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Comparison of Psychological and Physiological Changes of the Anxiety in Various Sports

Sertan KAGAN[1], Ziya KORUC[2], Gozde LATIFOGLU[3]

Abstract

The aim of this study is to determine a more convenient physiological measurement instead of HR (the physiological indicators of competition anxiety). STAI, CSAI-2 and ProComp+Biofeedback were used before and after the competition (N=38). Data were analyzed with repeated measure ANOVA and Multiple Linear Regression. Non-significant difference was found between the results of HR, EMG, skin transmission, EEG, state anxiety and self confidence before and after the competition. Significant difference was found between the respiration, skin temperature, cognitive, somatic and trait anxiety before and after the competition. The post competitive variables are significant predictors of post competitive cognitive and somatic anxiety. As a result respiration, skin temperature measurements and questionnaires can be used instead of Heart Rate.

Keywords: heart rate, competitive state anxiety, biofeedback, EEG, EMG, respiration.

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Introduction

Competition is an activity during which athletes try to display their entire physical and spiritual capacity and test themselves following a lengthy physical and psychological preparation period (Baser, 1986). That physical capacity of an athlete is in good condition does not necessarily mean that s/he is ready for the competition. During any competition, serious changes take place in the skill level and physiological status of an athlete regardless of the level of importance of that competition. Variations in the performances of athletes mostly stem from the conflicts that athletes experience in their minds. In such type of situations the stimulation level of an athlete increases at an extra involuntary level (Harris & Williams, 1993).

Just as the case in all fields of our lives, fulfillment of the tasks that are given to us requires an optimal level of stimulation so as to activate energy in sports related tasks (Zaichowsky & Baltzell, 2001). Each athlete approaches the competition with different levels of stimulation. Different stimulation levels occur in each athlete. Stimulation is defined as "physiological activation or autonomic reaction" by Gould and Krane (1992). According to Malmo (1959), stimulation can occur in an interval that changes from deep sleep to excessive excitement and is best defined as a general blending of physiological and psychological activation or, in other words, motivation structure that represent the intensity level of behaviour (performance) (Lander, 1980). There is a correlation between the stimulation level and cognitive anxiety level of the body and cognitive anxiety increases in athletes as stimulation increases. Sports psychologists Males and Kerr (1996) found out that athletes experience the highest level of stress when they approach the game which is called as the pre-competition period.

These techniques can be used in order to determine the best performance levels and anxiety levels of athletes in several researches; they were also used for treatment purposes in clinical literature (Tremayne & Barry, 2001; Konttinen, Lyytinen, & Viitasalo, 1998; Schedlowski & Tewes, 1992; Zaichkowsky & Baltzell, 2001; Solberg *et al.*, 1998; Woodman & Hardy, 2001; Caruso *et al.*, 1990). Schedlowski and Tewes (1992) measured the heart beats of three different groups of parachuters before jumping, namely elite, medium and beginner, and found out that the heartbeats of the "beginner" group were faster compared to the other two groups. These findings tell us that the athletes in beginner parachuting group were more stimulated compared to the athletes in other two groups. Among these techniques, heart rate (HR) is the most frequently used type of evaluation which is used as an indicator of anxiety in the field of sports. However, the conducted studies show that HR is not a much desirable measure for anxiety (Hackfort & Schwenkmeger, 1989; Hatfield & Landers, 1983; Zaichkowsky & Baltzell, 2001).

The purpose of this study is to determine a more suitable physiological measure instead of HR, which is one of the physiological indicators of competition anxiety.

For this purpose the following hypothesis have been developed: (1) there will be differences in the heart rate, muscle electrical activity, respiration, skin transmittal, skin temperature and electroencephalography (EEG) values obtained before and after competition; (2) there will be difference between anxiety scores obtained before and after competition; (3) there will be correlation between the anxiety scores and heart rate, muscle electrical activity, respiration, skin transmittal, skin temperature and electroencephalography (EEG) values obtained before competition; (4) there will be correlation between the anxiety scores and heart rate, muscle electrical activity, respiration, skin transmittal, skin temperature and electroencephalography (EEG) values obtained after competition.

Method

Research sample

A total of 70 people were included in the study that consisted of the athletes of 4 soccer (A team), 1 men's volleyball (A team), 1 ladies' basketball (A team), 1 men's handball teams and 1 athleticism team at First League level in the Turkish Republic of Northern Cyprus; however, measurements of 32 people could not be made due to various reasons (the anger felt by the coach, game result, unwillingness of the athletes etc.). For such reasons 38 athletes, 31 men and 7 women, were included in the study whose measures could be taken before and after the game (X =21.28; ss=2.89).

Data collection tools

Spielberger State-Trait Anxiety Inventory (STAI): This inventory was translated into Turkish by Oner and Le Compe and following its translation Oner (1987) conducted reliability tests. The inventory was developed by Spielberger, Gorsuch and Cushene and consists of two sub-sections. These sections are measured in two ways, namely "state" and "trait". Test-retest-retes reliability was found to be between 0.16 and 0.54 for state anxiety scale and 0.73 and 0.86 for trait anxiety scale. According to the alpha coefficients related to the internal consistency of the scale, it has been found out that the scale has a high internal that varies between 0.83 and 0.92 (Oner, 1987).

Competition State Anxiety Inventory-2 (CSAI-2): Competitive State Anxiety Inventory-2- CSAI-2 was developed by Martens, Burton, Vealey, Bump and Smith in 1982. The latest version of the scale consists of 27 question articles. Evaluations are made in cognitive anxiety, somatic anxiety and self-confidence dimensions which are the components of CSAI-2 Competitive State Anxiety (Martens, Vealey and Burton, 1990). Koruc (1998) made the adaptation of CSAI-2 to Turkey.

In a study which was conducted for the repeatability of the scale, cognitive anxiety has showed .961, somatic anxiety showed .929, and self-confidence showed .949 correlation within the period of one month. As the competition approached the changes in anxiety began to increase. Measurements made in two-week intervals revealed correlations at .561, .672, 541 levels respectively, whereas the correlation found two days before the competition turned out to be at 230, .223, .321 level.

ProComp/BioGraph Biofeedback: The tool was developed by Thought Technology Ltd. in Canada. (Thought Technology Ltd. 2180 Belgrave Avenue Montreal, Quebec, Canada, H4A 2L8). The system name of the tool is Procomp+/BioGraph. The name of the tool is Procomp+ Encoder and its number is SA7008P. The tool which is used for measuring muscular electrical activity, brain waves, blood pressure, skin temperature, skin transmittal and respiration has 8 sensor entries. These sensors are *Input A:* EEG1(electroencephalography), *Input B:* EEG2, *Input C:* EMG1 (muscular electrical activity meter), *Input D*: EMG2, *Input E*: SC/GSR (skin transmittal meter), *Input F*: TEMP (skin temperature meter)**,** *Input G*: BVP (heart rate meter/minute), *Input H*: RESP (respiration meter). In addition the tool has computer connection and it has the necessary software (BioGraph Software, version 2.1, MINDMEDIA, Physiological Monitoring and Feedback System/ Training and Workshop, MAASBRACHT, THE NETHERLANDS). The tool operates by connecting to the computer. During measurement B and D sensor entries were not used. B sensor entry was reserved for second EEG meter sensor and D sensor entry was reserved for second EMG meter sensor; therefore these canals were not used.

Collection of Data

During measurements before and after competition in five different athletic branches, the following method was followed for each group of sports and each athlete. After the athletes took shower and rested enough for 1.5 hour before and after each competition, their values were measured again after 1 hour.

One and a half hour before the competition, CSAI-2, STAI paper-pencil tests, EEG, EMG, respiration, skin transmittal, skin temperature and BVP measurements were conducted on the group on which preliminary test study would be made in a silent environment where no air conditioner or similar device existed. The same procedure was applied to the group on which final test would be conducted one hour after the competition following the period used by athletes for taking shower and relaxation. Measurement period: 20 minutes was spared for each athlete as adjustments had to be made for EEG measurement.

Points that require attention during EEG measurement: first, the measurement interval was adjusted as 2-40 Hz in BioGraph computer program during EEG measurement and FIR: *bandpass filter* and *Hamming* was used as filter. By making the adjustment that way, EEG reading was made easier. When ENG channel was being formed, the same method was followed but measurement interval was chosen as 45-70 Hz. This interval is an interval within which the muscular movement and tension that can affect EEG measurement can be captured. However this interval is also an interval in which electricity statics can be captured (50 Hz in Europe and 60 Hz in USA) an effort has been paid to avoid environments that can cause high electrical static during measurements. As such tools as ground lamp or extension cord can cause an activity that is equal to 60 Hz (Thompson and Thompson, 2002) measurements were made away from this type of factors. In some cases it is difficult to adjust the high beta square effectiveness in EEG from high frequency EMG effectiveness. High beta square effectiveness between 24 and 34 Hz can mean thinking deeply and concerns instead of muscular tension. The 45-70 Hz interval was chosen as it can help us to tell the difference between muscular tension and thinking deeply (Thompson and Thompson, 2002). When EEG measurement is being adjusted attention should be paid to the artifacts that represent electrical activities whose real source is not neural activities. For this reason unreal variations in wavelength which are called “artifact” are not handled as true EEGs. As each athlete is different from another, we have to understand how the eye movements and EMG artifacts are while observing their EEGs. For this reason athletes were asked to blink, move their eyes and look to right and left and up and down. The period of measurements showed a change between 1 and 3 minutes. The lowest zone interval within which BioGraph program can perform statistical procedures is between 1 and 3 minutes; this is why this interval was chosen (BioGraph and ProComp+ Manuel, 2002). Measurements were completed after necessary adjustments were made.

Although 70 athletes in total were reached during the study, whose first measurements were made, the post-game measurements were conducted on only 38 athletes due to a variety of reasons (game result, the coach not giving permission etc.).

Analysis of the data

According to the data obtained from this research, Measurements Repeated on Single Factors Analysis of Variance was conducted so as to determine whether there was a difference between the measurements conducted before and after the game. Multiple Linear Regression Analysis technique was used so as to be able to explain any potentially existing relations with a mathematical equation between one of the variables measured by ProComp+ and paper-pencil tests (CSAI-2, STAI).

Results

In this section findings are handled according to the hypothesis order. Analysis for variance in repetitive measurements has been applied to the data obtained with the purpose of testing the hypothesis that there will be difference between heart rate, muscular electrical activity (EMG), respiration, skin transmittal, skin temperature and electroencephalography (EEG) values taken from the athletes before and after the competition. Findings regarding analysis for variance in repetitive measurements are provided in *Table 1*.

Table 1. Repeated measures variance analyses results of pre and post-test values of athletes' heart rate, EMG,respiration, skin transmittal, skin temperature, EEG.

Variables	Source of Variance	Mean(n=38)	Sd	F (1,37)	p	η²
HR	Pretest	93.73	18.77	3.63	0.064	0.089
	Posttest	85.81	16.97			
EMG*	Pretest	1.01	0.47	1.06	0.309	0.028
	Posttest	0.90	0.54			
Respiration	Pretest	37.33	1.86	4.22	0.04**	0.103
	Posttest	38.10	1.74			
Skin Transmittal	Pretest	8.45	4.12	0.164	0.688	0.004
	Posttest	8.83	5.02			
Skin Temperature	Pretest	26.42	4.11	4.66	0.03**	0.112
	Posttest	28.02	3.56			
EEG*	Pretest	1.85	0.44	0.389	0.537	0.010
	Posttest	1.91	0.44			

**Logaritmic trasnformation applied. **p<.05*

When *Table 1* is examined, it can be seen that there is no significant difference between the values heart rate (F(1, 37) = 3.63; p>.05, eta square 0.089), EMG [F(1, 37) = 1.066; p>.05; eta square 0.028], skin transmittal [F(1, 37) = 0.164; p>.05. eta square. 0.004] and EEG [F(1, 37) = 0.389; p>.05, eta square , 0.010] values before and after the game. Significant difference has been found between respiration [F(1, 37) = 4.22; p: 0.04; eta square , 0.103] and skin transmittal [F(1, 37) = 4.66; p: 0.03; eta square , 0.112] values before and after the game.

Analysis for variance in repetitive measurements has been applied to the data obtained with the purpose of testing the hypothesis that there will be difference between anxiety scores obtained from athletes before and after the competition. Findings regarding Analysis for variance in repetitive measurements are provided in *Table 2*.

Table 2. Repeated measures variance analyses results of pre and post-test values of competitive anxiety.

Variables	Source of Variance	Mean (n=38)	Sd	F (1,37)	p	η^2
State Anxiety	Pretest	44.47	11.82	0.080	0.778	0.002
	Posttest	45.13	9.47			
Trait Anxiety	Pretest	42.78	7.94	5.267	0.028*	0.125
	Posttest	47.78	10.23			
Cognitive Anxiety	Pretest	21.65	3.62	5.405	0.026*	0.127
	Posttest	20.23	3.59			
Somatic Anxiety	Pretest	20.0	3.92	5.845	0.021*	0.136
	Posttest	18.10	3.83			
Self Confidence	Pretest	29.28	5.06	1.22	0.276	0.032
	Posttest	28.28	4.85			

*$p<.05$

When *Table 2* is examined, it can be seen that there is not a significant difference between state anxiety (F(1, 37) = 0.080; p>.05, eta square,0.002) and self-confidence [F(1, 37) = 1.220; p>.05, eta square, 0.032] before and after the game. Significant difference has been found between constant anxiety (F(1, 37) = 5.267; p<.05, eta square, 0.125), cognitive anxiety [F(1, 37) = 5.405; p<.05, eta square, 0.127] and somatic anxiety [F(1, 37) = 5.845; p<.05, eta square, 0.136] scores.

Multiple regression results as regards the relations between physiological values obtained after competition and cognitive and somatic anxiety are given in tables 3 and 4. As standard (direct) approach application was used in multiple regression analysis, regression equation was formed; all independent variables were included in the equation regardless of their contributions to the variance explained in the dependent variable. Here the common impacts of all predictor variables on dependent variable have been examined.

Table 3. Regression results for cognitive anxiety predicted by posttest physiological variables

Variables	B	SE_B	Β	β^2	t	p
HR	.047	.034	-.225	0.050	-1.400	.171
EMG	-1.626	1.142	-.246	0.060	-1.434	.164
Skin Transmittal	.108	.114	.150	0.025	.943	.353
Skin Temperature	.407	.173	.403	0.162	2.345	.025
Respiration	.233	.342	.113	0.012	.681	.501
Constant	4.751	16.280			.281	.781
R= 0.623, R^2=0.388, F(1,37)=4.056, p=0.006						
Y=4.751+0.047.HR-1.626.EMG+ 0.108.Skin Transmittal+0.407.Skin Temperature+ 0.233.Respiration						

Table 4. Regression results for somatic anxiety predicted by posttest physiological variables

Variables	B	SE_B	B	β^2	t	p
HR	-.101	.038	-.446	0.198	-2.664	.012
EMG	-.198	1.269	-.028	0.000	-.156	.877
Skin Transmittal	.022	.127	.029	0.000	.175	.862
Skin Temperature	.224	.193	.208	0.043	1.162	.254
Respiration	-.007	.380	-.035	0.001	-.202	.841
Constant	23.374	18.088			1.292	.206
R= 0.578, R^2=0.334, F(1,37)=3.214, p=0.018 Y=23.374-0.101.KAH-0.198.EMG+0.022.Skin Transmittal+0.224.Skin Temperature- 0.007.Respiration						

Discussion

In this research significant difference was found between heart rate, EMG, skin transmittal and EEG values of athletes obtained before and after competition, whereas significant difference was found in respiration values and skin temperature values taken before and after competition. Landers, Wang and Courtet (1985) measured HR values of the test subjects in three different situations and stated that there were significant differences between three different situations. According to the results of the analysis that they conducted in order to determine the causes of this difference, they saw that high stress levels caused more stimulation compared to lower stress levels and comfortable environments. HR levels of the subjects were found higher under high stress conditions compared to lower stress conditions (Caglar, 1996). Departing from the assumption that stress level would be higher before the competition, the hypothesis that HR values of the athletes before the competition would be higher than the post-competition measurements; however, no difference has been detected in this study between heart rates measured before and after the competition. This result is similar to the results found by Caglar (1996) and Yilmaz *et al.* (2002).

Hackfort and Schwenkmezger (1989) stated that analysis depending on physiological measurements were method-dependent. Although the physiological symptoms of emotive situations can be measured, it has been displayed that there are a number of certain reactions for different kinds of excitements. This means that an increase in heart rate can indicate anger and rage as well as happiness and excitement. Occurrence of such type of behaviors depends on the perception and evaluation of the stimulant situation in a cognitive manner. Therefore the result obtained after the competition, be it success of failure, can increase heart rate depending on any kind of emotion that occur after both results.

In this study it was expected that EMG, skin transmittal and EEG values, which are accepted among the physiological components of somatic anxiety would display difference between pre-competition and post-competition periods;

however, at the end of the measurement the expected difference was not found. According to the "reaction stereotype" prototype of Lacey, Bateman and Van Lehn, an athlete *A* shows can increase in heart rate under a stress condition whereas an athlete *B* experiences abdominal and intestinal activity (Williams, Landers & Boutcher, 1993; Caglar, 1996). Hatfield and Landers (1983) stated that when a single physiological variable of a group is examined only, other individually stress-related systematic reactions cannot emerge. Therefore as the values obtained before and after the competition are compared through average values, it can be that significant differences were not obtained depending on the method employed, as stated by Hackfort and Schwenkmezger. When the heart rate of an athlete increases, the heart rate of another athlete can remain unchanged whereas his/her muscular tension increases. At this point the data obtained from average values of pre-competition and post-competition periods can be meaningless. When anxiety theories are concerned, the IZOF theory (Singer, Murphy &Tennant, 1993) which is one of the most widely used theories in sports, basically handles the information provided above. This means that stimulation situations of the athletes are handled individually and the stimulation interval within which each individual displays their best performance is determined and established. In summary, as the physiological reaction showed to stress situation by each athlete can display difference, it can be that differences expected before and after competition in EMG, skin transmittal and EEG values were not obtained in this study.

Significant difference has been found between the respiration and skin temperature values obtained before and after competition. The respiration values of the athletes obtained before competition are higher than their post-competition values. It can be claimed that athletes are more anxious before the competition. Respiration level is accepted as one of the most important physiological variables of anxiety (Ronsen *et al,* 2002; Berntson, Cacioppo & Quigley, 1993). Several types of anxiety that follow physical stimulation display numerous similar characteristics that can be explained as preparation for physical effectiveness. An increase occurs in sympathetic tonus, cardiovascular system increases blood exit from the system and glands in the skin begin to secrete sweat. Hormones are secreted through HPA (Hypothalamic – pituitary- adrenal) mechanism. Several changes in the brain that occur can be detected as electrical, magnetic or blood flow changes. Significant difference has not been found between state anxiety scores of the athletes obtained before competition and after competition; however, significant difference has been discovered between constant anxiety scores obtained before and after competition.

According to Oner (1987) static anxiety is temporary and changes depending on the relevant situation. However, static anxiety levels of athletes before and after competition did not show any difference in this study. At this point either athlete did not experience tension and anxiety as they overlooked their rivals and the competition was not an essential one, or they experienced tension and anxiety depending on the result of the competition and therefore their static anxiety scores before and after the competition did not show any difference. According to the results, static anxiety scores obtained both before and after competition were found to be over the limit value accepted as normal for people who are not athletes (1987). According to these data, it can be considered that the perceptions of athletes for the environment and conditions before and after the competition remained unchanged. The data obtained by Caglar (1996) and Yilmaz *et al.* (2002) support these findings.

Constant anxiety scores of athletes before and after the competition display significant difference in favour of the post-competition period. At this point the reason might be that athletes gave average answers as per social popularity principle so as to avoid any negative opinions that the researcher could develop about them. Or it might be that they gave biased answers to questions by disregarding their emotional statuses so as to keep their morale raised. It might be that they gave more objective answers after the competition depending on the result of the competition as their attitudes before the competition were not needed any more.

In this study significant difference was found between cognitive anxiety and somatic anxiety scores obtained before and after the competition. No significant difference was found between self-confidence scores obtained before and after the competition. Krane's study (1994) displayed that cognitive anxiety increased at the time of the competition, whereas self-confidence decreased concurrently. Hanton, Thomas and Maynard (2003) performed measurements at five different moments before the competition (1 week before, 2 days before, 1 day before, 2 hours before and 30 minutes before). At the end of the study, the intensity of cognitive and somatic anxiety showed increase at measurements taken 2 hours and 30 minutes before the competition, whereas self-confidence decreased. The intensity of cognitive anxiety showed an increase from 1 week to 2 days, 1 day to 2 hours and 2 hours to 30 minutes. The intensity of somatic anxiety increased from 1 week to 2 days and from 2 hours to 30 minutes. Finally, the intensity of self-confidence presented an increase from 1 week to 2 days.

Findings obtained from this study show that cognitive and somatic anxiety increases just before competition, whereas self confidence remains unchanged; after the competition self confidence still remains unchanged whereas cognitive and somatic anxiety decreases. Findings obtained from this study displayed findings similar to those obtained by Krane (1994), Koruc, Altay & Yilmaz (2004), Hanton, Thomas & Maynard (2003). As competition approached an increase was observed in the cognitive and somatic anxiety of athletes whereas no change was observed in their self-confidence level.

No correlation was found between static, cognitive, somatic anxiety and self-confidence scores before competition and heart beat rate, muscular electrical activity, respiration, skin temperature and brain electrical activity values. Obtained data show similarities with those obtained by Caglar (1996), Yilmaz *et al.* (2002), Galucci & Williams (2001), Gerstein *et al*.(2015).

Deffrenbacher claimed that perceived physiological reactions (excitement, somatic anxiety etc.) and real physiological reactions (heart beat rate, blood pressure etc.) should not be perceived as identical as performance is affected independently. According to Karteroliotis and Gill there is no significant relation between physiological (HR, blood pressure) and psychological measurements (somatic anxiety) of the anxiety (Caglar, 1996). Caruso *et al.* (1990) could not find any significant relation between the psychological measurements and frontal EMG measurements, which is among physiological measurements of anxiety in cases of success and failure. Topkaya (2015) hereby underlines the importance of the willingness of psychological help.

The research found out that there is no significant relation between static and constant anxiety and self-confidence scores, on one hand, and HR, EMG, skin transmittal, skin temperature, respiration and EEG values, on the other. Landers *et al.* (2002) examined the relation between competition static anxiety scores and heart beat rates of 15 female athletes and found no significant relation between these two variables. Yan, Lan & Gill (1984) found some data similar to those obtained by Landers et al. The findings obtained by Caglar (1996), Yilmaz *et al.* (2002), Galucci & Williams, (2001), Caruso *et al.* (1990) support the results obtained by this study.

Conclusions

Significant relation has been found between cognitive anxiety and somatic anxiety scores, on one hand, and heart beat rates, muscular electrical activity, skin transmittal, skin temperature, respiration and EEG values, on the other. However, when physical variables are taken independently, significant relation can be seen between HR and somatic anxiety. In conclusion, findings obtained from this study do not support most of the hypothesis of the study. There is still no clarity about the physiological parameters of anxiety. It might be that the athletes included in this study reacted with different physiological parameters to anxiety. Due to this reason, it is probable that significant relation was not found between anxiety scores and physiological parameters; another possibility is that experience levels of athletes and the importance of the game affected the results about correlation.

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