Using EEG biofeedback in karate: The relationship among anxiety, motivation and brain waves

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Abstract

The aim of the study was to investigate the comparison of anxiety, motivation and brain waves according to gender and education levels. In addition, the study also examined the relationship among anxiety, motivation and brain waves in karateists.

Material/Method:
Sixty one participants voluntarily participated in the study. CSAI-2 (Competitive State Anxiety Inventory), STAI (State Trait Anxiety Inventory), Sport Motivation Scale and Pro-Comp Infinity Biofeedback Device were used for data collection. The data was analysed in SPSS 13.0 package program.

Results:
As a result of the study; While a significant difference between education levels was observed for the values of somatic anxiety and theta wave (p<0.05), there was no significant difference in trait anxiety, cognitive anxiety, somatic anxiety, self-confidence, intrinsic motivation, extrinsic motivation and amotivation (p>0.5). Pearson’s correlation test revealed that there was only a significant positive correlation between the values of age and theta brainwave (r: 0.654, p<0.05), whereas, there was no significant correlation between other variables (p>0.05).

Conclusions:
EEG biofeedback procedure is employed for reducing anxiety and increasing motivation and self confidence. The present study helps to arrange these psychological patterns for athletes and coaches.

Key words: anxiety • motivation • brain waves • self confidence • karateist

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BACKGROUND

The brain-body issue has always been a subject of human interest. Every physiological change whatsoever is accompanied by a parallel change in mental and/or emotional state [1] Green, Green and Walters (1970) have formulated this central psychophysiological principle as follows: “every change in the physical state is accompanied by an appropriate change in the mental emotional state, conscious or unconscious, and conversely every change in the mental emotional state, conscious or unconscious, is accompanied by an appropriate change in the physiological state”. Essentially, this statement reflects a very deep, firm view concerning the “eternal” brain-body issue [2].

The electroencephalogram (EEG) is a complex biologic signal that reflects the functional status of large pools of cortical neurons and their modulation by sub cortical regulatory influences. The interpretation of this signal requires a comprehensive knowledge of both the technical aspects of EEG recording and neuropathology of central nervous system. Thus, the application this modality in the biofeedback context must be conducted or supervised by properly trained and experienced professional [3].

The human brain produces a continuous output of minute electrical signals. The magnitude of these signals is so small that it is measured in microvolts (µv), or millionths of a volt. However, the signals can be accurately detected and recorded. To do this, the signals must...
Anxiety – is a generalized mood condition that can often occur without an identifiable triggering stimulus.

The number of EEG cycles occurring within a given time internal is called its frequency and measured in hertz (Hz) or cycles per second (CPS). The greater number of per second, the higher the frequency. The EEG appears to contain four major frequency bands: beta (above 13 Hz), alpha (8–13 Hz), theta (4–7 Hz), and delta (0.5–3.5 Hz). And EEG is not useful for determining specific brain functions, but for discerning more general states arousal, which are identified as: delta: deep sleep; theta: period of dreaming; alpha: relaxed awareness; beta: full alertness [4–8].

Research has shown that intrinsic motivation (IM) and extrinsic motivation (EM) are important concepts for understanding motivational processes in sport settings [9,10]. IM refers to “doing an activity for its inherent satisfactions and pleasures rather than for some separable consequence” [11]. On the other hand, EM reflects behaviors that are performed not for their own sake, but to achieve some separate goal (e.g., receiving a reward, avoiding punishment, and maintaining contingent self-worth). Finally, amotivation refers to the absence of IM or EM and is considered central to understanding motivated behavior [9]. As such, it is perceived that one’s actions have no control over outcomes and that forces beyond one’s individual control determine behavior [12]. Previous research has shown that more self-determined motives are positively associated with various cognitive, affective, and behavioral outcomes in sport settings [10–14].

Material and Methods

Participants

Sixty one participants (37 male made of 60.7% of participants and 24 female made of 39.3% of the participants) voluntarily participated in this study. The mean of their age was: x = 18.15±2.09 year, the mean of their training age was 7.97±2.39 year, education level of 21 of the participants (34.4%) was university and 40 of the participants (65.6%) reported their educational level as high school.
Motivation), and it is not clear to me anymore; I feel while improving some of my weak points (Intrinsic Motivation, “… For the pleasure I feel while improving some of my weak points (Intrinsic Motivation)”, and “It is not clear to me anymore; I don’t really think my place is in sport (Amotivation)”. The reliability and validity evidences of the SMS for Turkish sample were obtained in a study carried out by Kazak [26] IM to Know and IM to Accomplishment subscales combined in one factor in the Turkish version of the scale. The alpha coefficients for the present sample ranged from 0.35 (IM to Experience Stimulation) to 0.84 (To Know/Accomplishment).

Pro-Comp Infinity Biofeedback Device

The Pro-Comp Infiniti is a new 8 channel, multi-modality encoder (Figure 1) that has all the power and flexibility you need for real-time, computerized biofeedback and data acquisition in any clinical setting. The first two sensor channels provide ultimate signal fidelity (2048 samples per second) for viewing RAW EEG, EMG and EKG signals. The remaining six channels (256 samples/sec) can be used with any combination of sensors (Figure 2), including EEG, EKG, RMS EMG, skin conductance, heart rate, blood volume pulse, respiration, goniometry, force, and voltage input. Pro-Comp Infiniti™ offers internal, user-activated calibration to ensure that you can always obtain the highest quality signal, without the costly downtime associated with factory re-calibration. In short, the Pro-Comp Infiniti covers the full range of objective physiological signals used in clinical observation and biofeedback. Housed in an ergonomically designed case and requiring only a USB port, ProComp Infiniti can be used with any IBM-compatible laptop or desktop PC. What’s more, Pro-Comp Infiniti can capture data in real time by connecting directly to the PC via fiber-optic cable, or it can store data on a Compact Flash memory card for uploading later to the PC. ProComp Infiniti comes complete with: 14 bit resolution, eight-channel ProComp Infiniti encoder unit. TT-USB interface unit. Fiber-optic cables (1’and 1’’). Four alkaline/AA/batteries. Sleek fabric storage and carrying case.

States of the art, they offer a four-point Likert type assessment (1 is for almost never, 4 is for almost always) and was used for overlap validity in the present study. Cronbach’s alpha of the scale was between .83 and .87 and test-retest reliability was reported to be between .34 and .72 [24].

Pro-Comp Infinity Encoder.

Figure 1. Pro-Comp Infinity Encoder.

EEG sensors.

Figure 2. EEG sensors.
Data collection

The questionnaires were collected from participants before daily training. Athletes, who received standardized verbal instructions, were assisted by the researcher. They were encouraged to answer honestly and were assured that their responses were confidential. The brain waves were measured in a dressing room by the researcher. EEG biofeedback involves the measurement of brainwave activity. EEG activity was recorded at the scalp. Participation was voluntary, and relevant permissions were obtained from athletes.

Data analysis

In this study, descriptive statistical techniques and independent simple t test were used. The simple correlations among anxiety, motivation, and brain waves were tested by Pearson Product Moment Correlation. The data were analyzed using SPSS statistical program. An Alpha level of 0.05 was used for all statistical tests.

Results

Significant difference between education levels was observed for the values of somatic anxiety and theta wave (p<0.05), there was no significant difference in trait anxiety, cognitive anxiety, somatic anxiety, self-confidence, intrinsic motivation, extrinsic motivation and amotivation (p>0.5) (Table 1).

A significant difference between males and females was not observed for the values of trait anxiety, cognitive anxiety, somatic anxiety, self-confidence, intrinsic motivation, extrinsic motivation and amotivation (p>0.05) (Table 2).

Pearson’s correlation test revealed that there was only a significant positive correlation between the values of age and theta wave (r: 0.654, p<0.05), whereas, there was no significant correlation between others variables (p>0.05) (Table 3).

Discussion

The present study examined the comparison of anxiety, motivation and brain waves according to gender and education levels. In addition, the study also examined the relationship among anxiety, motivation and brain waves in karateists. First hypothesis: anxiety, motivation and brain waves difference were dependent on karateists’ education.
Results of the present investigation indicated that any difference was not found in anxiety, motivation and brain waves between high school and university level except somatic anxiety and beta wave (Table 1). According to Tenenbaum et al. [14] research in sport not to mention relationship psychology and education but Kolayi & Sari [23] supported the findings of this research. The difference of somatic anxiety between high school and university could be interpreted as that athletes with university degree feel the pressure over them to accomplish certain things due to the expectations from significant others. This could be the reason of why athletes with university degree reported significantly higher somatic anxiety. Another result of this study showed that there was a significant difference of beta brain-wave between education levels. In the current study, athletes with university degree reported significantly higher beta brain-wave. Higher beta brain-waves were activated by listening, thinking, solving analytical problems, making a decision. If it is thought that people with university level have these cognitive processes, the present study supported this information.

Second hypothesis was that there would be a significant difference of anxiety, motivation and brain waves

<table>
<thead>
<tr>
<th>Variables</th>
<th>Gender</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>p</th>
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<tbody>
<tr>
<td>Cognitive anxiety</td>
<td>Male</td>
<td>37</td>
<td>21.49</td>
<td>4.89</td>
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<tr>
<td></td>
<td>Female</td>
<td>24</td>
<td>21.12</td>
<td>4.43</td>
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<tr>
<td>Somatic anxiety</td>
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<td>16.32</td>
<td>3.91</td>
<td>0.361</td>
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<tr>
<td></td>
<td>Female</td>
<td>24</td>
<td>17.29</td>
<td>4.15</td>
<td></td>
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<tr>
<td>Self confidence</td>
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<td>37</td>
<td>27.41</td>
<td>5.12</td>
<td>0.268</td>
</tr>
<tr>
<td></td>
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<td>24</td>
<td>25.75</td>
<td>6.38</td>
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<tr>
<td>Trait anxiety</td>
<td>Male</td>
<td>37</td>
<td>47.51</td>
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<tr>
<td></td>
<td>Female</td>
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<td>theta wave (µv)</td>
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<td>21.35</td>
<td>9.54</td>
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<tr>
<td></td>
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<td>24</td>
<td>21.80</td>
<td>7.37</td>
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<td>alfa wave (µv)</td>
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<td>8.65</td>
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<td>beta wave (µv)</td>
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<td>1.32</td>
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<tr>
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<td>3.69</td>
<td>1.34</td>
<td></td>
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</table>

Table 2. The difference between genders according to anxiety, motivation and brain waves.

Table 3. The correlation among anxiety, age, training age, motivation and brain waves.
between males and females. Previous literature supported this result and reported that there was not a significant difference between males and females according to state anxiety, cognitive anxiety, and somatic anxiety points [24]. However, result of some of previous studies [25,27–30] contrasted with present results.

The last hypothesis was there would be a significant correlation among age, training age, anxiety, motivation and brain-waves. But, according to the results of the study there was only positive significant correlation between age and theta wave. Theta brain waves are defined as deep meditation, deep inward thought. Theta brain waves are associated with life-like imagination, high state of mental concentration, a magical mind, internal pictures/visualization, intuition, inner guidance, access to unconscious material and dreaming.

**REFERENCES:**


**CONCLUSIONS**

Combat sports requires optimal levels of anxiety, motivation and self confidence. Combat situations in judo, karate, taekwondo, boxing may change within extremely short period of time: accordingly, emotional states during combat matches are subject to extreme fluctuations. It is often difficult for the competing athlete to attack and to defend at the same time. Psychological preparation for combat sport should therefore be derived from making decisions under time pressure, and being flexible in tactical movements [31]. EEG biofeedback procedure is employed for reducing anxiety and increasing motivation and self confidence. The present study helps to arrange these psychological patterns for athletes and coaches.