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RESEARCH ARTICLE

Deep Knowledge Principles as a Mediating Factor between Neuroticism and Sports Anxiety

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Abstract:

Aim:

The study aimed to investigate the relationship between neuroticism and sports anxiety and the mediating effect of the Principles for Deep Knowledge (PDK) on this relationship among athletes.

Methods:

130 athletes (males = 81, females = 49) actively competing in 16 sports teams completed three tests: the 12-item Neuroticism sub-scale of the NEO Personality Inventory, the PDK Survey, and the Sport Competition Anxiety Test.

Results:

The results revealed neuroticism to be significantly correlated to sports anxiety, especially in female athletes, and females have been found to have a higher tendency toward neuroticism. Furthermore, mediating analyses demonstrated the mediating role of PDK in linking neuroticism and sports anxiety.

Conclusion:

This study has concluded five PDK Alternating, Contrasting and Complementing, Changing and Transforming, Contradiction, and Void as better approaches to assist female athletes with high neuroticism in reducing sports anxiety. These five principles can be developed as five training approaches to avoid attitudes indicative of neuroticism and as potential coping strategies. These propositions can be developed into an outline for future research.

Keywords: Neuroticism, Sports anxiety, Principles for deep knowledge, Habitual domains, Mediating Factor, Athletes.

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1. INTRODUCTION

Persons with high neuroticism scores tend to have negative emotions and higher stress levels [1]. Previous studies have found that neuroticism is strongly associated with a propensity to experience negative emotions [2] and indirectly affects human performance, for instance, sports performance [3]. Athletes with a higher level of neuroticism are more likely to experience negative affect and sports anxiety, and these negative emotions can affect performance [4]. In addition, a recent study showed a strong correlation between neuroticism

and competitive anxiety [4]. Thus, it is essential to find a coping strategy to reduce sports anxiety among athletes with neuroticism.

Furthermore, Lin *et al.* [5] proposed one behavioral factor named Principles for Deep Knowledge (PDK) that indirectly affects sports anxiety and performance. They examined 194 athletes and found that athletes who had higher levels of sports performance had higher use of mental skills and thus higher scores on PDK; in addition, PDK had shown positive correlations with mental skills and negative correlations with sports anxiety. An earlier study by Lin *et al.* [6] indicated females to have higher tendencies toward the principles of Contrasting and Complementing and Cracking and Ripping, and also found positive correlations between exercising habit

* Address correspondence to this author at the Graduate Institute of Sports and Health Management, National Chung Hsing University, #145 Xingda Rd., South Dist, Taichung City 402, Taiwan R.O.C.; Tel: 886(04)22840845702; Fax: 886(04)22852400 E-mail: linraytw@gmail.com

and the principles of Alternating, Changing and Transforming, and Void. They concluded that the survey of PDKs is a psychometric property. PDKs have been identified by habitual domain (HD) and are one of three practical tools for expanding an individual's HD [7 - 11]. HD is defined as each person's collection of ideas and actions, including thinking, memory, judging, and reacting, for handling situations or problems over a lifetime [12 - 14]. This collection gradually becomes stable within a certain domain over time, and people have habitual ways of thinking, doing actions, judging, reacting, and behaving. Previous literature has demonstrated that various methods can assist in expanding a person's HD, including the nine PDKs. The nine principles include The Deep and Down, The Alternating, The Contrasting and Complementing, The Revolving and Cycling, The Inner Connection, the Changing, The Contradiction, The Cracking and Ripping, and The Void. The Deep and Down principle implies going deeply down by lowering the charge structures for the minds to empty any irrelevant thoughts and obtain useful information at the same time [5, 7]. The Alternating principle involves the awareness to remove or add subsets of assumptions in one's mind and alternating and combining these assumptions [5, 7]. The Contrasting and Complementing principle is the perception of duality, such as existent/nonexistent, known/unknown, good/bad, male/female, and so forth [5, 7]. The Revolving and Cycling principle is to realize that the life cycle moves up and down; each success is constructed from the elements of failures, and likewise, each failure involves the elements of success [5, 7]. The Inner Connection principle builds as many strong connections as possible to the inner core of others [5, 7]. People with an attitude toward the Changing principle are willing to accept any changes to follow the constantly changing world [5, 7]. The Contradiction principle encourages people to look at things from various perspectives and to re-assess any conclusions [5, 7]. The Cracking and Ripping principle is used to identify cracks that consist of old fears, conflicts, or negative attitudes that hinder personal development [5, 7]. People repeat the same set of concepts and procedures named the same HDs to deal with daily life; however, they can not respond effectively when a situation occurs outside of the same HDs. Thus, the Void principle states that the outside of the same HDs is not void, and it can expand HDs by emptying some of the existing HDs and absorbing new HDs into the space [5, 7]. Scholars [7 - 10, 12 - 15] proposed a complete description of how these nine PDKs have enriched people's HD. In a broad sense, the PDKs represent attitudes, which serve as general enduring behavioral tendencies in particular conditions [7], such as learning [6] and training. The PDKs can be the thinking procedures and attitudes used to understand neuroticism's HD to expand HDs, which leads neuroticisms to avoid any physiological, physical, and psychological symptoms and behaviors related to neuroticism traits [7, 15].

As Yu's team [7, 9, 10, 15] mentioned, most people are not aware of their own habitual domains and their assessment is of great importance; therefore, the PDKs were introduced as attitudes. These attitudes can produce better assessments to understand and expand peoples' habitual domains. For example, in athletes with neuroticism, the resulting higher levels of sports anxiety might be caused by the unawareness of

any physiological, physical, and psychological symptoms and behaviors related to neuroticism traits. The process of obtaining or creating positive ideas and attitudes for relieving anxiety is a significant function of PDKs. Lin *et al.* [5] found positive correlations between PDKs and exercise. Further studies [16] have reported PDKs to significantly impact mental skills and concluded that PDKs represent one practical approach to improve and expand athletes' ability to develop decision-making styles in order to reduce anxiety. However, the impact of PDK on the association between neuroticism and sports anxiety is unknown. Therefore, this study aimed to determine whether the association between neuroticism and sports anxiety can be mediated by PDKs.

2. MATERIALS AND METHODS

2.1. Participants and Procedure

The participants were 130 athletes (age $M = 20.08$, $SD = 2.27$; training years $M = 7.43$, $SD = 3.32$) competing in 16 different team and individual sports from the National Changhua University of Education located in the center area of Taiwan, either on national or international levels. The participants included 81 males (age $M = 20.19$, $SD = 2.44$; training years $M = 7.03$, $SD = 3.33$) and 49 females (age $M = 19.90$, $SD = 1.98$; training years $M = 8.08$, $SD = 3.23$). During the competition season from the beginning of March to the end of July 2022, participants completed the questionnaire individually or in small groups of 5–20 athletes while being away from their competitions and training fields. Most of them took the questionnaire during classes on campus. Participants were given an introduction to the study and their informed consent was obtained to complete the questionnaire without reimbursement. All participants were treated in accordance with APA ethical standards.

2.2. Measures

Personality. Trait neuroticism was assessed with the 12-item Neuroticism sub-scale of the NEO-Five Factor Inventory (NEO-FFI) [17, 18]. In this study, the values of factor loading ranged from .31 to .65, and Cronbach's α was .68 for females, .62 for males, and .66 for the whole sample.

Principles for Deep Knowledge. The feature of deep knowledge was measured with the 45-item Principles for Deep Knowledge Survey (PDKS). Lin *et al.* [5] initially developed the PDKS, and the items have been rephrased to reflect the general features of the nine PDK of the habitual domain. The reliability and validity of the PDKS have been confirmed, and a previous study indicated that it is an appropriate instrument to measure individual differences in the features of deep knowledge [6]. In the current study, the values of factor loading ranged from .35 to .75, and Cronbach's α ranged from .51 to .84, with a value of .93 for the whole PDKS.

Sports anxiety. The Sports Competition Anxiety Test (SCAT), developed by Martens [18], was used to measure competitive anxiety. The SCAT consists of 15 items that are scored on a 3-point scale. In the current study, the values of factor loading ranged from .31 to .78, and Cronbach's α was .63 for females, .66 for males, and .83 for the whole sample.

2.3. Data Analysis

The statistical analyses were performed with SPSS 20.0. Exploratory factor analysis was used to examine the factor structures, and internal consistency was used to test the reliabilities. Descriptive statistics (means and standard deviations) for all measures were calculated. Pearson product-moment correlations were computed between four variables. Bootstrapping analysis technique was used to assess the mediating effect.

3. RESULTS

3.1. Inter-correlations and Gender Differences

Results of correlation analyses showed neuroticism as significantly correlated with sports anxiety in all participants ($r = .25, p = .004$), while none of the intercorrelations with PDKS were significant. Three of the nine principles measured with the PDKS had significant positive correlations with sport anxiety and consisted of the Principle of Revolving and Cycling ($r = .18, p = .04$), the Principle of Inner Connection ($r = .19, p = .03$), and the Principle of Cracking and Ripping ($r = .21, p = .02$). We further found a significant difference in neuroticism between males and females ($t = -3.11, p = .002$; $M_f = 3.11 \pm 0.57, M_m = 2.79 \pm 0.57$), with females having higher scores than males. Hence, the data for each gender were tested separately.

None of the intercorrelations for male athletes reached the level of significance. However, for female athletes, the results indicated neuroticism to be significantly correlated with sports anxiety ($r = .34, p = .02$), and with two principles of the PDK, including the Principle of Revolving and Cycling ($r = .29, p = .04$) and the Principle of Inner Connection ($r = .31, p = .03$). Finally, a positive significant correlation was found between the Principle of Deep and Down and sports anxiety ($r = .34, p = .02$).

3.2. Mediation Analysis

In order to assess whether PDKs mediate the relationship between neuroticism and sports anxiety, bootstrapping analysis techniques with bias-corrected (BC) confidence estimates and a 95% confidence interval (CI) of the indirect effects were performed with 5000 bootstrap samples [19]. In the current study, the mediation model consisted of the following components: neuroticism was the independent variable, PDKs were introduced as the mediator variable, and sports anxiety was the dependent variable. The results indicated the total effect of neuroticism to be significant for sports anxiety ($\beta = .18, t = 2.28, p = .03$); however, the direct impact of neuroticism on sports anxiety became nonsignificant when PDK was the mediator variable [$\beta = .02, BCa\ 95\% CI (-.01, .10)$].

4. DISCUSSION

The current results agree with previous findings on the association between neuroticism and sports anxiety [4], and confirm the distinct effects of gender, with female athletes showing higher levels of neuroticism [3]. The analyses further found a significant correlation between neuroticism and sports

anxiety in female athletes. In addition, PDK mediated between neuroticism and sports anxiety in female athletes. Thus, this study adds to the extensive literature on the construct of sports anxiety by identifying variables, such as PDK, that mediate the relationship between sports anxiety and neuroticism in a sample of college athletes, particularly female athletes. We suggest that the five principles, including Alternating, Contrasting and Complementing, Changing and Transforming, Contradiction, and Void should be considered as coping tools to reduce sports anxiety in female athletes who tend towards neuroticism. For instance, an athlete might have perceived previous training demands from the coach as challenging. However, after receiving helpful tips, the athlete will likely make significant improvements using the Alternating principle. According to the principle of Changing and Transforming, athletes willing to change have a better chance of achieving higher goals. A typical example of Cracking and Ripping is a coach's understanding that the fear of trying a novel approach or takeoff technique can be a distinct crack that can lower the self-confidence of a long jumper. Finally, as Yu [16] mentioned, the Void principle is a very enthusiastic attitude to expand HDs continuously, and the Void becomes even more critical. Female athletes with neuroticism are more anxious and are negatively associated with muscle strength [20]. The Void can help female athletes identify and decrease the six facet-level traits of anxiety, anger, hostility, depression, self-consciousness, impulsiveness, and vulnerability. With this principle, HDs of others, such as the mental skills of goal setting, automaticity, emotional control, relaxation, and positive thinking, can enter these female athletes' minds more quickly and truthfully to reduce sports anxiety [5] and to improve muscle strength. Consequently, these five principles can be developed as five training approaches to avoid attitudes indicative of neuroticism and as potential coping strategies. These propositions can be developed into an outline for future research.

CONCLUSION

Our current study, however, possesses some limitations. First, the sample was a small group of collegial student athletes; thus, our findings might not extend to other groups or the general population. Second, the cross-sectional design precludes making inferences on the potential impact of neuroticism on sports anxiety. Such causal associations should be examined in a longitudinal study. Further research is especially needed to determine how PDKs affect athletes with neuroticism to reduce sports anxiety and to develop assessment regarding the use of PDK strategies.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The present study was approved by the institutional ethics committee of the Institute of Sports and Health Management, National Chung Hsing University.

HUMAN AND ANIMAL RIGHTS

No animals were used for the studies. All the human experimentation was performed according to the Helsinki Declaration of 1975, as revised in 2008.

CONSENT FOR PUBLICATION

Informed consent was obtained from all the participants.

STANDARDS OF REPORTING

COREQ guidelines were followed in the study.

AVAILABILITY OF DATA AND MATERIAL

All the data and supporting information are provided within the article.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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REFERENCES

- [1] Widiger TA, Oltmanns JR. Neuroticism is a fundamental domain of personality with enormous public health implications. *World Psychiatry* 2017; 16(2): 144-5. [http://dx.doi.org/10.1002/wps.20411] [PMID: 28498583]
- [2] Matthews G, Deary IJ, Whiteman MC. *Personality traits*. Cambridge: Cambridge University Press 2009. [http://dx.doi.org/10.1017/CBO9780511812743]
- [3] Allen MS, Greenlees I, Jones M. An investigation of the five-factor model of personality and coping behaviour in sport. *J Sports Sci* 2011; 29(8): 841-50. [http://dx.doi.org/10.1080/02640414.2011.565064] [PMID: 21500081]
- [4] Kemarat S, Theanthong A, Yeemin W, Suwankun S. Personality characteristics and competitive anxiety in individual and team athletes. *PLoS One* 2022; 17(1): e0262486. [http://dx.doi.org/10.1371/journal.pone.0262486] [PMID: 35030214]
- [5] Lin MH, Huang MH, Hsiung WC. The learning feature of deep knowledge and its relationship with exercise. *SAGE Open* 2014; 4(2) [http://dx.doi.org/10.1177/2158244014535415]
- [6] Lin MH, Hsiung WC, Huang MH. Construction of an instrument to measure learning attitudes by principles for deep knowledge of habitual domains. *J Habitual Domains* 2011; 3(2): 11-21.
- [7] Yu PL. *Habitual domains and forming winning strategies*. Hsin-Chu, Taiwan: NCTU Press 2002.
- [8] Larbani M, Yu PL. Empowering data mining sciences by habitual domains theory, part I: The concept of wonderful solution. *Ann Data Sci* 2020; 7(3): 373-97. [http://dx.doi.org/10.1007/s40745-020-00290-0]
- [9] Yu PL, Chen YC. Dynamic MCDM, habitual domains and competence set analysis for effective decision making in changeable spaces. In: Ehrgott M, Figueira JR, Greco S, Eds. *Trends in Multiple Criteria Decision Analysis*. New York, USA: Springer 2010; pp. 1-35. [http://dx.doi.org/10.1007/978-1-4419-5904-1_1]
- [10] Larbani M, Yu PL. *Wonderful Solutions and Habitual Domains for Challenging Problems in Changeable Spaces: From Theoretical Framework to Applications*. New York, USA: Springer 2017. [http://dx.doi.org/10.1007/978-981-10-1981-4]
- [11] Ma L, Shi Y, Zhao W. Habitual domain exploration in inter-firm networks. *J Manuf Tech Manag* 2012; 23(8): 1057-70. [http://dx.doi.org/10.1108/17410381211276871]
- [12] Yu X, Shi Y, Zhang L, Nie G, Huang A. Intelligent beyond data mining: Influences of habitual domain. *Comm Assoc Inform Syst* 2014; 34(53): 985-1000. [http://dx.doi.org/10.17705/1CAIS.03453]
- [13] Ye X, Ma L, Feng J, Cheng Y, Liu Z. Impact of technology habitual domain on ambidextrous innovation: case study of a Chinese high-tech enterprise. *Sustainability* 2018; 10(12): 4602. [http://dx.doi.org/10.3390/su10124602]
- [14] Chen YC, Huang HS, Yu PL. Empower MCDM by habitual domains to solve challenging problems in changeable spaces. *Int. Int J Inf Technol Decis Mak* 2012; 11(2): 457-90. [http://dx.doi.org/10.1142/S0219622012400111]
- [15] Yu PL. Working knowledge mining by principles for deep knowledge. *Int J Inf Technol Decis Mak* 2006; 5(4): 729-38. [http://dx.doi.org/10.1142/S0219622006002210]
- [16] Lin MH, Huang MH. Decision-making styles, psychological skills, sport anxiety and principles for deep knowledge among athletes. *Int J Sport Psychol* 2015; 46(2): 167-86.
- [17] Costa PT, McCrae RR. *Revised NEO Personality Inventory (NEO-PI-R) and NEO Five-Factor Inventory (NEO-FFI) manual*. Odessa, FL: Psychological Assessment Resources 1992.
- [18] Martens R, Burton D, Vealey RS, Bump LA, Smith DE. Development and validation of the Competitive State Anxiety Inventory-2. In: Martens R, Vealey RS, Burton D, Eds. *Competitive Anxiety in Sport*. Champaign, IL: Human Kinetics 1990; pp. 127-40.
- [19] Preacher KJ, Hayes AF. Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behav Res Methods* 2008; 40(3): 879-91. [http://dx.doi.org/10.3758/BRM.40.3.879] [PMID: 18697684]
- [20] Tolea MI, Terracciano A, Simonsick EM, Jeffrey Metter E, Costa PT Jr, Ferrucci L. Associations between personality traits, physical activity level, and muscle strength. *J Res Pers* 2012; 46(3): 264-70. [http://dx.doi.org/10.1016/j.jrp.2012.02.002] [PMID: 23966753]

