Multidimensional Anxiety and Performance: 
An Exploratory Examination of the Zone 
of Optimal Functioning Hypothesis

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The purpose of the present investigation was to empirically examine Hanin's (1980) Zone of Optimal Functioning (ZOF) hypothesis using a multidimensional anxiety approach. Female collegiate softball players (N = 13) had optimal cognitive, somatic, and combined cognitive/somatic anxiety zones created using three different methods (retrospective-best, retrospective-postcompetition, precompetition) over seven different competitions to test the relationship between ZOF and both subjective and objective performance measures. Results revealed no significant differences between the three different methods of determining players' zones of optimal functioning. In addition, no significant differences were found in subjective performance regardless of whether performance was inside or outside players' cognitive, somatic, or cognitive/somatic combined zones. Nonparametric analyses revealed superior objective performance occurred when players were outside their combined somatic/cognitive ZOF. Results are discussed in terms of Hanin's ZOF hypothesis and methodological limitations in examining optimal anxiety states, assessing performance, and the operationalization of the optimal zone of functioning.

Although once the central explanation for the anxiety-performance relationship, in the past 10 years the inverted-U hypothesis has come under increased scrutiny and criticism (e.g., Gould & Krane, 1992; Hardy, 1990; Neiss, 1988; Raglin, 1992; Weinberg, 1990). These criticisms have focused on the lack of theoretical underpinnings for explaining the inverted-U relationship, the failure to precisely measure points along the arousal continuum, the failure to consider the multidimensional nature of anxiety, as well as a number of methodological and statistical limitations. Due to these limitations inherent in the inverted-U hypothesis, a number

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of new conceptualizations and explanations for the anxiety-motor relationship have been advanced in recent years, including catastrophe theory (Hardy & Parfitt, 1991), reversal theory (Kerr, 1985), psychic energy theory (Martens, 1987), and multidimensional anxiety theory (Martens, Vealey, & Burton, 1990). One of the most often cited approaches for finding athletes’ optimal level of anxiety is Hanin’s Zones of Optimal Functioning (Hanin, 1980, 1986, 1989). Developed by Yuri Hanin, the zone of optimal functioning (ZOF) approach was originally developed as a practical tool to identify an optimal zone of anxiety in which an athlete would perform at his or her optimal level. Through systematic observations of elite athletes over a period of time, Hanin found critical differences among athletes’ precompetitive anxiety levels when attempting to determine what would be optimal to achieve peak performance (Hanin, 1989). In essence, some athletes performed best at low levels of anxiety, others at moderate levels, and still others at high levels. Due to these individual differences, Hanin (1986, 1989) used an intraindividual approach in determining athletes’ optimal level of anxiety which he termed their zone of optimal functioning (Hanin, 1989). In essence, unlike the inverted-U hypothesis which took a group approach, Hanin recommends using the individual as the unit of analysis due to the great variability among athletes.

Hanin (1986, 1989) predicts that athletes whose precompetitive state anxiety falls within their ZOF will perform better than when their precompetitive anxiety falls outside their ZOF. Specifically, based on his own research and observations, Hanin (1980) suggests that an individual’s ZOF be operationalized as plus or minus four points (1/2 SD) on Spielberger, Gorsuch, and Lushene’s (1970) State-Trait Anxiety Inventory.

Hanin has provided descriptive data to support his ZOF hypothesis using swimmers and weight lifters. However, some of his methodology has been called into question (Gould, Tuffey, Hardy, & Lochbaum, 1993; Krane, 1993), especially the use of a state anxiety measure three days prior to competition because research has shown that somatic anxiety increases as competition draws nearer (Gould, Petlichkoff, & Weinberg, 1984; Jones, Swain, & Cale, 1991; Krane & Williams, 1987). There also have been several recent empirical investigations attempting to test the predictions emanating from the ZOF approach.

Unfortunately, the results of many of these investigations have been called into question due to methodological or statistical limitations. For example, studies by Morgan and his colleagues using elite distance runners and swimmers as participants (Morgan, O’Connor, Sparling, & Pate, 1987; Morgan, O’Connor, Ellickson, & Bradley, 1988; Raglin, Morgan, & Wise, 1990), seemingly provided support for Hanin’s notion of a ZOF. However, a close examination of these studies reveal that ZOF predictions were not strictly tested. Specifically, in these studies, zones of optimal functioning were derived using group means instead of using an intraindividual approach suggested by Hanin and thus a direct test of the hypothesis was not possible (Krane, 1993). In addition, in the Morgan et al. studies (1987, 1988), arousal, not state anxiety, was assessed, and Hanin’s work is based on state anxiety measurements.

Imlay, Carda, Stanbrough, Dreiling, and O’Connor (1993) tested Hanin’s ZOF using track and field athletes with precompetitive state anxiety being assessed across seven meets. Partial support was found for the ZOF hypothesis with 63% of the athletes who were within their individualized ZOF having a good
performance, whereas 31% of athletes within their ZOF exhibited a poor performance. Turner and Raglin (1993) also recently investigated the ZOF notion using track and field athletes. They used a retrospective method to develop athletes' zones of optimal functioning and found that athletes performed best when they were inside their unique optimal zone. However, due to the use of only three meets and the retrospective recall method to develop individualized zones, an accurate test of the ZOF is called into question. Thus, although the above studies have provided some support for the ZOF notion, they have been limited by methodological and statistical considerations.

In an attempt to provide stronger support for Hanin's ZOF, several researchers have recently incorporated a multidimensional approach to the assessment of anxiety (Dennis, Bartsokas, Lewthwaite, & Palin, 1993; Gould et al., 1993; Krane, 1993). Previous research has used the State-Trait Anxiety Inventory which provides a unidimensional, nonsport-specific measurement of the anxiety construct. However, recent empirical and theoretical work (e.g., Jones & Hardy, 1989; Martens, Vealey, & Burton, 1990) has suggested that anxiety is a sport-specific multidimensional construct consisting of both cognitive and somatic components. Furthermore, different relationships between anxiety and performance have been predicted for cognitive and somatic anxiety. Specifically, cognitive anxiety is predicted to have a negative linear relationship with performance whereas somatic anxiety is predicted to have an inverted-U relationship with performance (Martens et al., 1990).

The studies by Dennis et al. (1993) and Krane (1993) both found partial support for the ZOF hypothesis using a multidimensional anxiety approach. Specifically, Dennis et al. (1993) found that performance within the somatic anxiety ZOF was significantly better than performance outside the zone, although no significant relationships were found for cognitive anxiety and ZOF. Krane (1993) found that athletes' best performance occurred when they were below or in their ZOF for both cognitive and somatic anxiety, whereas poorest performance was exhibited when athletes were above their ZOF for both somatic and cognitive anxiety. Because cognitive anxiety is predicted to have a negative linear relationship with performance, these results support multidimensional anxiety theory. However, somatic anxiety is predicted to have a curvilinear relationship with performance and thus, the somatic anxiety findings are inconsistent with multidimensional anxiety theory predictions. Although not specifically predicted by multidimensional anxiety theory, it would be interesting to assess what unique combination of somatic and cognitive anxiety would facilitate optimal performance (i.e., what combination would make up an athlete's ZOF?).

Gould et al. (1993) improved upon the previous designs by combining optimal somatic and cognitive state anxiety points, using both normally distributed-based calculations and multidimensional anxiety theory-based calculations to test the use of Hanin's ZOF hypothesis. In Hanin's research and applications, he formed the ZOF using a normal distribution where each athlete's zone was created by adding and subtracting one-half standard deviation from his or her optimal state anxiety using Spielberger's (1966) state anxiety inventory. Gould et al. (1993) extended Hanin's work to a multidimensional situation by assuming that each athlete has a unique combination of cognitive and somatic anxiety. Each athlete's optimal somatic and cognitive anxiety scores were then placed on the x-axis and y-axis respectively, where the intersection of these two scores was used to help
define an athlete’s ZOF. Once this point in space was located, one-half standard deviation was added and subtracted to both cognitive and somatic state anxiety to identify the athlete’s ZOF. Results revealed that the multidimensional-based zone was a better performance predictor than the zone based on Hanin’s procedures, although the differences were small. Although Gould et al.’s (1993) study provided some initial direction for assessing multidimensional anxiety within Hanin’s ZOF framework, it must be viewed as only preliminary due to the use of retrospective anxiety assessments taken within 24 hours after competitions. In addition, the results were only found for subjective performance (athletes’ assessment of their performance) but not for objective performance (athletes’ actual race times in comparison to their goal times) which makes interpretation more difficult.

It may be concluded from this review of literature that more research empirically testing the ZOF hypothesis is warranted. Therefore, the purpose of the present investigation was to provide an empirical test of the ZOF predictions, attempting to avoid the methodological limitations that have marred many of the previous studies. Specifically, the present study will attempt to enhance previous research and methodology investigating the ZOF by focusing on the following: (a) comparing the retrospective method (retrospective-best and retrospective-postcompetition) with the precompetitive method of identifying an athlete’s ZOF, (b) using a multidimensional measure of competitive state anxiety to test multidimensional anxiety predictions within a ZOF framework, (c) assessing the combination of cognitive and somatic anxiety in determining an athlete’s ZOF, (d) using an intraindividual approach to develop athletes’ ZOF, and (e) using both objective and subjective assessments of performance.

Method

Participants

Participants in the study were 13 collegiate female varsity softball players from a Midwestern university ranging in age from 18 to 23 years (M = 20.0). Players’ participation in the study was voluntary and all subjects were assured that their results would be kept confidential.

Demographic Questionnaire

Background information regarding age, number of years of softball experience, and position was gathered via a questionnaire that was administered to players after a practice session.

Competitive State Anxiety

Competitive state anxiety was measured by the Competitive State Anxiety Inventory-2 (Martens, Burton, Vealey, Bump, & Smith, 1990), which has been used extensively in the sport psychology literature to measure precompetitive state anxiety. The CSAI-2 was developed as a sport-specific inventory designed to measure cognitive and somatic state anxiety as well as confidence. The authors present psychometric data attesting to its internal consistency reliability and construct validity. Employing the CSAI-2, optimal state anxiety was assessed under three different sets of instructions:
**Retrospective-Best CSAI-2.** In the retrospective-best condition, players completed the CSAI-2 after a practice session. Players were instructed to recall how they felt just prior to their best softball performance within the past six months. Although typically used in a prospective fashion, the CSAI-2 was used retrospectively, similar to its use in several recent tests of ZOF (e.g., Gould et al., 1993; Imlay et al., 1993)

**Retrospective-Postcompetition CSAI-2.** The CSAI-2 was administered to players within 24 hours after seven different competitions. Players were instructed to recall how they felt just prior to the game they last played.

**Precompetitive CSAI-2.** The CSAI-2 was administered within 30 minutes of seven competitions. Players were instructed to respond how they felt right now at this moment.

**Performance Assessment**

Based on the recommendations of anxiety researchers (Raglin, 1992; Weinberg, 1990), both subjective and objective measures of performance were gathered for each game. Objective measures were separated into two categories (offensive and defensive) since players can have great success in one category but perform poorly in the other category (e.g., hit two home runs but make two fielding errors). Objective performance measures (derived from each individual game performance statistics) included batting average, slugging percentage (number of total bases divided by number of at-bats), and on-base percentage. For pitchers, earned run average, walks, strikeouts, total bases of opposing team, slugging percentage of opposing team, and batting average of opposing team were employed as performance measures.

Subjective performance measures were divided into the following categories: (a) offensive, (b) defensive, (c) intangibles (e.g., hitting behind the runner, taking an extra base on base hit), and (d) overall performance. Specifically, within 24 hours after the game was concluded, players were asked to rate their own performance on an 11-point Likert scale for the four above categories. The instructions asked players to respond to the following: "In relation to your average or usual performance, rate how you performed in today's game," from 1 = played much poorer than usual, to 11 = played much better than usual (with 6 being average). Similarly, the coach rated each player using the exact same scales described above. For pitchers, the subjective assessment of performance included control, pitching with batters on base, getting ahead on the count, and overall pitching.

**Procedure**

After obtaining permission from the head softball coach, a meeting with the team was arranged after a practice session. At this time, informed consent was obtained and the rationale and procedures of the present investigation were explained. Data collection was conducted at three different times: (a) at the end of a practice session, (b) 30 minutes prior to competitions, and (c) within 24 hours after competitions. In the first phase, the demographic questionnaire and the retrospective-best CSAI-2 (how they felt just prior to their best performance within the past six months) were administered at the end of a practice session. In the second phase, the CSAI-2 was administered within 30 minutes of the competitive event, asking players to respond how they felt right now. This was done over seven games throughout the
second half of the season. In the third phase, players were asked to complete the CSAI-2 within 24 hours after the same seven competitions noted above. Specifically, they were asked to recall their precompetitive anxiety within 30 minutes of the preceding competition (retrospective-postcompetition). Furthermore, within 24 hours after each competition, both players and coaches were asked to complete the subjective assessment of their performance from the previous game. Objective performance measures for each game were derived from game statistics.

Results

Descriptive Statistics

Descriptive statistics were calculated for each of the 11 softball players (see Table 1), which included optimal CSAI-2 subscores and subjective average performance measures (Note: two subjects had to be eliminated from all analyses because an optimal performance could not be identified for either subject using the criteria set up in the performance assessment). It should also be noted that because the three different methods (retrospective-best, retrospective-postcompetition, and precompetition) of determining optimal cognitive and somatic anxiety did not differ (i.e., there were no significant differences in optimal cognitive and somatic anxiety found using the three different methods), average optimal cognitive and somatic anxiety scores were calculated across the three methods for each player. As would be predicted by ZOF hypothesis, there was a range of optimal cognitive and somatic scores for the players, although the scores were more varied for cognitive than somatic anxiety. In addition, it should be noted that there was a great deal of intraindividual differences when attempting to compute each player’s own optimal somatic and cognitive anxiety using the three different methods (see Table 2). Finally, it should be noted that best game performance for each player was determined through a combination of the objective and subjective performance

Table 1  Average (From Each Method) Optimal Somatic and Optimal Cognitive State Anxiety Points and Subjective Performance for Each Subject

<table>
<thead>
<tr>
<th>Subject number</th>
<th>Average optimal somatic</th>
<th>Average optimal cognitive</th>
<th>Average subjective performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>13.67</td>
<td>20.33</td>
<td>9.3</td>
</tr>
<tr>
<td>2</td>
<td>12.33</td>
<td>22.33</td>
<td>8.3</td>
</tr>
<tr>
<td>3</td>
<td>11.16</td>
<td>11.50</td>
<td>7.7</td>
</tr>
<tr>
<td>4</td>
<td>12.00</td>
<td>23.00</td>
<td>7.3</td>
</tr>
<tr>
<td>5</td>
<td>9.33</td>
<td>9.67</td>
<td>9.0</td>
</tr>
<tr>
<td>6</td>
<td>11.00</td>
<td>17.33</td>
<td>10.0</td>
</tr>
<tr>
<td>7</td>
<td>14.00</td>
<td>19.33</td>
<td>7.4</td>
</tr>
<tr>
<td>8</td>
<td>11.00</td>
<td>15.67</td>
<td>5.7</td>
</tr>
<tr>
<td>9</td>
<td>10.67</td>
<td>15.33</td>
<td>7.7</td>
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<tr>
<td>10</td>
<td>10.33</td>
<td>9.33</td>
<td>7.3</td>
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<tr>
<td>11</td>
<td>10.00</td>
<td>13.00</td>
<td>9.0</td>
</tr>
</tbody>
</table>
Table 2  Optimal Somatic and Cognitive State Anxiety of Each Subject for the Retrospective-Best, Retrospective-Postcompetition and Precompetitive Methods

<table>
<thead>
<tr>
<th>Subject</th>
<th>Somatic</th>
<th>Cognitive</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Retrospective</td>
<td>Post-competition</td>
</tr>
<tr>
<td>1</td>
<td>21</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>12</td>
<td>13</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>10.5</td>
</tr>
<tr>
<td>4</td>
<td>11</td>
<td>14</td>
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<tr>
<td>5</td>
<td>9</td>
<td>9</td>
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<tr>
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<td>11</td>
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<td>12</td>
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<tr>
<td>11</td>
<td>11</td>
<td>10</td>
</tr>
</tbody>
</table>

measures noted above. Specifically, the criteria for a best game performance was achieving at least a 7 on three of the four subjective questions and having an average objective performance of .500 (using batting average, slugging percentage, and on-base percentage). Correlational analyses indicated that subjective and objective measures of performance were generally significantly correlated (although modest) in the ranges of .2 to .4.

Calculation of the ZOF

Previous research (Gould et al., 1993) has investigated using a normative (normal distribution) versus a multidimensional approach in determining an athlete’s ZOF and found that the multidimensional approach was significantly related to athletes’ performance, whereas the normative approach did not yield a significant relationship. Therefore, in the present study, a multidimensional approach was taken as this also allows for the opportunity to develop a combined cognitive/somatic ZOF.

Using the multidimensional approach employed by Gould et al. (1993) to determine players’ ZOF, a point in space was located based on different boundaries. Specifically, the somatic anxiety zone was defined by adding and subtracting one-half of a standard deviation from the optimal somatic state anxiety point. However, the cognitive state anxiety zone was defined only by an upper boundary of one-half of a standard deviation with no lower boundary being set because multidimensional theory asserts that only high levels of cognitive state anxiety are debilitating to performance. Because one of the purposes of the present investigation was to examine the three methods of identifying a player’s ZOF (retrospective-best, postcompetition, precompetition), two within-subjects one-way repeated measures ANOVAs were conducted on somatic and cognitive state anxiety to examine potential differences in retrospective-best, retrospective postcompetition, and precompetition anxiety methods.
Results indicated no significant differences among the three methods for somatic and cognitive state anxiety optimal points. Means and standard deviations for optimal somatic anxiety were 12.00 (SD 3.26), 11.41 (SD 2.18), and 10.8 (SD 1.25) for retrospective-best, postcompetition, and precompetition, respectively. Similarly, optimal cognitive anxiety means and standard deviations were 14.91 (SD 5.17), 16.95 (SD 6.25), and 16.24 (SD 4.84) for retrospective-best, postcompetition, and precompetition, respectively. Using the combination of the three methods noted earlier, optimal somatic state anxiety ranged from 9.33 to 14.00, and optimal cognitive state anxiety ranged from 9.67 to 23.00.

A combined (somatic/cognitive) optimal state anxiety point was also developed using the optimal cognitive and somatic state anxiety points that were identified in operationalizing separate cognitive and somatic ZOF. The combined somatic/cognitive optimal point was calculated using multidimensional anxiety theory which “assumes that there is a negative linear relationship between cognitive anxiety and performance and a curvilinear relationship between somatic anxiety and performance” (Gould et al., 1993, p. 91). Based on the intersection of optimal somatic and cognitive points, an optimal zone “can be conceptualized as a rectangle extending from zero on the y-axis to a distinct level and bounded within a specific range on the x-axis” (Gould et al., 1993, p.92, see Figure 1). Because the optimal cognitive and somatic anxiety points were not different for each method, the averaged optimal somatic and cognitive points developed earlier were used to determine the optimal combined (cognitive/somatic) state anxiety point of intersection for each player. From this point of intersection, a combined somatic/cognitive ZOF was developed for each player to examine the combined effects of somatic and cognitive state anxiety on performance.

![Figure 1](image-url)

**Figure 1**—Multidimensional anxiety-based zones of optimal functioning for CSAI-2 cognitive and somatic anxiety.
Development of Individual Players’ ZOF

In order to analyze the relationship between players’ somatic and cognitive ZOF and performance, the optimal zone was identified in two different ways. First, Hanin (1980, 1986) defined the ZOF based on performance being either inside or outside of the ZOF. In the present investigation, each player’s optimal performance (as noted earlier) was determined, and then the corresponding cognitive and somatic anxiety was identified. As per Hanin’s suggestions, the optimal zone was created by calculating plus/minus one-half of a standard deviation for both somatic and cognitive anxiety. It could then be determined if athletes’ cognitive and/or somatic anxiety was within this zone. For example, in the present investigation, one-half standard deviation for cognitive state anxiety was 2.47. If an athlete’s optimal cognitive state anxiety was 22, then her optimal zone would be 22 plus or minus 2.47 (i.e., 19.53 to 24.47).

The second definition of the ZOF was based on three levels of performance (below, inside, and above) the ZOF (Gould et al., 1993). The three levels of defining ZOF only affects the somatic ZOF because the cognitive ZOF is defined as having no lower limit according to multidimensional theory. Thus, performance is either inside or above the cognitive ZOF. For somatic ZOF, if the optimal zone ranged from 19.53 to 24.47 (like the above example), then state anxiety somatic scores above 24.57 were designated above and scores under 19.53 were considered below the optimal zone.

The combined somatic/cognitive ZOF was developed by calculating similar distance scores based on the optimal somatic and cognitive state anxiety points developed earlier. The distance scores were correlated with both objective and subjective performance to test the ZOF hypothesis (Gould et al., 1993). The computational formula (inside/outside) is provided below:

\[
\text{somatic anxiety-maximum } ([\text{abs(game somatic anxiety-optimal somatic anxiety)-1/2 SD}, 0])
\]
\[
\text{cognitive anxiety-maximum } ([\text{abs(game cognitive anxiety-optimal cognitive anxiety)-1/2 SD}, 0])
\]
\[
\text{distance = square root (cognitive anxiety}^2 + \text{somatic anxiety}^2)
\]
\[
\text{if distance} > 0 \text{ then combined cognitive/somatic = “outside,” if not, combined cognitive/somatic = “inside.”}
\]

It should be noted, from a conceptual point of view, the above distance measure represents how far out of the zone each athlete was prior to a given performance. It would be predicted that the farther out an athlete was from her optimal zone, the poorer her performance would become. Furthermore, it should be pointed out that the method of deriving athletes’ ZOFs employed two different ways to operationalize one-half standard deviation. Specifically, one-half standard deviation was defined in one case using individual players’ optimal somatic and cognitive state anxiety points discussed earlier. In the other case, one-half standard deviation was defined using the population norms of female college athletes developed by Martens et al. (1990). Population norms have been employed in some of the previous research investigating ZOF (Gould et al., 1993; Imlay et al., 1992) whereas other studies have used the actual subjects’ standard deviation (e.g., Krane, 1993; Scallen, 1993).
Somatic and Cognitive ZOF and Objective Performance

Besides investigating the relationship of the combined somatic/cognitive ZOF and performance, it also was deemed important to determine how separate cognitive and somatic anxiety optimal zones were related to performance. First, a univariate procedure was conducted to determine if the performance measures (subjective/objective) were normally distributed. A Shapiro-Wilk “W” statistic was computed and the distribution of objective performance measures were not normally distributed ($W = 0.88$). Therefore, nonparametric analyses were conducted to examine the relationship between ZOF and objective performance. Unfortunately, attempting to apply nonparametric statistics to examine the relationship between the separate somatic and cognitive ZOF and objective performance proved to be unreliable because all tests were asymptotic and not appropriate for small samples (i.e., $N < 5$). Because cell sample sizes outside the ZOF were found to be less than 5, nonparametric statistics could not be computed for the separate somatic and cognitive ZOF.

Nonparametric analyses also were conducted to examine the relationship between the combined cognitive/somatic ZOF and performance because cell sizes were high enough. Savage scores (calculated from SAS statistical package) were computed for each objective performance measure and chi-square statistics were derived. Savage scores are expected values of the order statistic for exponential distributions. In essence, instead of examining the actual values, this analysis examines the ranks instead. Savage scores are powerful for comparing scale differences in exponential distribution or location shifts in extreme value distributions (Hajek, 1969).

Objective performance was found to differ significantly (chi-square $= 6.30$, $p < .01$) for the combined cognitive/somatic ZOF when the population norms (Martens et al., 1990) were used to operationalize one-half standard deviation in determining ZOF width. Direction of the means indicated that objective performance outside ($N = 10$) the combined (somatic/cognitive) was higher than inside ($N = 53$) the combined ZOF. No differences were found when using players’ norms to determine one-half standard deviation. Pitchers ($N = 3$) were analyzed separately due to different objective performance measures, and results indicated no significant differences between objective performance falling inside and outside of the ZOF (this occurred when either method of determining one-half standard deviation was used).

Results of the intraindividual correlations between the multidimensional-based distance and objective performance revealed significant correlations when population norms ($r = .61$, $p < .01$) and study norms ($r = .66$, $p < .01$) were employed to define the width of the combined cognitive/somatic ZOF. These positive correlations revealed that as players’ combined cognitive/somatic state anxiety points fell further from the combined ZOF, objective performance increased.

Cognitive and Somatic ZOF and Subjective Performance

Because subjective performance measures were found to be normally distributed, parametric statistics were appropriate in this case. Specifically, separate one-way ANOVAs were conducted on somatic and cognitive state anxiety to determine if there were any significant differences in subjective performance from inside to outside the ZOF. Results indicated no significant differences among players’
subjective performance measures when the somatic ZOF was defined at two levels (inside/outside) or three levels (below/inside/above). No analyses could be conducted on the cognitive ZOF due to the small number of observations above the cognitive ZOF that made it impossible to compare to observations within the ZOF with any degree of reliability.

**Combined Cognitive/Somatic ZOF and Subjective Performance**

Two separate repeated measures ANOVAs (using population and study means to determine one-half standard deviation) were conducted on the combined cognitive/somatic ZOF for subjective performance. To control for Type I error, a .01 alpha level was chosen. Results revealed no significant differences in subjective performance (using either method) whether players’ performance fell inside or outside of their own combined ZOF. Intraindividual correlations between the multidimensional-based distance and subjective performance were not significant regardless of whether population or study means were used to define the width of the combined ZOF.

**Discussion**

**Methods of Determining ZOF**

One purpose of the present investigation was to compare the retrospective-best, retrospective-postcompetition, and precompetitive methods of identifying players’ optimal state anxiety (somatic, cognitive, and combined somatic/cognitive). Results revealed no significant differences between the three methods in identifying players’ optimal anxiety states. This finding supports Hanin’s (1986) contention that the retrospective method of identifying athletes’ ZOF is just as reliable as using a precompetitive assessment and contradicts Krane’s (1993) criticism of taking a retrospective approach. This has important implications for future research and application in the anxiety-performance relationship. For example, when trying to assess athletes’ precompetitive state anxiety, the retrospective-postcompetition method may be more practical as well as ethical. That is, to continuously gather data from an athlete just prior to competition is often logistically impossible and possibly more importantly, there has always been the ethical question of the impact on athletes’ performance of completing anxiety questionnaires just prior to competition. Thus, the retrospective method can overcome these potential difficulties, and the findings of the present investigation also support Gould et al.’s (1993) use of the retrospective-postcompetition method for assessing precompetitive state anxiety. However, it should be noted that although there were no significant between-group differences for the three methods of determining athletes’ ZOF, a great deal of within-subject variability existed in certain players. This needs to be carefully considered in working with athletes in applied settings and deciding on how to develop the athlete’s ZOF. In essence, there may be some art as well as science in determining individual athlete’s ZOF.

**Relationship Between ZOF and Performance**

A second focus of the present study was to examine the relationship of players’ ZOF and performance using a multidimensional approach to the measurement of anxiety. First, it should be noted that players’ optimal cognitive state anxiety ranged
from 9.67 to 23.00 and optimal state anxiety ranged from 9.33 to 14.00. This partially supports the ZOF hypothesis which suggests that optimal state anxiety would differ for different athletes. In addition, these optimal anxiety scores tend to be in the low to middle range which might be expected because previous research (Simon & Martens, 1979) has found lower levels of precompetitive anxiety for team sport athletes. Along these lines, Gould et al. (1993), using middle distance runners (individual sport), found that optimal somatic anxiety ranged from 12 to 27 and optimal cognitive anxiety ranged from 13 to 32.

In setting up players' ZOF, separate as well as combined cognitive and somatic state anxiety scores were used as well as both objective and subjective performance. Unfortunately, due to small cell sizes (regarding performance inside or outside of players' ZOF), objective performance for the separate cognitive and somatic ZOF and the cognitive ZOF for subjective performance could not be statistically analyzed in a reliable fashion. Results regarding the relationship between players' somatic ZOF and subjective performance revealed no significant differences. Thus, no support was found for the ZOF hypothesis when multidimensional anxiety was used to define players' optimal zones. This is contrary to Krane's (1993) research which found that female soccer players had superior performance inside or below their somatic ZOF than above their ZOF. However, Krane defined the somatic ZOF width by one full standard deviation whereas the present study used one-half standard deviation suggested by Hanin (1989). The width of the ZOF suggested by Hanin is somewhat arbitrary, and future researchers and practitioners might explore other potential ways to define and operationalize athletes' ZOF.

Regarding players' combined optimal somatic and cognitive anxiety, results indicated that objective performance was significantly better outside of players' combined ZOF than inside. This result was only found when population means were used to determine one-half standard deviation. In addition, objective performance improved more as athletes' combined somatic/cognitive state anxiety intersection got further from their combined somatic/cognitive ZOF. This finding not only fails to support the ZOF hypothesis but contradicts it. It should be noted that the objective performance measures were discrete and volatile as a batting average within a game could change from 0.00 (0 for 1) to .500 (1 for 2) with one base hit. In addition, because objective performance measures used game statistics, the focus was on the outcome and not process. For example, one batter might hit two line drives that are caught (0 for 2), whereas another might strike out and hit a check swing just over the infield (1 for 2). In addition, task difficulty (i.e., ability of the pitcher) also is not factored into the objective performance. These two issues (process vs. outcome and task difficulty) have been noted by Gould and Tuffey (1996) as limitations in using objective performance measures.

Due to the limitations noted previously, subjective performance measures also were used in the present investigation. However, results revealed no significant performance differences for performance that fell either inside or outside the players' ZOF. This finding occurred both when the ZOF was created by somatic and cognitive anxiety separately or combined. Thus, whether objective or subjective performance measures were employed, no support for Hanin's ZOF was found. It might be argued that the relatively low number of games used to determine players' ZOF ($N = 7$) or small sample size ($N = 13$) might have resulted in a lack of variability in determining athletes' ZOF. However, Gould et al. (1993) had only 11 participants and used six different meets to determine athletes' ZOF, and they found
subjective performance inside the ZOF better than outside the ZOF, although no significant differences were found when using objective performance. It seems obvious that more research is necessary before more definitive conclusions can be made regarding the ZOF hypothesis. These studies should attempt to secure larger sample sizes and more state anxiety measures to provide a more definitive test of Hanin’s ZOF hypothesis.

In summary, the present investigation found no support for the ZOF hypothesis originally put forth by Hanin (1980). Most previous investigations have found partial support for ZOF predictions, with data supporting some aspects but not others. These investigations have used individual sport athletes (with the exception of Krane, 1993, who used soccer players) whereas softball players were used in the present study. Despite the improvements made on the methodologies employed in previous studies, including the use of multidimensional anxiety measures, a number of issues identified earlier still remain in providing an adequate test of ZOF predictions. The challenge to future researchers will be to set up their data collection and methodologies so that a reliable and valid test of ZOF assumptions is accomplished.

References


Notes

The computational formulas for developing the different (separate) somatic and cognitive ZOF (inside/outside as well as below/inside/above) can be obtained by writing the second author.

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