Self and Relative Effects of Competitive State Anxiety on Perceived Performance in Middle and High School Taekwondo Athletes: An Actor and Partner Interdependence Model Analysis

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Abstract

Background: The present study aimed to provide an empirical theoretical basis for the psychological phenomena that occur among competing athletes. To this end, we utilized the actor and partner interdependence model (APIM) to analyze the self- and relative effects of competitive state anxiety on perceived performance in middle and high school Taekwondo athletes.

Methods: Data were analyzed for 372 middle and high school athletes (red group=186, blue group=186) who participated in the first round of the 2020 Korea Taekwondo Association National Taekwondo Competition. Analysis based on the APIM was applied to the collected data, and a path analysis was conducted to verify the self- and relative effects of competitive state anxiety on perceived performance.

Results: Cognitive (red: P<0.01, blue: P<0.001) and physical state anxiety (red: P<0.01, blue: P<0.01) exerted a significant negative self-effect on perceived performance in both groups. In contrast, state confidence (red: P<0.001, blue: P<0.001) exerted a significant positive self-effect on perceived performance. Furthermore, cognitive (red: P<0.001, blue: P<0.01) and physical state anxiety (red: P<0.001, blue: P<0.001) exerted a significant positive relative effect on the opponent’s perceived performance in both groups, while state confidence (red: P<0.01, blue: P<0.001) exerted a significant negative relative effect on the opponent’s perceived performance.

Conclusion: Sports psychologists should focus on developing a psychological training program that provides practical psychological support as well as self-regulatory and relative strategies for improving athletic performance in competitive scenarios.

Keywords: Anxiety; Work performance; Relative biological effectiveness; Athletes

Introduction

In most sporting events, victory or loss is determined based on competition, making it important to exhibit superior performance compared to one’s opponent. Athletic performance is influenced by complex interactions among physical

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strength, skill, and psychological factors (1). Recently, scientists have elucidated key physical and technical factors associated with athletic performance, leading to rapid advancements in skill among competitive athletes. However, because there is a limit to enhancing athletic performance based on improvements in physical strength and technique alone, attention has shifted to the importance of psychological factors (2-3).

Anxiety is an essential psychological factor that exerts an important influence on player performance (4). During sporting events, athletes may experience competitive state anxiety, in which the competitive situation is perceived as threatening, leading to conscious reactions such as tension and concern. Competitive state anxiety is divided into three dimensions: cognitive state anxiety, physical state anxiety, and state confidence (5-6).

Previous studies have indicated that competitive state anxiety arising from sporting events is a major factor impeding performance (7-9). Specifically, cognitive and physical state anxiety is known to exert a negative effect on performance in the context of competitive sports, while state confidence is known to exert a positive effect (4,10-12). In addition, excessive anxiety interferes with the athlete's attention and concentration, causes physical tension, and induces fatigue and lethargy (13). Given that their skills require further development, anxiety can exert a profound effect on performance among elementary, intermediate, middle, and high school players. These athletes may be unable to demonstrate their usual level of performance and make uncharacteristic mistakes when they are too tense or hurried in an actual game situation (14).

Contrarily, it is necessary to pay attention to the psychological states of the opponent when playing sports in which victory or loss is determined based on direct interactions with a competitor. During an athletic event or game, players witness actions such as delays in game time, trash talk, time-outs at critical points, and player substitutions (15-17). These actions are part of a strategy to increase the chances of victory by decreasing the opponent's confidence, impairing concentration, and amplifying anxiety, highlighting the role of the opponent's psychology in their performance. However, sports psychology focuses only on the self-effects of players' individual inner psychology (motivation, anxiety, confidence, concentration, psychological coping, psychological skills, etc.) on performance (18). Although some studies have analyzed relative effects in doubles' sports (19) such as badminton, tennis, and table tennis (20-22), these are limited in that they have only investigated psychological effects in interdependent relationships, rather than those in opponent/rival relationships.

Therefore, additional scientific evidence is required to verify the psychological counterpart effect that occurs between players competing in a one-to-one pair (dyad), as in a Taekwondo game. In this paired data format, the actor and partner interdependence model (APIM) can be applied to analyze simultaneously self- and relative effects. To provide an empirical theoretical basis that can explain the psychological phenomena that occur among competing athletes, we aimed to verify the self- and relative effects of competitive state anxiety on perceived performance in middle and high school Taekwondo athletes by applying APIM analysis.

**Methods**

**Participants**

We collected data from 396 middle and high school athletes (red group=198, blue group n=198) who participated in the national Taekwondo competition held by the Korea Taekwondo Association in 2020. Prior to the event date, after explaining the purpose of the study to the association and leaders in detail and seeking cooperation, 10 researchers and research assistants visited the site and collected data using a questionnaire. The players encountered in the first game of the tournament were classified into pairs, and data were collected by classifying them according to the color (blue, red) of the hogu (body protection in Taekwondo game) worn in the first game. Data from 372 participants (red group=186, blue group n=186) were used for the analysis, after excluding the data of 24 participants (12 pairs).
who were judged to have omitted or duplicated entries or answered unscrupulously. Table 1 presents the general characteristics of the participants.

All study participants provided informed consent, and the study design was approved by Gachon University in Korea.

Table 1: General characteristics of participants

| Characteristics | N   | %   |
|-----------------|-----|-----|
| Gender          |     |     |
| Male            | 244 | 65.6|
| Female          | 128 | 34.4|
| School level    |     |     |
| Middle school   | 174 | 46.8|
| High school     | 198 | 53.2|
| Grade           |     |     |
| 1st             | 134 | 36.0|
| 2nd             | 138 | 37.1|
| 3rd             | 100 | 26.9|
| Years of career |     |     |
| Less than 2 years | 46  | 12.4|
| 3–4 years       | 172 | 46.2|
| 5 years or more | 154 | 41.4|
| Total           | 372 | 100%|

**Instruments**

A modified version of the Competitive State Anxiety Inventory-2 (CSAI-2), developed by Martens et al (6), was used to assess competitive anxiety. The competitive anxiety questionnaire was composed of 27 questions, including nine questions related to cognitive state anxiety, physical state anxiety, and state confidence each. Participants responded to each question using a 5-point Likert scale (absolutely agree=5 points, absolutely disagree=1).

A questionnaire developed by Mamassis and Doganis (23) was used to measure perceived athletic performance. The perceived performance scale was composed of a single factor, which consisted of eight questions designed to obtain information regarding a player’s thoughts on their performance during the game. Responses to each question were scored on a Likert scale ranging from not good (1 point) to very good (5 points).

**Evaluation of the measurement model**

Prior to analyzing our results, we conducted a confirmatory factor analysis using the maximum likelihood method to verify the validity and reliability of the overall measurement model consisting of four sub-factors and 35 items. The goodness-of-fit index of the whole measurement model was found to be relatively suitable, given the following data: \(X^2=1,447.774\), \(df=554\), \(P<0.001\); Turker–Lewis index (TLI)=0.915; comparative fit index (CFI)=0.921; root mean square error of approximation (RMSEA)=0.066. The factor load of the item explaining each latent variable was 0.577–0.876. In addition, as shown in Table 2, the concept reliability of each sub-factor was 0.700 or higher, the average variance extracted (AVE) was 0.500 or higher, and Cronbach’s \(\alpha\) was 0.700 or higher. Therefore, the validity and reliability of the measurement tools used in this study were verified.
Table 2: Evaluation of the measurement model

| Variables | Classification | Items | Standard regression weight | Critical ratio (t) | Construct reliability | Average variance extracted | Cronbach α |
|-----------|----------------|-------|-----------------------------|-------------------|----------------------|---------------------------|------------|
| Competitive state anxiety | Cognitive anxiety | 1     | 0.577                       | 11.677***         | 0.913                | 0.539                     | 0.912      |
|          |                 | 4     | 0.758                       | 16.240***         |                      |                           |            |
|          |                 | 7     | 0.735                       | 15.623***         |                      |                           |            |
|          |                 | 10    | 0.697                       | 14.617***         |                      |                           |            |
|          |                 | 13    | 0.816                       | 17.915***         |                      |                           |            |
|          |                 | 16    | 0.764                       | 16.817***         |                      |                           |            |
|          |                 | 19    | 0.689                       | 14.404***         |                      |                           |            |
|          |                 | 22    | 0.749                       | 16.013***         |                      |                           |            |
|          |                 | 25    | 0.791                       | -                 |                      |                           |            |
| State anxiety |                | 2     | 0.768                       | 17.778***         | 0.922                | 0.569                     | 0.932      |
|          |                 | 5     | 0.738                       | 16.783***         |                      |                           |            |
|          |                 | 8     | 0.763                       | 17.614***         |                      |                           |            |
|          |                 | 11    | 0.817                       | 19.595***         |                      |                           |            |
|          |                 | 14    | 0.581                       | 12.188***         |                      |                           |            |
|          |                 | 17    | 0.845                       | 20.733***         |                      |                           |            |
|          |                 | 20    | 0.867                       | 21.678***         |                      |                           |            |
|          |                 | 23    | 0.767                       | 17.757***         |                      |                           |            |
|          |                 | 26    | 0.841                       | -                 |                      |                           |            |
| Confidence |                | 3     | 0.853                       | 21.836***         | 0.935                | 0.616                     | 0.949      |
|          |                 | 6     | 0.820                       | 20.340***         |                      |                           |            |
|          |                 | 9     | 0.859                       | 22.128***         |                      |                           |            |
|          |                 | 12    | 0.856                       | 21.983***         |                      |                           |            |
|          |                 | 15    | 0.589                       | 13.042***         |                      |                           |            |
|          |                 | 18    | 0.846                       | 21.531***         |                      |                           |            |
|          |                 | 21    | 0.876                       | 22.955***         |                      |                           |            |
|          |                 | 24    | 0.834                       | 20.996***         |                      |                           |            |
|          |                 | 27    | 0.855                       | -                 |                      |                           |            |
| Perceived performance |                | 1     | 0.827                       | 14.218***         | 0.946                | 0.689                     | 0.933      |
|          |                 | 2     | 0.823                       | 14.158***         |                      |                           |            |
|          |                 | 3     | 0.803                       | 13.882***         |                      |                           |            |
|          |                 | 4     | 0.872                       | 14.869***         |                      |                           |            |
|          |                 | 5     | 0.831                       | 14.290***         |                      |                           |            |
|          |                 | 6     | 0.863                       | 14.738***         |                      |                           |            |
|          |                 | 7     | 0.661                       | 14.778***         |                      |                           |            |
|          |                 | 8     | 0.671                       | -                 |                      |                           |            |

***P<0.001; tested via confirmatory factor analysis

Statistical analysis
The collected data were analyzed using SPSS 25.0 and AMOS 25.0 (IBM Corp., Armonk, NY, USA). Frequency analysis was performed to determine the general characteristics of the participants, and confirmatory factor analysis was performed to verify the validity and reliability of the collected data. Conceptual reliability, AVE, and Cronbach’s α values were also calculated. Descriptive statistics were used to verify normality through a review of the mean and standard deviation of sub-factors, skewness, and kurtosis. In addition, Pearson correlation analysis was performed to determine the relationships between sub-dimensions. Finally, the
APIIM was applied for path analysis using synthetic scores to verify the self- and partner effects of competitive state anxiety on perceived performance. The significance level of the analysis was set to $\alpha=0.05$.

**Results**

**Descriptive statistics and correlation analysis**

Descriptive statistics and correlation analyses were conducted for the seven sub-dimensions of the data. As shown in Table 3, the average score of each sub-factor ranged from 2.62 to 3.99, and the score distribution had no outliers in the standard deviation, skewness ($\leq 2.00$), and kurtosis ($\leq 4.00$). Therefore, the score distribution of the measured variables was considered normal. Correlation analysis revealed that, in both red and blue groups, cognitive anxiety and physical anxiety were negatively (-) correlated with confidence and performance, and that confidence was positively (+) correlated with performance. In addition, cognitive and physical anxiety in the red group was positively (+) correlated with performance in the blue group, while confidence in the red group was negatively (-) correlated with performance in the blue group. Likewise, cognitive anxiety and physical anxiety in the blue group were positively (+) correlated with performance in the red group, while confidence in the blue group was negatively (-) correlated with performance in the red group. As no factors exhibited a correlation of 0.80 or more in these analyses, there was no issue with multicollinearity.

**Table 3: Descriptive statistics and correlation analysis**

| Variable                      | 1    | 2    | 3    | 4    | 5    | 6    | 7    | 8    |
|-------------------------------|------|------|------|------|------|------|------|------|
| Mean                          | 3.16 | 2.90 | 3.22 | 3.99 | 3.08 | 2.62 | 3.24 | 3.91 |
| Standard deviation            | 0.79 | 0.81 | 0.93 | 0.75 | 0.89 | 0.94 | 1.00 | 0.71 |
| Skewness                      | 0.45 | 0.96 | -0.37| -0.05| 0.30 | 1.23 | -0.45| 0.11 |
| Kurtosis                      | 0.83 | 1.67 | 1.26 | -1.13| 0.28 | 1.33 | 0.66 | -0.85|
| Cognitive anxiety (red)       | 1.00 |      |      |      |      |      |      |      |
| Physical anxiety (red)        | 0.78**| 1.00 |      |      |      |      |      |      |
| Confidence (red)              | -0.73**| -0.70**| 1.00 |      |      |      |      |      |
| Performance (red)             | -0.24**| -0.21**| 0.33**| 1.00 |      |      |      |      |
| Cognitive anxiety (blue)      | 0.55**| 0.38**| -0.34**| 0.26**| 1.00 |      |      |      |
| Physical anxiety (blue)       | 0.53**| 0.42**| -0.35**| 0.29**| 0.66**| 1.00 |      |      |
| Confidence (blue)             | -0.38**| -0.26**| 0.25**| -0.25**| -0.73**| -0.69**| 1.00 |      |
| Performance (blue)            | 0.29**| 0.28**| -0.21**| 0.26**| -0.26**| -0.23**| 0.38**| 1.00 |

**Self-effects and relative effects of competitive state anxiety on performance**

We applied the APIIM to verify the self- and relative effects of competitive state anxiety on perceived performance among middle and high school Taekwondo athletes. Path analysis was performed according to each factor using synthetic scores.

**Self- and relative effects of cognitive state anxiety on performance**

Table 4 and Fig. 1 show the self- and relative effects of cognitive state anxiety on perceived performance among middle and high school Taekwondo players. First, we observed significant negative (-) self-effects of cognitive state anxiety on performance in both red (-0.242, $P<0.01$) and blue groups (-0.439, $P<0.001$). Contrarily, we observed significant positive (+) relative effects of
the red group's cognitive state anxiety on the blue group's performance (0.332, \(P<0.001\)), and of the blue group's cognitive state anxiety on the red group's performance (0.160, \(P<0.01\)).

Table 4: Self-effects and relative effects of cognitive state anxiety on performance

| Path                          | RW   | SRW  | SE   | CR      |
|-------------------------------|------|------|------|---------|
| Cognitive state anxiety \(\rightarrow\) performance |       |      |      |         |
| Red group's self-effect       | -0.230 | -0.242 | 0.082 | -2.816** |
| Blue group's self-effect      | -0.348 | -0.439 | 0.064 | -5.394*** |
| Red group's relative effect   | 0.299  | 0.332 | 0.073 | 4.076*** |
| Blue group's relative effect  | 0.160  | 0.191 | 0.072 | 2.227**  |

**\(P<0.01\), ***\(P<0.001\); tested via actor and partner interdependence model, and was applied for path analysis

\(RW\): regression weight, \(SRW\): standard regression weight, \(SE\): standard error, \(CR\): critical ratio

Fig. 1: Effect of cognitive state anxiety on performance. \(e_1, e_2\): measurement error variance

Self- and relative effects of physical state anxiety on performance
Table 5 and Fig. 2 show the self- and relative effects of physical state anxiety on perceived performance among middle and high school Taekwondo players. First, we observed significant negative (\(-\)) self-effects of physical state anxiety on performance in both red (-0.221, \(P<0.01\)) and blue groups (-0.247, \(P<0.01\)). Contrarily, we observed significant positive (+) relative effects of the red group's physical state anxiety on the blue group's performance (0.283, \(P<0.001\)), and of the blue group's physical state anxiety on the red group's performance (0.278, \(P<0.001\)).

Table 5: Self-effects and relative-effects of physical state anxiety on performance

| Path                          | RW   | SRW  | SE   | CR      |
|-------------------------------|------|------|------|---------|
| Physical state anxiety \(\rightarrow\) Performance   |       |      |      |         |
| Red group's self-effect       | -0.205 | -0.221 | 0.072 | -2.856** |
| Blue group's self-effect      | -0.187 | -0.247 | 0.058 | -3.191** |
| Red group's relative effect   | 0.243  | 0.283 | 0.068 | 3.588*** |
| Blue group's relative effect  | 0.226  | 0.278 | 0.062 | 3.651*** |

**\(P<0.01\), ***\(P<0.001\); tested via actor and partner interdependence model, and was applied for path analysis

\(RW\): regression weight, \(SRW\): standard regression weight, \(SE\): standard error, \(CR\): critical ratio

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**Self- and relative effects of confidence on performance**

Table 6 and Fig. 3 show the self- and relative effects of confidence on perceived performance among middle and high school Taekwondo players. On the one hand, we observed a significant positive (+) self-effect of confidence on performance in both red (0.311, P<0.001) and blue groups (0.312, P<0.001). On the other hand, we observed significant negative (-) relative effects of the red group’s confidence on the blue group’s performance (-0.169, P<0.01), and of the blue group’s confidence on the red group’s performance (-0.182, P<0.001).

| Path                              | RW   | SRW  | SE   | CR       |
|----------------------------------|------|------|------|----------|
| Confidence → Performance         |      |      |      |          |
| Red group’s self-effect          | 0.311| -0.221| 0.056| 5.559*** |
| Blue group’s self-effect         | 0.312| -0.247| 0.048| 6.440*** |
| Red group’s relative effect      | -0.169| 0.283| 0.052| -3.243** |
| Blue group’s relative effect     | -0.182| 0.278| 0.052| -3.495***|

**P<0.01, ***P<0.001; tested via actor and partner interdependence model, and was applied for path analysis**

**RW**: regression weight, **SRW**: standard regression weight, **SE**: standard error, **CR**: critical ratio

**Table 6: Self-effects and relative effects of confidence on performance**
Discussion

In this study, we utilized APIM analysis to verify the self- and relative effects of competitive state anxiety on perceived performance in middle and high school Taekwondo players. Our findings indicated that, in both red and blue groups, cognitive and physical state anxiety exerted significant negative self-effects on perceived athletic performance, and state confidence exerted a significant static self-effect on perceived performance. These findings indicate that perceived performance decreases as cognitive state anxiety (e.g., excessive nerves or worry about the game) and physical state anxiety (e.g., physical tension and stiffness, excessive increase in heart rate) increase. In contrast, perceived performance increases as confidence in one’s state of mind and relaxation increase. These results are consistent with those of previous sports psychology studies regarding Taekwondo (7-8, 24), judo (25), golf (10), Kumdo (26), and volleyball (27), which have also reported negative effects of cognitive and physical state anxiety and positive effects of confidence on performance. Therefore, these findings highlight the need to engage actively in self-regulating psychological skills training to attenuate the negative effects of anxiety and enhance the positive effects of confidence in competitive Taekwondo, especially given recent increases in the intensity of competition.

Our APIM analysis also revealed significant positive relative effects of cognitive and physical state anxiety on the opponent’s perceived athletic performance in both red and blue groups. In contrast, state confidence had a significant relative negative effect on perceived performance. This finding indicates that, as cognitive and physical anxiety increased during the competition, the perceived performance of the opponent increased. However, increases in self-confidence were associated with decreases in the perceived performance of the opponent. The findings of the present study support the notion that psychological factors related to the other player can lead to changes in one’s own psychological state and performance during competition (16, 28). In addition, Taylor and Demick (29) argued that, for changes in a player’s own psychological state and performance to result in victory or loss, the opposite changes must be observed in the opponent. This viewpoint is in accordance with the results of the present study.

In fact, players grasp information regarding habits or phenomena that occur when the opponent is anxious or when their confidence is high. Knowledge and manipulation of this information can decrease morale while increasing vigilance, excitement, anger, and distractibility in the opponent. Players often employ psychological strategies to impede the opponent’s performance by stimulating the opponent, distorting information, and making sudden actions (18, 30). Therefore, winning a Taekwondo match requires not only training to control one’s own psychological state, but also developing a psychological strategy that can affect the opponent’s performance without compromising sportsmanship. Applying such strategies to competitive situations will ultimately aid athletes in improving their performance.

This study has some limitations. It did not take cultural differences or different sports into account in that it was conducted exclusively on Korean Taekwondo athletes. There is also a limitation in that the study was conducted using only two variables, anxiety and perceived performance, and causation could not be determined. Therefore, caution is required in interpreting and utilizing research results. Moreover, since the participants were recruited in the 2020 Korea Taekwondo Association National Taekwondo Competition, they may not accurately represent the global population of Taekwondo athletes.

Conclusion

We used APIM analysis to verify the self- and relative effects of competitive state anxiety on perceived performance among middle and high school Taekwondo players. First, cognitive and physical state anxiety exerted significant negative self-effects on perceived performance in both red and blue groups, while state confidence exerted a
significant positive self-effect on perceived performance. Second, cognitive and physical state anxiety exerted significant positive relative effects on the perceived performance of the opponent in both red and blue groups, while state confidence exerted a significant negative relative effect on the opponent’s perceived performance. These findings indicate that psychological training in self-regulatory and relative strategies may help to enhance performance among athletes during real-world competitive situations.

We believe that additional studies are required to investigate the relative effects of competition on performance in various sports other than Taekwondo. Furthermore, such studies should aim to analyze psychological variables other than anxiety, and to develop a psychological training program that can provide practical psychological support, as well as self-regulatory and relative strategies for improving athletic performance in competitive scenarios.

**Ethical considerations**

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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**Conflict of interest**

The authors have no conflicts of interest to declare.

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