Interactive effects of emotions on performance: An exploratory study in elite skeet shooters[1]

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INTERACTIVE EFFECTS OF EMOTIONS ON PERFORMANCE: AN EXPLORATORY STUDY IN ELITE SKEET SHOOTERS

KEYWORDS: IZOF model, performance prediction, emotion interaction, aggregated scale.

ABSTRACT: This study explored interactive effects of multiple emotions on performance (outcomes) in three male elite skeet shooters. Recalled emotional experiences associated to successful and poor performances and to current (actual) performances were measured using the aggregated Emotional State Profile-40 scale (ESP-40; Hanin, 2010b). Current performance involved 20 series of 25 shots. The results provide support for the practical utility of ESP-40 in the assessment of interactive effects of four emotion categories on performance. Recalled measures were instrumental in the prediction of current performances. The utility of ordinal logistic regression-based estimation is discussed.

Author Note

This study is the result of collaboration between Ruiz & Hanin (as supervisors) and Fogaça & Pääk (former master's students). The data presented in the article were collected (by the team coach) using an unpublished version of a questionnaire developed by Hanin (ESP-40). Hanin and Ruiz provide the questionnaire and assessment protocol to the students who instructed the coach in administration procedures. The entire "sample" that the students present in their masters thesis included three shooters, from whom emotion and affect data were collected. The article, however, presents an in-depth analysis of emotion data from one shooter used as an illustration of emotion dynamics. Cooperation with the students was not possible. There was mutual oral agreement on data publication. Written permission from students, however, was not materialized. Such requirement was not normal practice of the university. This practice is now being introduced.

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An accurate description of athletes' emotional experiences associated with individual success and failure is important for the development of effective intervention programs (Hanin, 2000, 2007, 2010a; Robazza, Bortoli, Nocini, Moser, & Arslan, 2000; Ruiz & Hanin, 2004b).

Previous research focused on the study of single emotions such as competitive anxiety (Jones, 1995; Martens, Vealey, & Burton, 1990; Raglin & Hanin, 2000). Cognitive and somatic components of anxiety were believed to impact performance differently. Hardy (1990, 1996) assumed that while physiological arousal and low cognitive anxiety followed an inverted-U relationship with performance, as cognitive anxiety increased, performance could improve up to a critical point, after which it suddenly declined. Although this assumption implies interaction effects, these components were assessed separately. Other studies indicate that anger associated to successful performances was perceived as beneficial or detrimental for athletes depending on the intensity and the situational meaning (Ruiz & Hanin, 2004a, 2011). Thus, a need to examine pleasant and unpleasant emotions in the prediction of athletic performance was highlighted (Hanin, 2000, 2004, 2007, 2010a; Robazza, Bortoli, & Hanin, 2004).

Methodologically, research has focused on the assessment of single emotions disregarding their interactive effects. For example, existing standardized scales include the Competitive State Anxiety Inventory-2 (CSAI-2; Martens, Burton, Vealey, Bump, & Smith, 1990), the Sport Emotion Questionnaire (SEQ, Jones, Lane, Bray, Uphill, and Catlin, 2005) or the Profile of Mood States (POMS; McNair, Lorr, & Droppleman, 1971). Although the so called "iceberg profile" characterized by high values for vigor

and low values for tension, confusion, depression, anger and fatigue may imply interactive effects, the athletes' rate the intensity for each item separately.

Research also revealed a discrepancy between the content of items in standardized scales, and the vocabulary used by athletes. For example, 80-85% of content of individual emotional experiences of soccer players was not assessed by standardized instruments (Hanin, 2007; Syrjä, 2000). A study with elite karate athletes indicated individual preferences in selection of idiosyncratic labels to describe performance-related anger states (Ruiz & Hanin 2004a).

In other words, group-oriented scales are limited in capturing the athlete's perspective or personal meaning. Thus, an individualized approach termed the Individual Zones of Optimal Functioning (IZOF) model (Hanin, 1997, 2000, 2004, 2007, 2010a) was advocated in the study of athletes' emotions. The IZOF model distinguishes emotional states (experiences per se), relatively stable emotional patterns (repeated experiences), and meta-experiences (i.e., knowledge, beliefs, and attitudes about recalled, actual or anticipated experiences) (Hanin, 2004, 2007). Emotion is conceptualized as a situational, multi-modal and dynamic manifestation of the total human functioning (Hanin, 1997, 2000). The content of emotions is conceptualized within the framework of two related factors: functioning (success-failure) and hedonic tone or valence (pleasure-displeasure) resulting in success-related functionally optimal pleasant (P+) and unpleasant (N+) emotions and failure-related dysfunctional unpleasant (N-) and pleasant (P-) emotions. These four categories serve to identify emotion labels relevant for performance reflecting readiness to perform (Hanin, 1997, 2000, 2010a).

An example of sport-specific individualized emotion measures is individualized emotion profiling (IEP, Hanin, 2000). In IEP, athletes identify individual and task-relevant content and intensity of emotional experiences (pleasant and unpleasant) accompanying successful and poor performances. With the help of a stimulus list, athletes generate idiosyncratic emotion descriptors based on four emotion categories. Idiographic profiles represent interactive effects of optimal and dysfunctional emotions where optimal emotions are placed in the middle and dysfunctional emotions by their sides. An ‘‘iceberg’’ emotional profile, typical in successful performances, is characterized by higher intensities of functionally optimal emotions. In contrast, a ‘‘cavity’’ emotional profile, typical of poor performances, is characterized by higher intensities of dysfunctional emotions.

A more recent approach involves aggregating (most often selected) self-generated labels across athletes and sport events and the four emotion categories (N- N+ P+ P-). Emotion State Profile (ESP-40, Hanin, 2010b) consists of an aggregated 40 item scale with ten items in each of the four emotion categories to assess interactive effects between these emotion categories. Thus, ESP-40 captures idiosyncratic content better than standardized psychometric scales. In addition, emotion items are similar for all athletes making possible between-individual comparisons across similar categories and across similar items within each emotion category. Similar to IEP, functional optimal categories of ESP-40 items are placed in the middle while dysfunctional categories are on the sides to facilitate a visual representation of interactive effects. Optimal emotional profiles related to success are iceberg (bell-shaped), and may indicate predominance of functionally pleasant emotions represented by the sequence N- < N+ < P+ > P-, or functionally unpleasant emotions (N- < N+ > P+ > P-). In contrast, dysfunctional

emotion profiles related to failure are flat or skewed profiles which reflect predominance of unpleasant dysfunctional emotions (N- > N+ > P+ > P-) or pleasant dysfunctional emotions (N- < N+ < P+ < P-).

Within the IZOF model, performance predictions are based on the "in-out of the zone" notion (Hanin, 2000). High probability of successful performance is expected when individual emotion content and intensity fall within optimal and outside dysfunctional zones previously established. Thus, predominance of optimal emotions and low levels or absence of dysfunctional emotions is expected in successful performances while predominance of dysfunctional emotions and absence of optimal emotions is expected in unsuccessful performances. Empirical support for these assumptions was obtained in cross-country skiers (Hanin, 1997), gymnasts (Cottyn, De Clercq, Crombez, & Lenoir, 2012), soccer and ice hockey players (Hagtvet & Hanin, 2007), swimmers and track & field athletes (Robazza, Pellizari, Bertollo, & Hanin, 2008).

Thus, the purpose of this investigation was to examine the interactive effects of emotions related to athletic performance in three elite skeet shooters. Specifically, this investigation examined the practical utility of an aggregated emotion scale, the ESP-40 scale, in the assessment of four emotion categories and their interactive effects on performance. In addition, this study explored the practical utility of recalled emotional experiences before successful and poor performances in the prediction of performance.

Method

Participants

Participants were three male skeet shooters. This was a convenience sample, with criterion for inclusion being that participants were experienced and represented the

highest level of achievement in their modality. Participants, with ages ranging from 18 to 27 years, were members of the Finnish National Team. They had from 3 to 13 years of international experience, and had achieved medals in major international competitions (e.g. European Championships, World Championships, or World Cups), being among the most successful athletes in their event.

Measures

The ***Emotion State Profile*** (ESP-40; Hanin, 2010b, see appendix, Fogaça & Päkk, 2012) is a 40-item scale that assesses functionally optimal pleasant (P+), functionally optimal unpleasant (N+), dysfunctional pleasant (P-), and dysfunctional unpleasant (N-) emotions. ESP-40 consists of a list of aggregated emotion labels drawn from most often selected words describing athletes' states before or during athletic performance. Specifically, ESP-40 consists of 10 rows of 4 columns with one adjective for each emotion category. To capture the interactive effects, a within row comparison is used. Participants rank each item based on how accurately it describes their emotional state from 4 (describes best) to 1 (describes least). Scores of 4 and 3 represent the presence of emotion whereas scores 1 and 2 represent low intensity or absence of emotion. An example of ranking is provided below:

N-	*N+*	*P+*	*P-*
[1] Tired	*[3]* ***Tense***	*[4]* ***Energetic***	*[2] Easy-going*

Subtotal scores are calculated by adding scores in each column (emotion category). Scores, ranging from 10 (minimum) to 40 (maximum), are visually

represented in an emotion profile, with functional optimal categories (N+, P+) placed in the middle and dysfunctional categories (N-, P-) by the sides to facilitate a visual representation of interactive effects. Optimal profiles have an iceberg form (or bell-shape), whereas dysfunctional profiles are flat or skewed. The ranking order in each row is an important indicator of specific interaction pattern across the emotion categories. This interaction can be also represented in a rank of emotion categories distinguishing four emotion profiles: N-<N+<P+>P- (type one – optimal positive), N-<N+>P+>P- (type two – optimal negative), N->N+>P+>P- (type three – dysfunctional negatively skewed), and N-<N+<P+<P- (type four – dysfunctional positively skewed)[2].

Performance measures. Shooting performance consists of series of 25 shots. Scores (0 = missing the target; 1 = hit), recorded at the end of a series of 25 targets, range from 0 to 25.

Procedure

The participants, recruited by the coach, gave written informed consent in accordance with APA ethical guidelines. Due to the study characteristics and nature of the sport, data were collected by the coach who was instructed in the use of the measures and procedures. Data collection took place during three training camps that lasted from 6 to 7 days each, organized within three months before the competition season. Before the first training camp, the shooters were asked to recall three most successful performances and to describe how they felt before each using the ESP-40. Then, they did the same for their three most unsuccessful performances. Current emotion measures were collected

[2] Previous research (Bortoli, Bertollo, Hanin, & Robazza, 2012) has indicated that types one and two are usually related to optimal performances, while types three and four are typically related to poor performances.

using the ESP-40, 30 min before 20 series of 25 shots. Shooting scores were recorded after each series.

Data Analysis

Individual emotion profiles were developed for successful, poor and current performances. Shooting scores were categorized as better than standard performance (scores 24 - 25), standard performance (scores 22 - 23), and sub-standard performance (scores 21 and below). In performance prediction, current (actual) emotions were contrasted against previously recalled emotions associated to successful and unsuccessful performances. Optimal zones of functioning were determined using min - max ranges of emotion intensities for each category before three most successful competitions, and three most unsuccessful competitions for dysfunctional zones. Distances between emotion intensity levels before actual performance and previously established optimal and dysfunctional zones were calculated. Probabilistic estimation approach (see Kamata, Tenenbaum & Hanin, 2002) applies ordinal logistic regression (OLR) models, where performance outcomes are assumed of categorical nature (e.g. optimal, non-optimal), and emotional intensity is the predictor variable. This method assumes the probability that non-optimal performance is associated with emotion intensities above or below intensity levels in optimal current performance. Logistic curves represent the relationships between probabilities and performance outcomes. Finally, Spearman's rank correlation coefficients were calculated for inter-correlations between 10 combinations based on four emotion categories: N-, N+, P+, P-, pleasant (P+ + P-), unpleasant (N+ + N-), helpful (P+ + N+), harmful (P- + N-), strong unpleasant (N+ - N-), and strong pleasant (P+ - P-). An inter-correlation matrix was used to draw maximum correlational paths (Vyhandu, 1964).

Results

Due to space limitations main results for one shooter will be presented. Additional data for the other two shooters were similar and will be summarized where appropriate. Individual emotion profiles and data (for shooter A) before most successful and unsuccessful performances are depicted in Figure 1. As expected, before successful competitions, A reported predominance of pleasant (optimal and dysfunctional) emotions. Characterized by the following emotion interactions N-<N+<P+>P- (8 out of 9 possible patterns). In contrast, unsuccessful performances were characterized by N-≤N+>P+<P- emotion interactions.

A's actual performances were better than standard on 11 occasions (55% of 20 series), standard performances (40%) and sub-standard (5%). Median values and min-max ranges for emotions before A's current performances are presented in Table 1. Emotional profiles for this shooter reflected N-<N+<P+>P- (type one – optimal positive) interactions before better than standard and standard performances. However, before below standard performance emotion interactions were N-<N+<P+<P-. Figure 2 presents boxplots of emotion intensities before three levels of current performance compared with recalled measures. Interestingly, very low variability for emotion intensities was experienced. In addition, emotion intensities before recalled successful performances (represented by bars) were very close to those experienced before current acceptable standard and better than standard performances.

Figure 3 illustrates probability curves for optimal performance based on emotion intensities before current performances. As it can be seen, highest probabilities of optimal performance were associated with absence or low intensities of emotions whereas predominance of pleasant emotions predicted 70% probability of optimal

performance. Table 2 presents lower and upper values for performance prediction using two estimation methods. Interestingly, an overlap was observed for success-related zones for N- and N+ emotions. However, for P+ and P- emotions, optimal ranges fell outside those actually experienced.

Interrelations between emotion categories.

Spearman rank correlation coefficients among the study variables are depicted in Table 3. As expected, N- negatively correlated with pleasant experiences, and positively correlated with total unpleasant experiences. N+ negatively correlated with pleasant and dysfunctional experiences and positively correlated with total unpleasant and strong unpleasant experiences. P+ correlated negatively with P- (functionally opposite effect), total unpleasant and dysfunctional emotions. P+ was also positively correlated with total pleasant experiences. Finally, P- correlated negatively with functionally helpful and strong pleasant experiences, and positively with functionally harmful experiences. Interestingly, only N- emotions correlated significantly and negatively with shooting scores. Figure 4 depicts the minimum spanning tree based on the maximum correlational path principle. A first major cluster was characterized by pleasant (helpful and harmful) emotions. The second major cluster was formed by unpleasant (helpful and harmful) emotions.

Discussion

This study aimed to explore the interactive effects of multiple emotions on athletic performance in three elite skeet shooters using the aggregated ESP-40 scale. We hypothesised that recalled emotional experiences accompanying successful and poor performances could be instrumental in prediction of actual performances. Typical success profiles were obtained before "better than standard" performance as well as before personally acceptable "standard" performances. These two "personal successful performance" profiles were compared with the emotional profile of sub-standard performances.

Recalled best and worst performances

Our findings provide partial empirical support for the notion that multiple emotions (positively- and negatively-toned) have adaptational significance in their co-occurrence before and during task execution. Previous research focusing on assessment of single and discrete emotions was not focused on the interactive effects of different emotions. Our findings, although based on single-case studies, provide empirical support for the assumption that co-occurrence of different emotions is manifested in multiple appraisals inducing pre-event anticipatory emotions. These include challenge-related (P+) and benefit-related emotions and moderate threat-related (N+ emergency) emotions. In contrast with previous research relatively high level of benefit-related (positive outcomes and gain) emotions were not always detrimental to performance.

The absence of dejection-related emotions (N-) was observed in all three levels of performances (Fig.1) and co-occurring with the predominance of challenge-related emotions. On the other hand, the presence of positively-toned emotions (P-) before all three most successful competitions suggests that this pattern is consistent. This also

indicates a favourable condition during preparation for these events. High scores of P- in combination with challenge (P+) and moderate level in emergency (threat-related N+) indicates that interactive effects provide more substantial information and higher predictive validity. In support of this assumption the data on recalls of the three unsuccessful competitions supports the success-related profiles: the lowest scores were in P+ category (challenge-related) with moderate scores in emergency (N+) and dejection (N-) emotion category. The athlete was not quite ready for the competition but still maintained positive mindset in all these poor competitions.

Recall measures and prediction of actual performance

Recall measures were used to estimate the predictive validity of actual performances (Fig.2). Each athlete executed 25 shots which were classified into "better than standard", personally "acceptable standard", and "sub-standard" performance categories. We explored the possibility of using boxplots as a summary of frequency data and results showed clear coincidence of actual scores with success-related emotion profiles: predominance of P+, slightly lower with P-, the absence of N-, and low on N+. In contrast, a single actual sub-standard performance had a predominant P- (complacency in response to a favourable outcome) in a poor performance emotion profile.

Using Ordinal Logistic Regression (OLR)-based estimation of emotion intensity and probability curves for different performance levels (Kamata et al, 2002) for optimal performance of the same shooter across four emotion categories is less clear in a visual presentation of the same summary of actual scores. One practical problem with using the OLR-based approach to estimate intensity zones is that often there are not enough observations to develop the probability curves (Fig.3). The number of observations

required depends on the nature of the data. Although two observations per performance category are the minimum to estimate probability curves, it is important to note that the required observations depend to a large extent on data distribution. Thus, in the case of elite performers were data are narrowly distributed, more observations are needed until one obtains a balanced distribution of emotion intensities associated with all performance categories. Three to five observations per category are usually necessary. In addition, shooters need to perform optimally in current (actual) situations, which may not always be possible. Secondly, the OLR-based procedure is a post-performance (retrospective) method that can be used only after data were collected and its predictive validity still needs to be further examined. This method is actually a summary of available frequency data to categorize multiple scores but does not provide the criteria for predictions of forthcoming performances. Moreover, probability curves for all four categories can only be developed separately for each emotion and they do not capture the co-occurrence of four emotion categories. Boxplot representations of multiple emotions data seems an adequate option. Further research requires description and testing the validity of probability curves in prediction of forthcoming performance. It is important to clarify if probability curves need to be identified on each occasion or whether they can be used across several competitions once identified.

Correlational data (Table 3 & Fig.4 across three shooters N=60 observations) suggest that there are several types of interactive effects across different constellations between valence and functionally – the same or contrast impact positively-toned with positively toned (by increasing the total valence effects, or functionally predominant). Interestingly, only N- emotions (weak and de-motivational category reflecting a lack of resources) correlated negatively with performance scores. The other emotions had

apparently only an indirect impact on performance. Although data presented here was correlational, thus, not implying a causal link, this line of research may be good to pursue in the future.

Our findings suggest that recalled optimal and dysfunctional performances and related emotional experiences as assessed by the ESP-40 scale could be used in prediction of multiple current assessments. These results are also in line with the previously formulated assumptions that the prediction of performance should be based on the assessment of interactive effects rather than on separate emotions (Hanin, 2004, 2007). Interactive effects include the contrasts between and within four emotion categories and across eight form modalities of the psychobiosocial (PBS) state (Ruiz, Hanin, & Robazza, 2011). In our study, positively-toned helpful emotions (P+) and negatively-toned harmful emotions (N-) seemed to be the core categories that co-occur and through this interaction determine successful or unsuccessful performance.

It is important to note that ESP-40 (10 items in each of the four categories) is a basic form of the scale. However, to make the scale more personal and relevant for the athlete a shorter version for repeated assessment can be developed using the best five core items (ESP-20), or the best three core items (ESP-12) in each category.

This exploratory study includes three case studies, which implies that generalization of the results must be taken with caution. However, according to generalizability theory, in the case of idiographic approaches applied to elite level athletes, the estimation of emotional patterns based on several observations from one or few individuals also allows for generalization of findings (Hagtvet & Hanin, 2007).

One limitation of this study was that in recall of three “best-ever” and three “worst-ever” competitions, performance as a task execution process was not assessed.

Moreover, in the assessment of current performance, only outcomes were measured. Although in this study it was not possible to assess individual patterns in task execution, the action-centered profiling would be most relevant and a promising research direction in future research of performance-related PBS states (Bortoli et al. 2012; Hanin, 2010a, 2011; Hanin, & Hanina, 2009; Ruiz, et al 2011).

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EFECTOS INTERACTIVOS DE MÚLTIPLES EMOCIONES SOBRE EL RENDIMIENTO: ESTUDIO EXPLORATORIO DE TRES TIRADORES DE SKEET DE ELITE

PALABRAS CLAVE: modelo IZOF, predicción del rendimiento, interacción emocional, escala agregada.

RESUMEN: Este estudio investiga los efectos interactivos de múltiples emociones en el rendimiento (resultado) de tres tiradores de skeet de elite. La escala de emociones agregadas Emotional State Profile-40 (ESP-40; Hanin, 2010b) evalúa las experiencias emocionales recordadas asociadas con rendimientos exitosos y pobres y con rendimientos actuales. El rendimiento actual consiste en 20 series de 25 tiros. Los resultados confirman la utilidad práctica de la escala ESP-40 en la evaluación de los efectos interactivos de cuatro categorías de emoción en el rendimiento deportivo. Las emociones recordadas fueron instrumentales en la predicción de los resultados actuales. Se discute la utilidad de la regresión logística ordinal en la predicción del rendimiento.

References

Bortoli, L., Bertollo, M., Hanin, Y. L., & Robazza, C. (2012). Striving for excellence: A multi-action plan intervention model for shooters. *Psychology of Sport and Exercise*, *13*, 693–701.

Cottyn, J., De Clercq, D., Crombez, G., & Lenoir, M. (2012). The interaction of functional and dysfunctional emotions during balance beam performance. *Research Quarterly for Exercise and Sport, 83*, 300–307.

Fogaça J. L. & Pääkk, P. (2012). *Performance-related affective experiences in elite shooters during the preparation season*. Unpublished master's thesis. University of Jyväskylä, Finland.

Hagtvet, K. A. & Hanin, Y. L. (2007). Consistency of performance-related emotions in elite athletes: Generalizability theory applied to the IZOF model. *Psychology of Sport and Exercise 8*, 47–72.

Hanin, Y. L. (1997). Emotions and Athletic Performance: Individual Zones of Optimal Functioning Model. European Yearbook of Sport Psychology, 1, pp. 29-72.

Hanin, Y. L. (Ed.). (2000). Emotions in sport. Champaign, Illinois: Human Kinetics.

Hanin, Y.L. (2004). Emotions in Sport: An Individualized Approach. In: C. D. Spielberger (Ed.), Encyclopedia of Applied Psychology. Vol. 1 (pp. 739-750). Oxford, UK: Elsevier Academic Press.

Hanin Y. (2007). Emotions in Sport: Current issues and perspectives. In G. Tenenbaum & R.C. Eklund (Eds.). *Handbook of Sport Psychology* 3rd ed. (pp. 31-58). Hoboken, NJ: John Wiley & Sons

Hanin, Y.L. (2010a). Coping with Anxiety in Sport. In: Adam Nicholls (Ed.) *Coping in Sport: Theory, Methods, and Related Constructs*. Nova Science Publishers, Inc. (pp. 159-175).

Hanin, J. L. (2010b) From Anxiety to Performance-related Emotions in Top-Level Sport. *Kalokagathia*, 2-3, 59-76.

Hanin, J. (2011). Emotion-centered and action-centered profiling in elite sport: Incorporating the concept of individual differences. In: D. Milanovic & G. Sporis (Eds.) *Proceedings Book of the 6th International Scientific Conference on Kinesiology* (pp. 368-374), University of Zagreb, Zagreb, Croatia.

Hanin, J., & Hanina, M. (2009). Optimization of performance in top-level athletes: An Action-Focused Coping With the Commentaries. *International Journal of Sport Sciences & Coaching, 4*, 47-91.

Hardy, L. (1990). A catastrophe model of performance in sport. In J. G. Jones & L. Hardy (Eds.), *Stress and Performance in Sport* (pp. 81-106). Chichester, England: Wiley.

Hardy, L. (1996). Testing the predictions of the cusp catastrophe model of anxiety and performance. *The Sport Psychologist*, *10*, 140–156.

Jones, G. (1995). Competitive anxiety in sport. In S.J.H. Biddle (Ed.), European perspectives on exercise and sport psychology (pp. 128 -153). Leeds, UK: Human Kinetics.

Jones, M. V., Lane, A. M., Bray, S. R., Uphill, M. & Catlin, J. (2005). Development and validation of the Sport Emotion Questionnaire. *Journal of Sport & Exercise Psychology*, *27*, 407-431.

Kamata, A., Tenenbaum, G., & Hanin, Y. L. (2002). Individual zone of optimal functioning (IZOF): A probabilistic estimation. *Journal of Sport & Exercise Psychology, 24*, 189-208.

Martens, R., Burton, D., Vealey, R. Bump, L. & Smith, D. (1990). Development and validation of the Competitive State Anxiety Inventory-2. In R. Martens, R. S. Vealey & D. Burton (Eds.). Competitive Anxiety in Sport (pp. 117-190). Champaign, IL: Human Kinetics.

Martens, R., Vealey, R.S., Burton, D. (1990). *Competitive Anxiety in Sport*. Champaign, IL: Human Kinetics.

McNair, D.M., Lorr, M., & Droppleman, L.F. (1971). Manual: Profile of Mood States. San Diego: Educational and Industrial Testing Service.

Raglin, J. S., & Hanin, Y.L. (2000) Competitive anxiety and athletic performance. In: Hanin, Y.L. (Ed.). *Emotions in Sport*. Champaign, Illinois: Human Kinetics. pp. 93-111.

Robazza, C., Bortoli, L., & Hanin, Y. (2004). Precompetition emotions, bodily symptoms, and task-specific qualities as predictors of performance in high-level karate athletes. *Journal of Applied Sport Psychology, 16*, 151–165.

Robazza, C., Bortoli, L., Nocini, F., Moser, G., and Arslan, C. (2000). Normative and idiosyncratic measures of positive and negative affect in sport. *Psychology of Sport and Exercise, 1*, 103-116.

Robazza, C., Pellizari, M., Bertollo, M. & Hanin, Y. L. (2008). Functional impact of emotions on athletic performance: Comparing the IZOF model and the directional perception approach. *Journal of Sports Sciences, 26*, 1033–1047.

Ruiz, M. C., & Hanin, Y. L. (2004a). Idiosyncratic Description of Anger States in Skilled Spanish Karate Athletes: An application of the IZOF model. Revista de Psicologia del Deporte, 13 (1), pp. 75-93.

Ruiz, M. C., & Hanin, Y. L. (2004b). Metaphoric description and individualized emotion profiling of performance related states in high-level karate athletes. Journal of Applied Sport Psychology, 16 (3), 1-16.

Ruiz, M. C. & Hanin, Y. L. (2011). Perceived impact of anger on performance of skilled karate athletes. *Psychology of Sport and Exercise 12*, 242-249

Ruiz, M. C., Hanin, Y. L. & Robazza, C. (2011, September). Assessment of performance-related psychobiosocial (PBS) state: An exploratory study. A poster presented at the Annual Association of Applied Sport Psychology (AASP) conference, Honolulu, Hawaii.

Syrjä, P. (2000). Performance-related emotions in highly skilled soccer players: A longitudinal study based on the IZOF model. Unpublished doctoral dissertation, University of Jyväskylä, Jyväskylä, Finland.

Vyhandu, L. (1964). The research of multi-level biological systems. The application of mathematical methods in biology. Collection III. LSU Publishers, pp 19-22.

Table 1. Median and min-max range (in brackets) for pre-event emotions (shooter A).

	Emotion Categories			
Performances	Unpleasant harmful (N-)	Unpleasant helpful (N+)	Pleasant helpful (P+)	Pleasant harmful (P-)
Better than standard (n=11)	10 (10-11)	20 (19-20)	38 (37-40)	32 (30-32)
Standard (n=8)	10 (10-11)	20 (19-20)	38 (36-40)	32 (30-34)
Below standard (n=1)	12 (N/A)	19 (N/A)	33 (N/A)	36 (N/A)

Note. Emotion intensity ranges from 10 (minimum) to 40 (maximum).

Table 2. Lower and upper limits for prediction of optimal performance.

	Emotion categories			
Estimation Method	N-	N+	P+	P-
Recalled method				
Success-related intensity zones	(10, 10)	(20, 20)	(34, 36)	(34, 36)
Failure-related intensity zones	(22, 28)	(24, 27)	(19, 23)	(26, 31)
OLR-based method				
Optimal intensity zones	(10, 11)	(19, 20)	(37, 40)	(30, 33)
Non-optimal intensity zones	(>11)	(<19,>20)	(<37,>40)	(<30,>33)

Table 3. Intercorrelations between emotions before 20 series for 3 shooters.

Emotions	1	2	3	4	5	6	7	8	9	10
1. N-										
2. N+	.12									
3. P+	-.35**	-.40**								
4. P-	-.29*	-.45**	-.43**							
5. Pleasant	-.63**	-.80**	.58**	.43**						
6. Unpleasant	.62**	.81**	-.58**	-.42**	-1**					
7. Helpful	-.11	.44**	.58**	-.88**	-.18	.18				
8. Harmful	.11	-.42**	-.59**	.89**	.18	-.17	-.99**			
9. Strong unpleasant	-.34**	.83**	.26*	-.19	-.43**	.44**	.41**	-.39**		
10. Strong pleasant	.07	.11	.76**	-.88**	-.02	.01	.89**	-.90**	-.01	
11. Shooting score	-.26*	-.13	-.08	.25	.17	-.16	-.14	.14	.03	-.21

Note. Pleasant= P+ + P-; unpleasant = N+ + N-; helpful = P+ + N+; harmful = P- + N-; strong unpleasant = N+ - N-; and strong pleasant = P+ - P-; *p < .05, **p < .01.

Figure captions

Figure 1

Performance emotions before most successful and unsuccessful performances (shooter A).

Figure 2

Boxplots of emotion intensities prior-current and bar graphs prior-recalled performances (shooter A).

Note. Bar graphs A and B represent median of emotion intensities before three best performances; bar graphs C represents emotion intensities before three worst performances

Figure 3

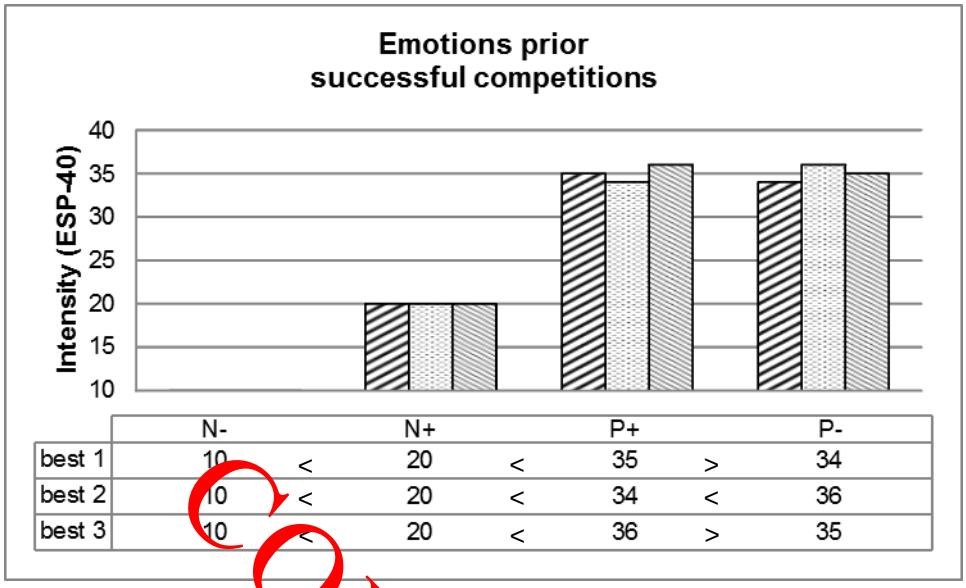
Probability curves based on intensities of four emotion categories (shooter A).

Note. OP = optimal performance; nOP/B = non-optimal performance with emotion intensity below average; and nOP/A = non-optimal performance with emotion intensity above average.

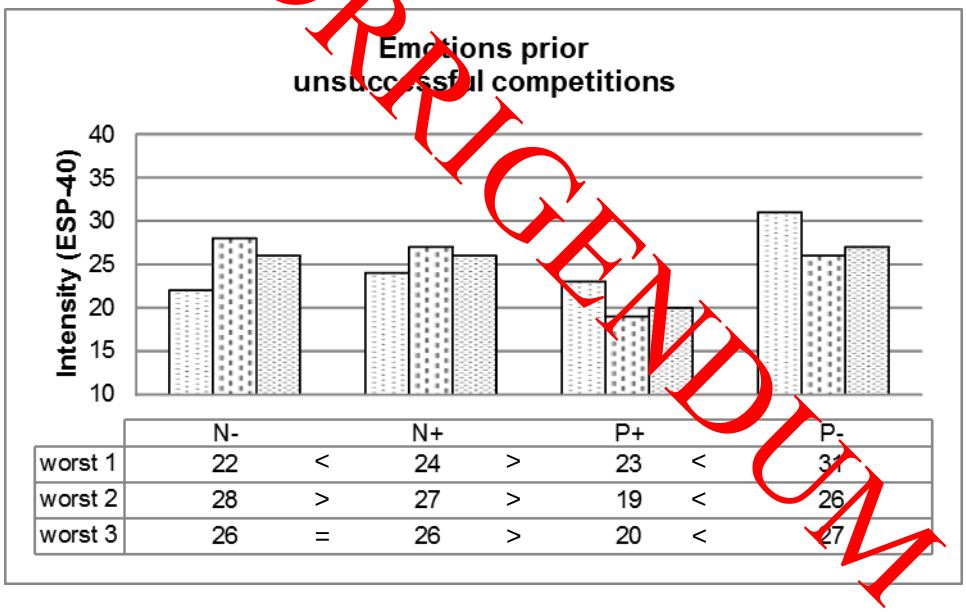
Figure 4

Minimum spanning tree for emotions before performance (n=60 observations).

Figure 1.

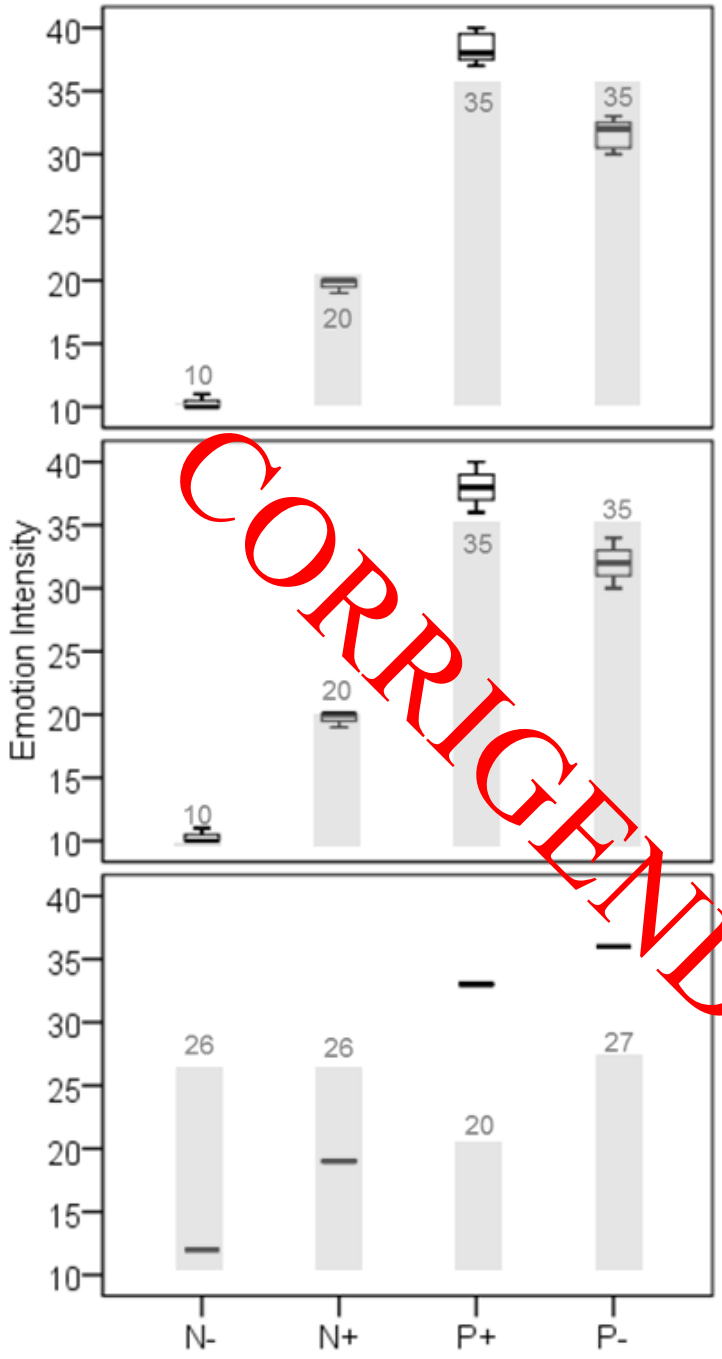


	N-		N+		P+		P-
best 1	10	<	20	<	35	>	34
best 2	10	<	20	<	34	<	36
best 3	10	<	20	<	36	>	35



	N-		N+		P+		P-
worst 1	22	<	24	>	23	<	31
worst 2	28	>	27	>	19	<	26
worst 3	26	=	26	>	20	<	27

Figure 2.



Better than standard performance

(n=11 shooting series)

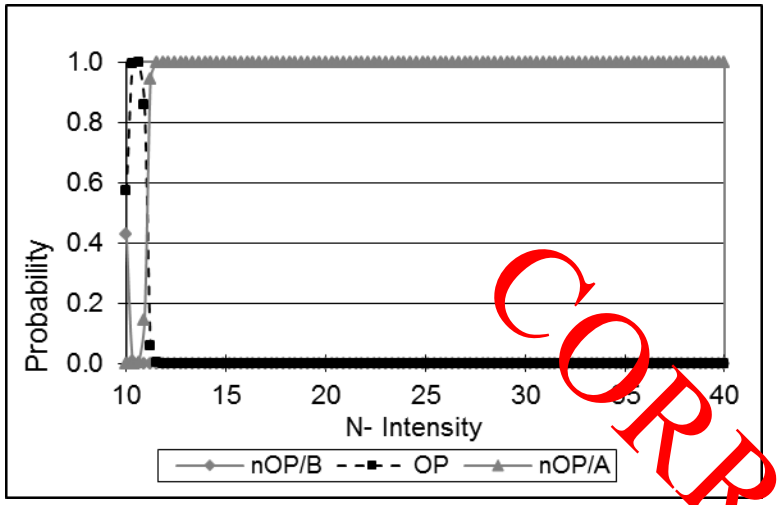
Standard performance

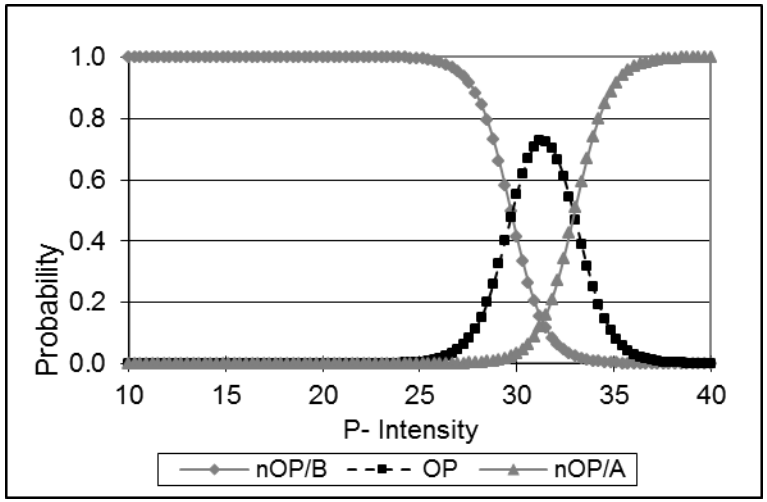
(n=8 series)

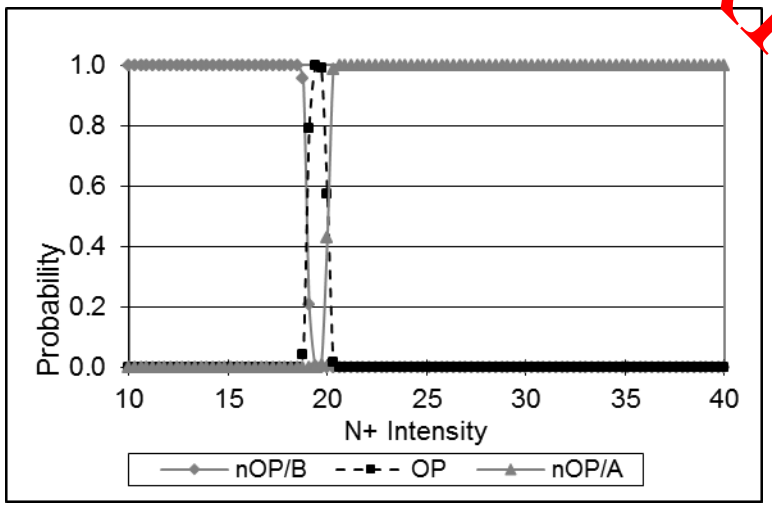
Sub-standard performance

(n=1 series)

Figure 3.







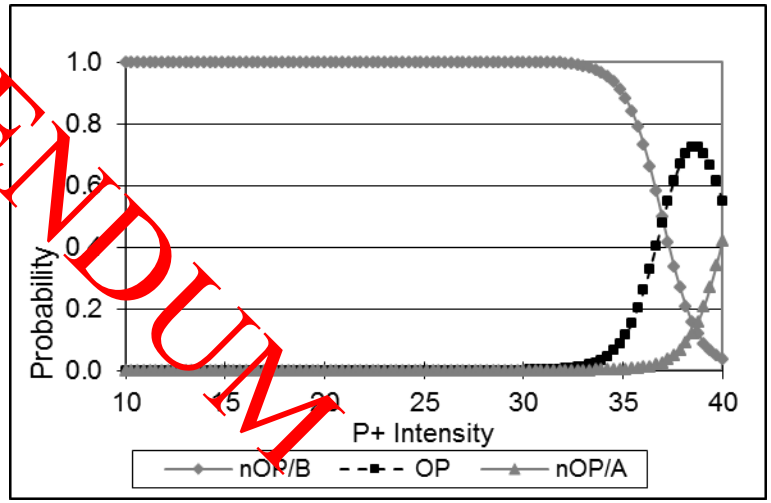
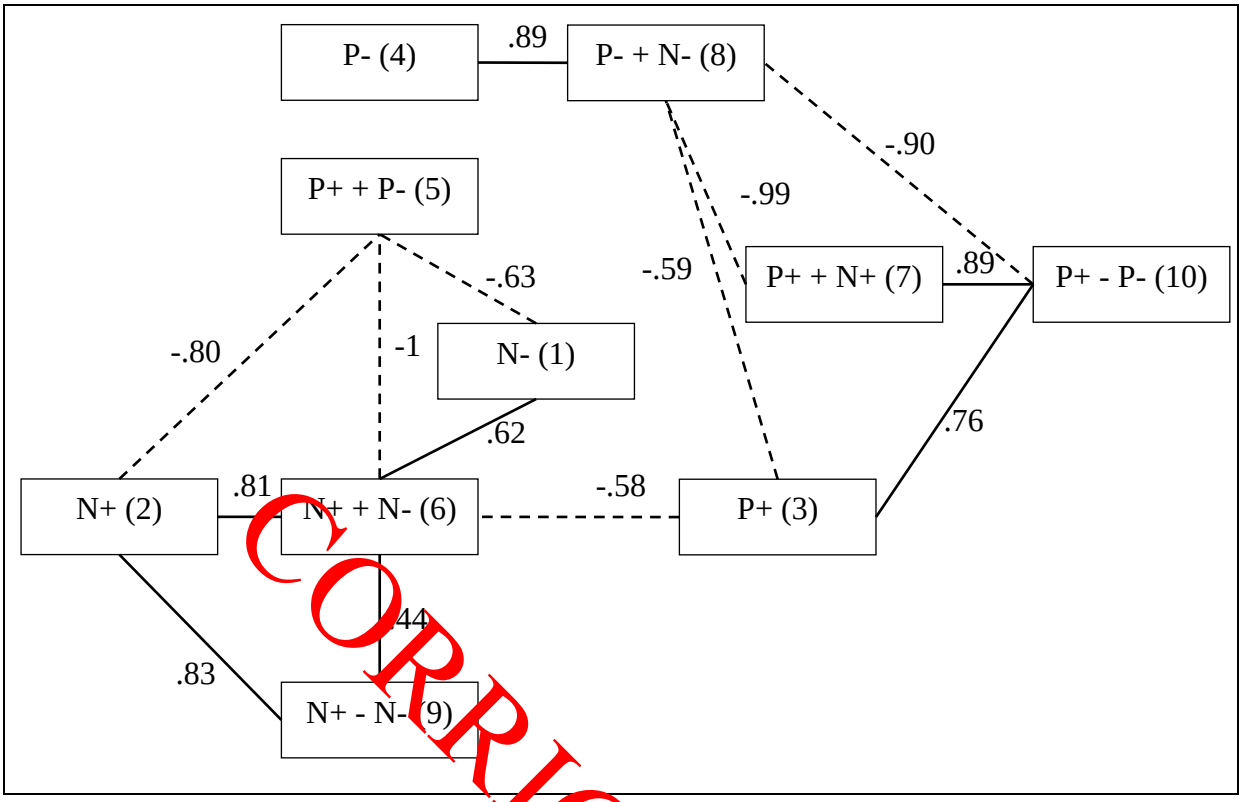


Figure 4



EMOTIONAL STATE PROFILE (ESP - 40)

The ESP helps to describe ***how*** you think ***you feel*** in different performance situations. There are no right or wrong responses! Make sure you:

- Consider how you actually feel (or felt), not how you would like to feel.
- Work across the page.
- Number the words in each row
- Give a 4 to the word that *best* describes you or that you relate to *best*.
- Give a 3 to the next best, then 2, and then 1 to the *least*.
- Make sure each row has a 4, 3, 2, and 1 (no duplicates)
- Go with your first reaction.

[_] Tired	[_] Tense	[_] Energetic	[_] Easy-going
[_] Sluggish	[_] Dissatisfied	[_] Confident	[_] Tranquil
[_] Reluctant	[_] Furious	[_] Charged	[_] Satisfied
[_] Doubtful	[_] Attacking	[_] Willing	[_] Joyful
[_] Sad	[_] Intense	[_] Motivated	[_] Happy
[_] Unhappy	[_] Angry	[_] Purposeful	[_] Pleased
[_] Upset	[_] Irritated	[_] Certain	[_] Comfortable
[_] Distressed	[_] Nervous	[_] Cheerful	[_] Calm
[_] Fearful	[_] Annoyed	[_] Enthusiastic	[_] Content
[_] Worried	[_] Restless	[_] Alert	[_] Relaxed
[_____]	**[_____]**	**[_____]**	**[_____]**
N-	N+	P+	P-

Instructions for scoring:

- Add up each column of the scale and put the totals below.
- Plot your scores & connect the points to create a graph