world cup ski jumping. *Front Psychol* 9: 1215, 2018.
31. Stoate I, Wulf G, Lewthwaite R. Enhanced expectancies improve movement efficiency in runners. *J Sports Sci* 30(8): 815-823, 2012.
32. Wulf G, Chiviacowsky S, Cardozo PL. Additive benefits of autonomy support and enhanced expectancies for motor learning. *Hum Mov Sci* 37: 12-20, 2014.
33. Wulf G, Chiviacowsky S, Drews R. External focus and autonomy support: Two important factors in motor learning have additive benefits. *Hum Mov Sci* 40: 176-184, 2015.
34. Wulf G, Lewthwaite R. Optimizing performance through intrinsic motivation and attention for learning: The OPTIMAL theory of motor learning. *Psychon Bull Rev* 23: 1382-1414, 2016.

35. Wulf G, Lewthwaite R, Cardozo P, Chiviawowsky S. Triple play: Additive contributions of enhanced expectancies, autonomy support, and external attentional focus to motor learning. *Q J Exp Psychol (Hove)* 71(4): 824-831, 2018.
36. Wulf G, Shea C, Park J-H. Attention and motor performance: Preferences for and advantages of an external focus. *Res Q Exerc Sport* 72(4): 335-344, 2001.
37. Wulf G, Su J. An external focus of attention enhances golf shot accuracy in beginners and experts. *Res Q Exerc Sport* 78(4): 384-389, 2007.
38. Zarghami M, Saemi E, Fathi I. External focus of attention enhances discus throwing performance. *Kinesiology*, 44(1): 47-51, 2012.
39. Zentgraf K, Munzert J. Effects of attentional-focus instructions on movement kinematics. *Psychol Sport Exerc* 10: 520-525, 2009.
40. Ziv G, Ochayon M, Lidor R. Enhanced or diminished expectancies in golf putting - Which actually affects performance? *Psychol Sport Exerc* 40: 82-86, 2019.

