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The Study of the Relationship between Flow and Cortisol Release under Stressful Situations

Hassan Sabzaligol[1], Hadi Nojavan[2]
[1]M.S. in Physical Education and Sports Sciences, Tehran University, Iran (has_sabz@yahoo.com)
[2]M.S. in Physical Education and Sports Sciences, Tehran University, Iran

***Abstract**: Flow is an enjoyable experience and occurs when individual fully immersed in an activity. Based on Stress Exchange Model, if individuals evaluate situational challenges as threats and beyond their skill levels, stress will occur. But if the task is assessed as challenge, flow can also be experienced in stressful situations. Flow is between the fatigue and anxiety spectrum. Therefore, when people are experiencing flow, they can also experience moderate arousal. Recent studies have shown a positive relationship between flow and physiological arousal, but no research has been conducted to examine the relationship betweenflow and high arousal in response tostressful situations of team sports yet. Therefore, the aim of the present study is to answer this question: 'Is flow related to the physiological response of cortisol release in stressful situations of team sports? To this aim, 24 students of physical education were divided into 4 teams, based on their performance level and according to the research purpose, and each team competed with the other three teams. Before and after each competition, salivary cortisol samples of the athletes were taken and at the end of eachcompetition, the athletes completed theflow scale. The collected data has been analyzed by Analysis of Covariance (ANCOVA). The results show that there is an Inverted-U relationship betweenflow andcortisol release, and the average cortisol concentration facilitates the experience of flow, while more or lesscortisol release interferes with the experience of flow. Using the literature of Stress Exchange Model (such asLazarus and Folkman, 1984) and in parallel withCsikszentmihalyi (1990), it can be said that if situational demands are assessed as challenges, they can lead to the flow experience [2]. As a result, flow is associated with the moderate level of arousal that is experienced as a challenge and reminds moderate and positive forms of stress, such as good stress.*

I. INTRODUCTION

Flow is an enjoyable experience and occurs when an individual is fully immersed in an activity. Thepsychological experience of flow can occur during the performance of challenging activities, in which the difficulty level of the task goes with the individual's skill level (Csikszentmihalyi and Csikszentmihalyi, 1988). Flow is characterized by high attention, but without any mental attempt, sense of control, losing self-consciousness andtransformation of time and the experience of joy and pleasure (Csikszentmihalyiand Nakamura, 2010).

Regarding the physiological processes,flow has already been proved to be associated with the activity of hypothalamus-pituitary-adrenal axis (HPA) (Keller et al., 2011; Peifer et al., 2014, 2015) and autonomic nervous system (ANS) (De Manzano et al., 2010; Keller et al., 2011; Peiferet al., 2014, 2015). In a correlational research,flow during playing the pianowas accompanied with the increased heart rate, blood pressure, activities of major zygomaticus muscle and also deep breath and decreased heart rate variability (HRV) (De Manzano et al., 2010). Bruya(2010) describesflow as a state of veryhigh attention and effortless which is achieved by the interaction between the positive effects and high attention, where both sympathetic and parasympathetic system are activated.

In contrast,flow is also correlated with the tension raised by the mental pressure and load (Keller et al., 2011). In an experimental study, the physiological responses of the participants exposed to a balanced task of skill-demand, similarities to the physiological responses in relation to salivary cortisol release and heart rate variability were shown during stress (Keller et al., 2011), which reflects the activation of thesympathetic system and HPA axis. The participants played Tetris, a video game, in one of the three levels of skill-challenge (suitable, weariness and fatigue and/or overload).The results show that thesalivary cortisol in balance group of theskill-challenge (to induce theflow) was the highest. The participants in this group released more cortisol than that of the overload group (where the situational demands were beyond the skill). However, cortisol response of the participants in the overload group may be caused by the low commitment to the responsibility because the participantsmight not consider the responsibility that is important, which is the prerequisite of the perceived threat (BlascovichandMendes, 2000; BlascovichandTomaka, 1996). Moreover, Keller et al (2011) observed a relationship betweenthe salivary cortisol release of the experimental groups of manipulated and non-manipulated levels ofskill-challenge with the self-report levels of theflow. These studies on how cortisol releaseis related to the task difficulty give insight, but give no insight about the relationship withthe flow. The second case is still an open and unanswered question, and so is the Inverted-U structure betweenthe flow and cortisol release.

Manipulating the skill-challengelevel of the situation, the self-report levels of theflow must be related to the psychological-physiological indices, such as salivary cortisol level. After all, it is not still clear that whether exposing individuals to a responsibility with more immersion can bring the same results. Recently, the results of a study show that the moderate activity of the HPA axis is related to the highest flow scores (Peifer et al., 2014). In this study,the physiological arousal was induced by Trier Social Stress Test (Kirschbaumet al., 1993) prior to the start of the complex computer-based task. The individuals with high and low cortisol responses reported the lowest level of theflow and those with the moderate low cortisol responsesreported the highest level of theflow. The findings ofPeifer et al. (2014) state that there isan Inverted-U relationship between theflow, sympathetic activities and HPA axis. However, the high arousal was triggered by a stressful task, prior to the inducedflow of the task. It is not still known that whether the relationship between the activities of theHPA axis andtheflow can be observed without causing high arousal, prior to the inducedflow of the task. Therefore, the question is still open that whether an Inverted-U structure can be observed in a self-involved activity, which is perceived as important by individuals.

The present study focuses on two questions: 1) How competitive challenge levels influence the cortisol release? 2) Is there a relationship between experiencingflow and cortisol release? The study was conducted on the students of physical education ofQom University, 2016. The participants were divided into four teams, each consisting of 6 individuals. Futsal, as a facilitating sport forflow, was selected for the following reasons. First, in the previous research, the evidence show that team sports facilitate experiencingflow (Russel, 2001). Second, regarding the individuals' performance during the practice and in the class, their skill level is obvious.

The first hypothesis of the research was that the futsal players of Team 2 in competition with those of Team 3, gained higher flow scoresthan the players of Team 1 and Team 4.

The second hypothesis was that thefutsal players of Team 2 in competitionwith those of Team 1 released more cortisol than whenin competition with Team 3 and released less cortisol in competition with Team 4 than when in competition Team 3.

Regarding the hypotheses in relation to the Inverted-U structure between arousal and performance (Yerkes and Dodson, 1908) and the consciousness and cortisol release (Born at al., 1989) and the above findings, a second-degree relation is predicted between the flow andcortisol release, wherethe flow must be at its highest level during the moderate concentration of thecortisol. On the other hand, the factor of challenge-skillbalanceofthe flow is related only to the sympathetic nervous branch (Peifer et al., 2014). Furthermore, the increased task demand is associated with the increasedcortisol release (Fibiger et al., 1986) and the low level of the challenge-skill balance ofthe flow (Rheinberg, and Vollmeyer, 2003). Therefore, the third hypothesis of the research is that there is an Inverted-U relationship between theflow andcortisol release in the athletes of thepresentresearch.

II. METHODOLOGY

The general research designis experimental, regarding the application purpose and data gathering.The general research design is of experimental pretest-posttest type.

Statistical Sample

The participants were 24students of physical education, ranging from 18 to 23 years old. All of theparticipants were selected from the students of physical education ofQom University.

Research Instruments

Zellbio'sSalivary Cortisol Test Kit: The concentration of the salivary cortisol was measured in the laboratory using thesalivary cortisol test kit, manufacturedin Germany by Zellbio Company, with the sensitivity of 1 ng/ml according to ELISA techniqueand based on the instructions of the kits.

The Flow State Scale-2: The Flow State Scale-2 has been developed by Jackson and Eklund (2002). The reason for choosing this instrument is the researches that have shown thatthe Flow State Scale-2 is able to measure the flow state and provide the conceptual and consistent statistical measurement of the dimensions of the flow in physical activities.

Statistical Methods

After gathering the data, the statistical tests of Analysis of Covariance (ANCOVA) were done. To guarantee the normality of the data and homogeneity of the variances, Kolmogorov-Smirnov test, Shapiro-Wilk test and Leven test were respectively used. The results were tested at significance level of $p<0.05$.

Research Findings

First, the mean and the descriptive data related to the cortisol release after the competition and the flow were calculated, which are shown in Table 1.

Research variables	Research groups	Mean	SD	N
The amount of the cortisol release after the competition and adjusting the pretest scores	High challenge competition	16.89	.62	6
	competition with the challenge proportionate to the skill	13.46	.51	6
	Low challenge competition	8.89	.79	6
	Total	13.07	3.42	18
flow	High challenge competition	111.67	8.64	6
	competition with the challenge proportionate to the skill	164.17	9.78	6
	Low challenge competition	89.83	12.54	6
	Total	33.56	121.88	18

Table 1: Descriptive statistics of the cortisol changes in futsal players of Team 2

Before giving any statistical tests, the normality of the research variables was examined through Kolmogorov-Smirnov test and Shapiro-Wilk test. Table 2 shows the test results.

Variable	Kolmogorov-Smirnov test			Shapiro-Wilk test		
	Statistic	Df	Sig.	Statistic	Df	Sig.
Cortisol release before the competition	0.145	18	0.124	0.912	18	0.094
Cortisol release after the competition	0.167	18	0.200	0.907	18	0.078
Flow	0.181	18	0.199	0.909	18	0.082

Table 2: Kolmogorov-Smirnov test and Shapiro-Wilk test to examine the normality of the research variables

As it can be inferred from the findings of Table 2, since the achieved significance level inKolmogorov-Smirnov test and Shapiro-Wilk test in theresearch variables, is more than the criterion amount of 0.05. Therefore, it can be said that the examined variable distribution in the statistical sample was normal and the research hypotheses can be tested through parametric tests. To examine the presupposition of the equality of the variances of the flow and cortisol release variables in the research groups,Leven test was used. The results of Leven test are shown in Table 3.

Variables	F	Df_1	Df_2	Significance level
Flow	0.912	2	15	0.423
Cortisol release after the competition	0.463	2	15	0.638

Table 3: The results of Leven test to examinethe presupposition of the equality of the variances of the flow and cortisol release after the competition

The above table shows that thevariances of the flow and cortisol release after the competition were equal in all the three levels of the competition and no significant difference was observed, which reveals the reliability of the next results. Regarding the findings of Leven test, the analyses related to the intersubjective effectswere examined, the results of which are shown in Table 4.

Resources	Dependent variable	SS	Df	MS	F	Sig.	Chi Square
Competition	Flow	17516.778	2	8758.389	80.156	0.000	0.914
	Cortisol release after the competition	113.220	2	56.610	127.965	0.000	0.948
Error	Flow	1639.000	15	109.267			
	Cortisol release after the competition	6.193	14	0.442			

Table 4: The results of ANCOVA of the effects the challenges of the competition in the flow and cortisol release after the competition

According to Table 4, in three levels of the competition of the subjects, there was a significant difference in the flowvariable ($F_{(2, 15)}$ =80.156, $p<0.0005$). As the flow of the players of Team 2 in competition with Team 1 (challenge beyond the skill) and Team 4 (challenge below the skill) was significantly lower than their scores when in competition with Team 3 (challenge proportionate to the skill) and the flow scores of Team 2 in competition with Team 1 (challenge beyond the skill) were higher than their flow scores in competition with Team 4 (challenge below the skill).As the cortisol release of the players of Team 2 in competition with Team 3 (challenge proportionate to the skill) was significantly lower than the cortisol release of the players in competition with Team 1 (challenge beyond the skill). Also thecortisol release of the players of Team 2 in competition with Team 3 (challengeproportionate to the skill)was significantly higher than their cortisol release when in competition with Team 4 (challenge below the skill).

III. DISCUSSION AND CONCLUSION

Based on Canal Flow Model, when people assess the tasks as challenging but doable, using their skills, they will experience the flow. This situation is cited as challenge-skillbalance (Csikszentmihalyi, 1975). In contrast, if the task demand is too low, it will lead to the individuals' fatigue. Therefore, the ideal and optimal level of the challenge-skill to achieve an ideal level of the challenge and as a result facilitation of the flow experienceis required. It is notable that assessing the situational challenges and the individuals' abilities is based on their experience and mental perceptions and not on the objective standards. Based on this model, the first research hypothesis has been that the futsal players of Team 2, in competition with those of Team 3 (the challenge of the competition proportionate to the players' skill)got higher scores in the flow than in competition with Team 1 (the challenge of the competition beyond the players' skill) and in competition with Team 4 (the challenge of the competition below the players' skill). The results confirmed theresearch hypothesis and the players of Team 2 in competition with Team 3 got the highest flow scores, which supports the idea that when there is an ideal and favorable balance between the competition challenges and the athletes' skills, and the individual's skills are able to overcome these challenges, the flow will be experienced at a higher level. The research results were in parallel with those of Peifer et al. (2014) and Fullagar et al. (2013).

Based on Canal Flow Model, flow is located between the fatigue and anxietyspectrum. Therefore, when individuals are experiencing ideal flow, they can also experience a moderate physiological arousal. Similar toFlow Model (Csikszentmihalyi, 1975), Stress Exchange Model (Lazarus and Folkman, 1984) states that the mental assessment of the situational challenges andone's abilities lead to different mental states. Based on Lazarus and Folkman's model (1984), if individuals assesssituational challenges as threatening or harmful and beyond their skill levels or coping resources, stress will occur. RegardingStress Exchange Model, stress is the result of psychological and physiological responses to a threat, harmful or challenging situation (Blascovich and Tomaka, 1996;Lazarus**,** 1999). Therefore, if the situation demands are beyond the individuals' skill levels, which are interpreted as a threat or injury, both concepts of anxiety (Csikszentmihalyi, 1975) and stress (Lazarus and Folkman, 1984) can equally be interpreted (Peifer, 2012). On the other hand, Stress Exchange Model, when the existing resources meet the situational demands, defines challenge as an enjoyable state (Lazarus and Folkman, 1984). The second research hypothesis was that the amount of theparticipants cortisol releaseof the players of Team 2 in competition with Team 3, which was challenge-skill balance, is more than that of the competition with Team 4 (the challenge is below the skill) and it is less than that of thecompetition with Team 1 (the challenge beyond the skill). The findings have confirmed this hypothesis and showed that whenthere is challenge-skill balance and the challenges go with the athletes' skills, the cortisol release has moderate concentration. The highest amount ofcortisol release occurred when the athletes of Team 2 competed against Team 1, in which the skill level of Team 1 was more than that of Team 2 and as a result theskills of the athletes ofTeam 2 could not overcome those ofthe athletes ofTeam 1; therefore, stress and anxiety occurred at a high level that resulted in more secretion of cortisol in the athletes of Team 2. Moreover, in competition of team 2 with Team 4, the skill level of whose athletes was much lower than that of the athletes of Team 2, their challenges were much lower than the skill level of theathletes of Team 2 and as a result it caused fatigue and boredom in the athletes of Team 2 and the amount of cortisol release was at its lowest level. These results were correspondent with the research conducted by Peifer et al. (2014) and Fullagaret al. (2013) and confirmed their results.

The third hypothesis was that there is an Inverted-U relationship between the flow experience and the activation level of HPA axis, which is measured by the amount of cortisol release, among the athletes of the present study. Measuring the amount of cortisol release after the competition and adapting the post-competition cortisol release, the research results supported the third hypothesis. The high experience of the flow in the moderate levels of cortisol has been found, while the increase of cortisol is more related to the stress and anxiety and the lowexperience of the flow in the lower levels of cortisol is associated with the fatigue and boredom and low experience of flow. Therefore,there is an Inverted-U relationship between the experience offlow and the amount ofcortisol release.

This finding, i.e. themoderate level of cortisol in a stressful situation is accompanied with the ideal experience of flow, is in parallel with the reported effects of cortisol in the related articles: cortisol increases the diagnosis of threshold of the auditory stimuli, which in return helps increase keeping attention from the stimulirelevant to the task, and so it helps individuals focus their attention (Wolfsdorf & Nagel, 1996; WolfSdorf et al., 1993), that is a key element of flow. Cortisol secretion increases glucose level of the blood and provides extra energy resources for the individuals to meet their demand for the increased energy during stress (Benedictet al, 2009; Cryer et al. 2005; Sapolski,Romero, and Munck, 2000). This mechanismfacilitates continuous and permanent attention, which is another key element of experiencing flow. Furthermore, the high level of cortisol is related to the improved attention and decreased fatigue and is again associated to the experience of flow (Born et al., 1988).

By integrating the research findings for hypotheses 1, 2, and 3, it can be physiologically supported that the experience of flow is related to the moderate level of arousal, which is reflected by the activation of thesympathetic system and HPA axis. Highand low arousal are accompanied by low amounts of the flow experience. In parallel with Weimar (2005), the findings of the present research show that the flow can well be experienced in stressful situations and the results are in parallel with the findings of De Manzanoet al. (2010) and Keller et al. (2011) that the moderate level of arousal was accompanied by the flow. Moreover, the results show that at higher-than-moderate levels of arousal, more arousal is accompanied by lower flow. Using the Stress Exchange Model literature (such as Lazarus and Folkman, 1984) and in parallelwithCsikszentmihalyi (1990), it can be said that the situational demands that are assessed as challenges- and at the same time not as threats- can result in experiencing flow. Therefore, the flow is related to the moderate level of arousal, which is experienced as a challenge and moderate and positive forms of stress are reminded, such as the concept of good stress.

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