THE RELATIONSHIP BETWEEN AROUSAL ZONE, ANXIETY, STRESS AND SPORTS PERFORMANCE

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THE RELATIONSHIP BETWEEN AROUSAL ZONE, ANXIETY, STRESS AND SPORTS PERFORMANCE

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Abstract

The purpose of this study was to examine the relationship between optimal functioning zone, anxiety, stress, and athletic performance. It presents an up-to-date compilation of publications on the analysis of methods in previous scientific articles, valid data and a description of future uses. It only takes into account literature that may be relevant or helpful in understanding stressed athletic performance. It discusses the method and validity of hypotheses and approaches that have already appeared scientifically. It examines multidimensional approaches and discusses the suitability and implications of some of the newer and more complex models of stress and performance that are now available in the psychological literature. The results conclude that the relationship between stress and athletic performance is extremely complex and includes the interaction between the nature of the stressor, the cognitive needs of the task to be performed, and the psychological characteristics of the individuals performing it (JONES-HARDY, 2007). In many cases, it is not the professional training of the sport, the physical abilities, the general training that is decisive, but the psychological preparation (BALOGH et al., 2014). A further aim of the article is to provide a historical overview of the use, testing and measurement of IZOF and other applied models.

Keywords: *physiological and psychological arousal, stress, anxiety, optimal arousal, zone, motivation and emotions*

THEORETICAL BACKGROUND

Examining the performance of athletes is not new. We have already become aware of a number of influencing factors, both at the intrinsic and extrinsic levels. Nowadays, it is not enough to simply prepare the players and develop their sports skills. Physical and psychological factors need to be considered simultaneously when identifying talented athletes, and a holistic approach should be taken in which motor skills and psychological characteristics can be studied and developed simultaneously (KISS-BALOGH, 2019). Mentally, psychologically, you also need to be able to provide maximum in the field of sports skills. The high level of expectations and the rapid pace of development of results can put incredible pressure on athletes. Occasionally, stress, various forms of anxiety, and motivation threaten during a sporting career. Motivation, stress, anxiety, self-confidence, the level of activity and activation of the organization, excitement can be a factor influencing performance (Figure 1). Since 1943, a number of theses and theories have come to light as to which psychological concept may be closest to reality, which context is most substantiated and proven.

Figure 1: Components of the optimal zone level (according to Kiss-Balogh's, Balogh's, Hebb's, Hardy-Parfitt's, Hanin's & Robazza's rewiev)

According to Donald O. Hebb's (1955) theory of optimal arousal (further considering the Yerkes-Dodson relation), there is an optimal level of arousal that an athlete can achieve the best performance. Inadequate stress levels can significantly impair the execution of fine-coordination movements due to musculoskeletal relationships, and thus also sports performance (BALOGH, 2014). Fazey and Hardy's (1988) disaster model (based on Hebb's thesis of optimal arousal levels) drew attention to the relationship between anxiety and performance. The theory makes a distinction between an athlete with high and low trait anxiety. He claims that as anxiety increases, the athlete transcends the level of optimal arousal and in direct proportion to this his performance begins to decline spectacularly. „Other nonparametric procedures have shown that the critical decrease in performance was greater in the state of high cognitive anxiety" (HARDY-PARFITT, 1991). According to the IZOF (Individualized Zone of Optimal Functioning) model of Yuri L. Hanin (1978, 1986, 2000), each athlete has a specific, characteristic optimal functioning zone. He further developed Hebb's theory of optimal arousal levels, while also taking into account the individual presence of anxiety and excitement. „The zone, through the degree of anxiety, examines an athlete's performance individually. So while one type of athlete provides the best performance in a low anxiety zone, the other brings out the maximum in moderate to high anxiety" (BALOGH et al., 2015). If an athlete's actual condition exceeds the optimal zone, he or she is likely to perform below his or her capabilities. The notion inside and outside the zone „describes the range of intensity that has an optimal and dysfunctional effect on individual performance" (HANIN, 2013). When determining an individual's optimal zone, great emphasis should be placed on emotional patterns related to performance, as it can involve both positive and negative emotions. „Potential excitement can reduce complexity without simultaneously increasing negativity" (WANN-BRANSCOMBE, 1995).

„The concept and nature of the zone has emerged as a key concept of peak performance in sport" (BALOGH, 2014). „Previous research suggests that feeling in a zone is strong when the demand for the task is equal to the person's ability level" (KENNEDY et al., 2014). Hanin (2000) argued that „the concept of zone implies a categorical conceptualization of the effects of emotion intensity, in which optimal (or non-optimal) performance is predicted to occur when emotion intensity is within (or outside) previously established optimal intensity zones. located" (ROBAZZA, 2006). The meaning and concept of the word arousal are interpreted differently in many scientific studies (Figure 2). It is referenced in several ways in the available literature, linked to other psychological factors. Some dissertations refer to the state of alertness as activation or activation level. Others correlate with motivation, building theory on that. There are also cases of stress and anxiety in the articles related to it, however, most of the literature uniformly describe excitement, excitement, level of excitement (HANIN, 2013, LAMBOURE-TOMPOROWSKI, 2010, MIKICIN et al., 2018). Traditionally, excitement describes the intensity of a body's physiological functions as a reaction to person-environment relationships. However, the definition of excitement as a bodily reaction captures only one aspect of these (person-environment) relationships (HANIN, 2013). Published studies focus on the assessment of exercise-induced excitement, however, the methods used to manipulate participants levels of excitement are not uniform (LAMBOURNE-TOMPOROWSKI, 2010). There is a correlation between the nature and complexity of a given task and the level of activity. The more difficult a task is, the lower the optimal level of activation. Separating anxiety and excitement is not an easy task. The symptoms of the phenomena may be similar, but anxiety is primarily an emotional phenomenon, and excitement is more of a physiological phenomenon. An important difference is that as long as anxiety is always accompanied by something negative, a feeling can be pleasant. A sufficiently high arousal level is a prerequisite for racing. One of the benefits of a high arousal level is that it leads to a narrowing of attention, meaning the athlete rules out any distracting stimuli that could impair their performance. Sometimes, though, it is coupled with poor performance - there are psychological reasons behind it. The increased arousal level narrows the athlete's focus until, at an optimal point, all unnecessary cues disappear and the athlete becomes able to focus solely on the most important information.

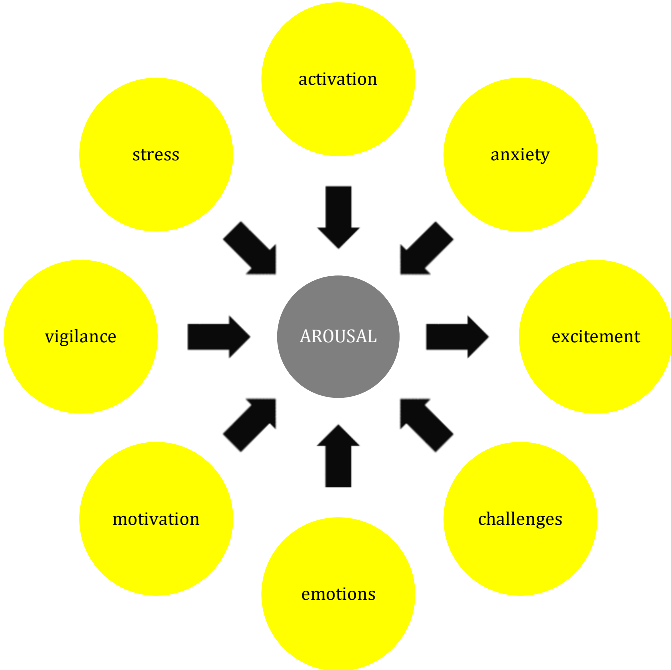


Figure 2: Interpretations of the meaning of arousal (according to Hanin's, Lambourne-Tomporowski's, Mikicin's rewievs)

METHODS

To prepare my study, I used the following databases available on the Internet: pubmed.ncbi.nlm.nih.gov, scientdirect.com, researcgate.net, tandfonline.com, journals.humantikenics.com, scholar.google.com, onlinelibrary.wiley.com, and chapters of scientific books. Out of 76 processed scientific publications, 32 were selected and used by me. I used the following keywords: arousal and sport performance (hits: 89,800 pcs, processed: 29 pcs, used: 9 pcs), optimal arousal in sport (hits: 35,900 pcs, processed: 20 pcs, used: 4 pcs), arousal and anxiety hits: 460,000 pcs, processed: 11 pcs, used: 7 pcs), optimal zone in sport (hits: 84,100 pcs, processed: 9 pcs, used: 5 pcs), optimal arousal measurement (hits: 194,000 pcs, processed: 7 pcs, used: 7 pcs). 27 studies were conducted between 2001 and 2020, and 4 between 1970 and 1995. So I tried to review a total of 50 years of work on specific topics. Research with athletes has included elite athletes, mostly among the young adult age group. Among the sports were: basketball, handball, tennis, bowling, cross-country skiing, athletics, cycling, running and football.

Subjective measurements

„Research in sports psychology generally neglects the subjective status and experience of athletes as it focuses on performance and competitive outcomes" (KIMIECIK-STEIN, 2008).

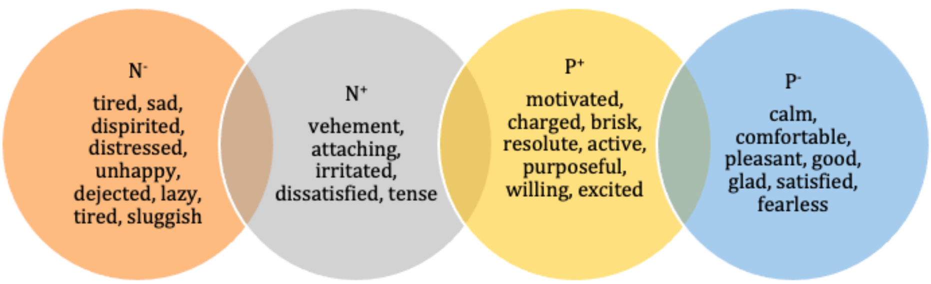
The STAI (Spielberger State-Feature Anxiety Questionnaire) test is used to measure the strength of anxiety. It helps to distinguish a temporary state of anxiety from a general tendency to anxiety. The Anxiety Scale points to transient tensions, anxieties, and restlessness, which can be triggered mainly by physical danger and psychological stress.

The trait anxiety scale is used to detect and screen for anxiety disorders. Spielberger and Gaudry (1970) also examined the effects of anxiety and intelligence on learning among 72 college students aged 17–26 years. Separate analyzes were made of the early and later stages of learning. The results showed that in the early stages of learning, high anxiety facilitated the performance of both high and low IQ students, however, in both stages of learning, high IQ students performed better than those with low IQ (GAUDRY-SPIELBERGER, 1970).

The CSAI-2 (Competitive State Anxiety Inventory-2) questionnaire is linked to the names of Martens et al. This was the first sports-specific test procedure. The test examines athletes pre-race anxiety patterns as well as their level of self-confidence. It examines a practical life situation in terms of somatic and cognitive anxiety as well as self-confidence. Jim Taylor (1987) examined psychological traits to predict performance. 84 athletes – in cross-country, tennis, basketball – completed an adapted questionnaire from university sports teams covering topics of self-confidence, somatic anxiety, and cognitive anxiety (CSAI-2). After each competition, he received subjective and objective performance evaluations. The results show that all three psychological traits significantly predicted performance in both fine motor anaerobic sports and motor aerobic sports (TAYLOR, 1987).

The aim of the study by Robazza et al. (2008) was to examine the effect of emotions on sports performance. 56 Italian athletes took part in the process. Both STAI and CSAI-2 questionnaires were used. Individual scores were categorized as near or far from optimal to dysfunctional zones and were recorded as independent variables (ROBAZZA et al., 2008). „Emotions play a central role in sports performance" (JONES, 2003).

The aim of Yuri L. Hanin's (2003) qualitative analysis of subjective experience was to provide an overview of selected data collection techniques on subjective emotional experiences related to athlete performance. His work focused on a review of data collection techniques that assessed the specific content and quality of athletes performance-related emotional subjective experiences (HANIN, 2003). He examined existing practices of individualized assessment of emotional states in sport, with particular emphasis on the specifics of subjective experiences. He described that both positive and negative emotions can improve and worsen the performance of athletes (Figure 3).



3. Figure: Induvidualized emotion profiles, positive-negative effects (based on the study of YurI L. Hanin)

Objective measurements

Hans Berger (1924) was the first scientist to create an EEG (electro encephalogram) to detect arousal levels. A study by Miroslaw Mikicin et al (2018) analyzed changes in attention and activation of athletes after neurofeedback-EEG training. The study involved military university students. Neurofeedback-EEG training improved shooters 'attention levels but had no effect on their optimal excitement levels. „Numerous sources have demonstrated that neurofeedback-EEG training helps athletes achieve better concentration, improve their resilience to stress, improve their well-being, achieve inner peace and relaxation, and eliminate their internal tension" (MIKICIN et al., 2018).

Marcin Kołodziej and colleagues (2019) published that a number of methods can be used to read emotional states, including heart rate measurement, ECG analysis, EEG analysis, and electrodermal activity measurement (EDA). Unfortunately, all of these methods have weaknesses, and the effectiveness of the known solutions is still unsatisfactory. „Some features of EDA have been shown to be useful in recognizing the level of excitement" (KOŁODZIEJ et al., 2019).

The aim of the study by Noteboom, Barnholt, and Enoka (2001) was to determine the effects of trait anxiety and stress intensity on excitement and motor performance. Subjects in the anxiety group received an electric shock and experienced a significant increase in cognitive and physiological excitement compared to baseline and control subjects. Heart rate, systolic blood pressure, and electrodermal activity were elevated during stress, while diastolic blood pressure was unchanged. Cognitive and physiological excitement usually increased with the intensity of the stress and was accompanied by a change in balance. These findings show that the increase in excitement and deterioration of balance increased with trait anxiety and the intensity of the harmful stimulus. The level of anxiety in the condition was assessed using the CSAI-2 test and the visual analog scale (VAS). Subjects treated with electric shock stress experienced significant changes in cognitive and physiological excitement. Cognitive and physiological excitement increased with the intensity of stress and was associated with decreased performance (NOTEBOOM et al., 2001).

In a study by Arent and Landers (2003), 104 college-age participants performed simple response time tasks while driving a bicycle ergometer. Prior to the task, a questionnaire (CSAI-2) was completed to assess the effects of cognitive and somatic anxiety. Optimal performance of the task was experienced at 60-70% of maximum excitement. „In addition, for the task used in the present study, it was only meant of somatic anxiety as measured by the questionnaires" (ARENT-LANDERS, 2003).

In the work of Hardy, Parfitt, and Pates (2008), eight experienced athletes bowled with high and low cognitive anxiety. On each of these occasions, the physiological excitement was manipulated (reduced, increased) by physical work. „Statistical procedures showed that subjects with best cognitive anxiety had significantly better performance and worst had significantly worse performance than those with low cognitive anxiety. The results did not provide clear support for the disaster model of anxiety and performance" (HARDY et al., 2008).

Perkins, Wilson, and Kerr (2010) induced 22 male and 6 female elite athletes into motivational states. Personalized, directed imaging techniques and specific breathing techniques were used to alter psychological and physiological excitement. „The significant increase in performance came when the excitement was high. Heart rate and other indicators of parasympathetic and sympathetic nervous system activity have not been shown to mediate between psychological excitement and performance" (PERKINS et al., 2010).

Lambourne and Tomporowski (2010) examined the effects of acute exercise on cognitive performance using meta-analytical techniques. Cycling was associated with increased performance during and after training, while running on a treadmill led to a deterioration in performance during exercise and a slight improvement after exercise. „Cognitive performance may improve or deteriorate depending on when measured, the type of cognitive task selected, and the type of exercise performed" (LAMBOURNE-TOMPOROWSKI, 2010).

Adam J. Cocks and colleagues (2015) examined the effect of anxiety using a dynamic, time-limited task. Skilled and less-skilled tennis players waited for their opponents to strike in low and high anxiety conditions. Involvement of high and low level cognitive processes during waiting and how these may relate to anxiety was observed. Skilled players recorded higher levels of accuracy and efficiency than their less skilled counterparts. Efficiency was significantly reduced under high and low anxiety conditions. During misdirections, anxiety was most detrimental to performance (COCKS et al., 2015).

A study by Kamuran Yerlikaya Balyan et al (2016) examined the association between personality, competitive anxiety, somatic anxiety, and physiological excitement in athletes with high and low anxiety. 50 men played a computer-simulated football game. Electrodermal activity (EDA) was measured and a CSAI-2 questionnaire was completed. The winners had higher cognitive anxiety and lower physiological excitement than the losers. „Based on these findings, they concluded that the neurotic personality of athletes can influence their cognitive and physiological responses in a competition" (BALYAN et al., 2016).

Kalman F. Szucs and colleagues (2018) the effects of stress on the central nervous system and gastrointestinal smooth muscle depressants electromyography detected in rats. In the functional gastrointestinal (GI) tract, slow-wave myoelectric signals can be detected by electromyography (EMG). „The smooth muscle EMG instrument is able to measure the level of acute stress and is suitable for studying the central nervous system affecting drugs acting through the GI tract in alert rats. This is the first tool to measure the stress response through GI tract responses. The technology opens new perspectives in the therapy and diagnosis of psychosomatic disorders" (SZŰCS et al., 2018).

Balogh and Donka (2020) conducted cross-sectional studies on 24 team athletes. The VTS DT software package was used to measure cognitive abilities and the MDE Heidelberg Stress Holter (gastro, HR, TH, GSR) was used to measure stress. The stress holter complex results found a difference in the stress-tolerant ability of experienced and young team athletes. „Experienced athletes show less out of balance than their young peers, showing more stable, balanced performance" (BALOGH-DONKA, 2020).

RESULTS

Exercise enhances faster decision making and performance. Excitement facilitates mental processes and improves memory storage and retrieval. Positive effects were observed after training, independent of the study population. Changes in the ability to perform mental tasks were indicated by the subjects, both during and after training. Some reported mental sharpness and mental clarity, while others reported mental disorientation and difficulties following exercise. The relationship between various physical activities and cognitive function has been investigated in more than 150 empirical studies over the past 50 years. „A common assumption in these theories is that cognitive performance depends on the allocation of energy resources to meet the needs of tasks" (LAMBOURNE-TOMPOROWSKI, 2010). It is hypothesized that exercise alters the brain systems that influence mental resources in the performance of cognitive tasks. „Evaluation of exercise-induced excitement was the focus of most published studies, and the methods used to manipulate participants levels of excitement were not uniform" (LAMBOURNE-TOMPOROWSKI, 2010).

Researchers in sports psychology unanimously agree that there is a high level of stress and anxiety in competitive sports. To date, much research is being done to understand how anxiety can affect athletic performance. It is well known that sport has the potential for high stress and anxiety, and that the practice and application of psychological strategies can be helpful in treating anxiety (FORD et al., 2017). In a meta-analysis of 19 studies (146 effect sizes based on 6387 participants) published between 1978 and 1997, Jokela and Hanin (2010) examined the predictive power of anxiety zone on and off and determined the magnitude of the overall effect. STAI and CSAI-2 questionnaires were used. The notion that unpleasant emotions are always bad for performance and pleasant ones are good has been questioned by the IZOF model from the very beginning, when it was proven that anxiety can be not only harmful but also beneficial. Pleasant and unpleasant emotions can be helpful, harmful, or even both, depending on the individual's evaluation (ROBAZZA, 2006). In an emotion-performance study, a review of the IZOF model was applied using emotions and psychobiosocial conditions. Several issues were addressed: the definition of emotion and related terms, the description of the basic characteristics of emotion, the explanation of the emotion-performance relationship, and the dynamics of emotions. According to Hanin (2000), „emotions can improve or worsen performance during practice and competition". The implications for internships have been presented to help athletes increase their optimal self-awareness and maximize their performance (ROBAZZA, 2006). Critics have argued that IZOF is essentially an individual difference „theory" without a difference variable. However, the model has emphasized from the outset that "individual differences in emotions should be examined first before examining the impact of personality and environmental factors" (ROBAZZA, 2006). The findings of this work resulted in IZOF's ability to demonstrate how pre-competitive anxiety affects performance. The number of studies related to the model is constantly increasing. It continues to provide a fertile foundation for studying and understanding the fundamental and applied problems of sports psychology in order to achieve the ultimate goal of gaining personal insight into how mental processes work and thus help them achieve their maximum performance (RUIZ et al., 2015). Thanks to Hanin et al. (1978), the IZOF model provides a solid framework for sports psychology research.

Regarding arousal, more recent studies have found that „the reticular seemingly diffuse, loosely connected network neuronal connections in the formation are actually much more structured and have more specific functions than the researchers initially thought" (STAMATELOPOULOU et al., 2018). Despite the widespread view that arousal is considered a general activation, it is no longer considered by psychologists or neuroscience practitioners to be some simple, unified process. An individual's response to stress can be influenced by two factors: the average level of anxiety and the intensity of the stressor. Individuals with a high trait anxiety index tend to respond to stress with increased cognitive and physiological excitement and deteriorating motor performance (NOTEBOOM et al., 2001). The distinction between emotions depends primarily on cognitive processes. However, this view also reflects that arousal is a mandatory corollary of emotion. From here, it is only a step to evoke emotions (as well as impulses) characterized by objectively difficult to measure, difficult to verbalize, and difficult to access subjective experience to arousal that is relatively objectively measurable by physiological methods.

Table 1: Summary of the results of subjective and objective measurements

Who?	Who?	What?	How?	With what?	Zone identification
GAUDRY-SPIELBERGER	students	anxiety, intelligence	subjectively	questionnaire	not know
TAYLOR	open sports	anxiety, self-confidence	subjectively	questionnaire	not know
ROBAZZA et al.	open sports	emotion, sports performance	subjectively	questionnaire	not know
JONES	open sports	emotion, sports performance	subjectively	questionnaire	not know
HANIN	open sports	emotion, sports performance	subjectively	questionnaire	know
BERGER		arosual level	objectively	EEG	not know
MIKICIN et al.	students, open sports	arousal level	objectively	EEG	know
KOŁODZIEJ et al.		emotional states	objectively	EEG, ECG, EDA	know
NOTEBOOM et al.		anxiety, stress, arousal	objectively / subjectively	EEG, ECG, EDA, questionnaire	know
ARENT-LANDERS	students	anxiety, performance	objectively / subjectively	ergometer, questionnaire	know
HARDY et al.	open sports	anxiety, performance	objectively	physical work	not know
PERKINS et al.	open sports	arousal level	objectively	imaging procedure	not know
LAMBOURNE-TOMPOROWSKI		sports performance	objectively	meta-analitics, physical work	not know
COCKS et al.	open sports	anxiety, performance	objectively	physical work	not know
BALYAN et al.		anxiety, arousal	objectively / subjectively	EDA, questionnaire	not know
SZŰCS et al.	patkány	stress	objectively	EMG	not know
BALOGH-DONKA	open sports	stress	objectively	MDE	know

Source: Németh (2020)

Currently, the main focus is on qualitative analysis of experiences rather than their presentation. I found few scientific dissertations that attempted to quantify the existence of the zone. The use of questionnaires and the detection of subjective experiences are most common in publications measuring the optimal zone and arousal level. Instrumental measurements are also gaining prominence, but they do not provide the maximum support for the existence of the zone and its impact on sports performance. Measurements were made between the relationships between athletic performance, anxiety, intelligence, self-confidence, emotions, stress, arousal, and exercise. In the course of these, the concept of optimal arousal and the optimal zone level, the possibilities of achieving it, and the subsequent subjective experiences are discussed. However, I hypothesize that the use of the MDE Heidelberg stress holter could be appropriate to obtain quantitative data as well as to objectively determine and measure the optimal zone during action.

DISCUSSION

Daniel M. Landers attempted to re-examine the relationship between excitement and performance. He stressed that the role of attention in the fulfillment of most sports knowledge should be emphasized, with special emphasis on the phenomenon of narrowing of attention. „It also discusses the measurement of anxiety and suggests that it be seen as a multidimensional construct consisting of physical, behavioral, and cognitive components” (BALOGH et al., 2015). The lack of differentiation between anxiety, excitement, and stress was highlighted by Krane’s (2012) research, which also suggested the need for a multidimensional perception of anxiety. The rationale for this is the assumption that perceived physiological excitement is generally seen by researchers as a negative effect (KRANE, 2012).

Despite comprehensive research to determine the relationship between stress and performance, there is little systematic study of the mechanisms underlying the relationship. Recently, researchers have begun to empirically address the attentional mechanisms underlying the theory of stress, anxiety, and excitement. „Given the critical role of visual attention in sports-related expertise, they deal with different identification and processing of visual cues in the event of anxiety. New evidence shows that when anxiety exists, it often leads to ineffective strategies” (JANELLE, 2002).

Much research has been done on IZOF’s anxiety suggestions, however, scientists have recently begun to explore new developments in its psychobiosocial model. „There have been few attempts to contrast IZOF and other views. Comparing and combining these views can contribute to the understanding of psychological traits and state factors that interact with performance” (ROBAZZA, 2006). Ruiz et al. (2015) began to take several sports-specific approaches. Their attention was extended beyond the study of anxiety toward performance-related emotions. The aim was to review the emotion-performance relationship through the position of the IZOF model. The level of excitement can vary independently of the emotions, and the emotions can be experienced with different levels of excitement. Increased emotional excitement usually reduces the space of attention, which improves or degrades performance depending on the task and the individual.

Positive effects occur when the narrowing of attention blocks external distractions so that the person can focus on signs that are relevant to the task. However, further increase in excitement leads to too narrow a focus, which can undermine an athlete's ability to pay attention to important cues, process information properly, and make appropriate decisions. „Future IZOF research directions will focus on multimodal profiling of emotional and non-emotional experiences related to athlete performance and assessment of individual optimal performance" (RUIZ et al., 2015). „The number of studies related to IZOF is constantly increasing. Thus, it is clear that the model continues to provide a fertile basis for studying and understanding the fundamental and applied problems of sports psychology in order to achieve the ultimate goal of giving athletes personal insight into how mental processes" (RUIZ et al., 2015). This can help them achieve maximum performance. They strive to achieve new levels of performance at all levels of competition, making the sport an ideal context for examining optimal human functioning (SWAN et al., 2017). „Continuously improving performance, pushing physical barriers and striving for ever-better results are top goals for athletes. These cannot be achieved solely on the basis of innate talent and the acquisition of technical and tactical knowledge. It is equally important to understand mental processes and be able to develop and support them professionally" (KISS-BALOGH, 2019). By understanding the psychological states behind excellent performance in sport, we are able to provide recommendations and interventions that help athletes achieve them and utilize them as much as possible (SWAN et al., 2017).

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