Original Article

Trait creativity, personality, and physical activity: a structural equation model

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Background: Previous studies have shown that personality affects creativity, and physical activity and is associated with cognitive function. However, the relationship among physical activity, creativity, and personality remains unclear. This study sought to examine the relationship among personality, physical activity, and creativity to identify relevant risk factors of trait creativity. Structural equation modeling (SEM) was used to assess the effect of personality (extraversion, agreeableness, conscientiousness, neuroticism, and openness) on physical activity, the effect of physical activity on creativity traits.

Methods: A total of 296 university students were recruited for this study. The survey was administered by WeChat. The self-reported questionnaires included questions related to demographic information, creativity (from the Williams Creativity Assessment Packet), the Big Five personality traits, and physical activity. A correlation analysis was conducted and the structural equation models were constructed using SPSSAU.

Results: The SEM analysis showed that openness in personality was positively correlated with physical activity. Physical activity was negatively correlated with curiosity, challenging, risk-taking, and imagination.

Conclusions: Among university students, openness may be a profound positive factor affecting physical activity. Moreover, physical activity was also associated with trait creativity. Consideration should be given to assessing personality traits and physical activity to ensure the selection of more creative students.

Keywords: Personality; physical activity; structural equation modeling (SEM); trait creativity

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Introduction

Creativity, which is defined as the ability to generate novel and useful ideas or ideas (1), is key to the progress of human civilization, and can lead to important scientific discoveries (2,3). Research has shown that creativity plays a key role in problem solving (4). The theory of creative cognition asserts that the number of automatic associations imposes a fundamental limit on the possibility of generating creative solutions (5). Some findings have suggested that the dopaminergic system plays a vital role in creativity and seeking personality characteristic predicts the effects of methylphenidate on creativity in healthy individuals (6). Further, research has shown that individuals with certain creative personality traits (i.e., imagination, curiosity, challenge, and risk-taking) are more likely to make scientific discoveries (2).

Emotional intelligence is positively associated with trait creativity (7). Brain volume changes in the orbitofrontal cortex are related to top-down emotion regulation processing and may play an important role in improving trait creativity (7). Creative traits are imprinted in the social brain and the link between creative traits and neural activity for dealing with self and others is mediated by cultural traits (4). Different novelty-seeking behaviors may have different effects on the boredom level of high

creativity individuals and low creativity individuals during isolation (8). Additionally, in proud people, trait creativity is related to the executive control of bottom-up processing, and bottom-up information from visions or visual images may be related to trait creativity (9). A previous study found that the creative traits of participants moderated the relationship between their emotions and creativity (10). A survey showed that stressful life events moderated the direct effect of the promotion focus on boundaryless thinking, and also moderated the indirect effect of promotion focus on creativity through boundaryless thinking (11).

Theories and research on personality and creativity share a fundamental characteristic; that is, an emphasis on the uniqueness of the individual (12). Many studies have investigated the relationship between creativity and personality (12-16). Creative people are more open to new experiences, less conventional, and more confident. Openness and conscientiousness are the most influential personality traits (12). A cross-sectional study of nurses showed that creativity, job autonomy, and agreeableness were associated with the job crafting dimensions (17).

Research on the relationship between personality and creativity in the Big Five personality model has shown that neuroticism is negatively correlated with creativity (16). A study of entrepreneurial education among Chinese college students also showed that neuroticism had a negative effect on creativity, while extraversion, openness, and conscientiousness had a positive effect on creativity (18). Research with French respondents during the Coronavirus Disease 2019 pandemic showed that among the Big Five factors, loneliness preferences can predict individual creativity (19).

There is growing evidence that there is a link between physical activity and cognitive function (20-23). However, little is known about the relationship between physical activity and creativity. A study (24) showed that optimal physical activity in childhood is necessary for the development of thought processes. Thus, encouraging active play with family and peers can encourage creativity. Another study tested a serial-multiple mediation of physical activity enjoyment and physical activity intention in the relationship between creativity and physical activity level, and these findings underscore the importance of shaping cognitive and emotional functioning for physical activity promotion (25).

Thus, cultural and ethnic differences could affect personality, personality factors could affect the trait creativity of Chinese college students, and physical activity could boost creativity. This study sought to assess individual differences reflecting the effects of the Big Five personality dimensions of extroversion, agreeableness, conscientiousness, neuroticism, and openness on the physical activity and creativity characteristics of college students. It was hypothesized that: (I) extraversion, agreeableness, conscientiousness, neuroticism, and openness affect physical activity; (II) physical activity affects trait creativity; and (III) the Big Five personality traits affect trait creativity through the promotion of physical activity. We present the following article in accordance with the SURGE reporting checklist (available at https://apm.amegroups.com/article/view/10.21037/apm-22-1310/rc).

Highlight box

Key findings

- Threre are a relationship between creativity and physical activity. However, the role of physical activity in development of trait creativity needs further confirmed.

What is known and what is new?

- Previous studies have shown that personality affects creativity, and physical activity and is associated with cognitive function.
- Among university students, openness may be a profound positive factor affecting physical activity.

What is the implication, and what should change now?

- Consideration should be given to assessing personality traits and physical activity to ensure the selection of more creative students.

Methods

Participants

A total of 296 university students from Taizhou University, Zhejiang, China participated in this study. The participants received WeChat text message reminders to complete the follow-up questionnaires. The questionnaires included questions related to demographic information, creativity (from the Williams Creativity Assessment Packet), the Big Five personality traits [from the Big Five Inventory (BFI)], and physical activity. Verbal informed consent was obtained from all the individual participants in this study.

The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by ethics board of Affiliated Hospital of Taizhou

University.

Measures

Demographic information

Data on demographic and socioeconomic factors, such as age, gender, grade, major, father's education, mother's education, and annual household income, were collected.

Personality

The BFI developed by John and Srivastav (26) comprises 44 items designed to examine the following 5 dimensions: extraversion, agreeableness, conscientiousness, neuroticism, and openness. Participants are asked to rate each item on a 5-point scale on which 1= strongly disagree and 5= strongly agree. A total of 220 points can be obtained. The items related to extraversion are 1, 6R, 11, 16, 21R, 26, 31R, 36, and others; the items related agreeableness are 2R, 7, 12R, 17, 22, 27R, 32, 37R, and 42; the items related to work responsibility are 3, 8R, 13, 18R, 23R, 28, 33, 38, and 43R; the items related to neuroticism are 4, 9R, 14, 19, 24R, 29, 34R, and 39; the items related to openness are 5, 10, 15, 20, 25, 30, 35R, 40, 41R, and 44. "R" indicates the reverse-scored items; reverse scoring was used for the reverse questions. In the present study, the Cronbach's α of the BFI was 0.76. The reliability coefficient values of the research data were all >0.7, indicating that the reliability quality of the data was high and the data could be used for further analysis (27). The KMO value was 0.816, and the Bartlett test was significant, P=0.000, which means the model of the study was good effectiveness (28).

Trait creativity

The Williams Creativity Assessment Packet (29) [Chinese version] examines the following 4 dimensions: curiosity (i.e., inclination to explore, or play with an idea; items 2, 8, 11, 12R, 19, 27, 33, 34, 37, 38, 39, 47, 48R, and 49); challenging (i.e., the tendency to look for new alternatives and ways to solve problems, and restore order from chaos; items 3, 4R, 7, 9R, 10, 15, 17R, 18, 26, 41, 42, and 50); risk-taking (i.e., the tendency to act and defend one's ideas in disorganized conditions; items 1, 5, 21, 24, 25, 28, 29R, 35R, 36, 43, and 44); and imagination (i.e., the tendency to imagine and construct mental images, or feel intuitively; items 6, 13, 14, 16, 20, 22, 23, 30, 31, 32, 40, 45R, and 46) (30). "R" denotes the reverse-scored items; reverse scoring was used for the reverse questions. The participants indicated their responses on a 3-point Likert scale, ranging from 1 (strongly disagree) to 3 (strongly agree). In this study, the Cronbach's α value was 0.88, the KMO value was 0.85, and the Bartlett's test P=0.000. See Table S1.

Physical activity

The participants were asked the following 2 questions about their physical activity in the last 7 days: (I) How much time (in minutes) do you typically spend in moderate physical activity on one of these days? (II) For 7 days, how many days have you walked for at least 10 minutes each time? See Table S2.

Statistical analysis

The data were analyzed by SPSSAU (https://www.spssau.com.). Descriptive statistics were used to assess the participant characteristics. Cronbach's α, KMO and Bartlett test results were calculated for the nested items in each analysis dimension. SEM was used to assess the effect of personality on physical activity and the effect of physical activity on trait creativity.

SEM is a multivariate data analysis method that can be used to examine the influencing relationship between multiple latent variables (31). Our structural equation model consisted of the following two parts: measurement relation, and influence relation. This study included the following 10 latent variables: personality (extraversion, agreeableness, conscientiousness, neuroticism, and openness), physical activity, and trait creativity (curiosity, challenging, risk-taking, and imagination). Each latent variable was measured by a specific item.

Missing data were processed by tabular deletion. In this study, the Chi-square to degrees of freedom ratio (χ^2/df), standardized root means square residual error (SRMR), and approximate root mean square error (RMSEA) criteria were used to evaluate the hypothesized fit model. The acceptable fit index criteria in SEM were as follows: χ^2/df <3.00, SRMR <0.10, and RMSEA <0.10. The magnitude of the standardized regression coefficients and their significance were used to assess the hypothesis of the structural relationships in the final model (32).

Results

Participant characteristics

There were 296 participants, with an average age of 20.41 years (standard deviation =0.99, range, 18–23 years). As *Table 1* shows, there were relatively more women

Table 1 Characteristics of the participants included in this study (N=296)

Variable	Frequency	Percentage (%)
Gender		
Male	50	16.89
Female	246	83.11
Grade		
Freshman year	80	27.03
Sophomore year	129	43.58
Junior year	64	21.62
Senior year	23	7.77
Major		
Clinical medicine	85	28.72
Nursing	104	35.14
Midwifery	107	36.15
Father's education		
Junior high school or below	182	61.49
High school or secondary school	86	29.05
College degree	11	3.72
Bachelor's degree	16	5.41
Master's or above	1	0.34
Mother's education		
Junior high school or below	209	70.61
High school or secondary school	65	21.96
College degree	14	4.73
Bachelor's degree	7	2.36
Master's or above	1	0.34
Annual household income (CNY)		
10,000–30,000	45	15.20
30,001–80,000	74	25.00
80,001–150,000	96	32.43
150,001–300,000	61	20.61
300,001–1,000,000	17	5.74
≥1,000,001	3	1.01
Age (years), mean (SD)	20.41 (0.99)	–

CNY, Chinese Yuan; SD, standard deviation.

(83.11%) in the sample than man. Among the participants, sophomore-year students accounted for 43.58% of the students. Midwifery students accounted for the highest proportion (36.15%) of the students, while nursing students accounted for 35.14% of the students. In relation to the educational background of the fathers of the participants, the highest proportion (61.49%) had a junior high school level of education or below. In relation to the educational background of the mothers of the participants, the proportion of mothers with a junior high school level of education or below was relatively higher at 70.61%. In terms of annual household income, >30% of the samples had an income of CNY 80,001–150,000.

SEM results

The measurement factors of the latent variables in the SEM are shown in Tables S1,S2 and previous study (26). The initial model was built on the theoretical assumptions presented in the introduction (*Figure 1*). The initial model had an acceptable fit with the sample data (χ^2=2.240, SRMR =0.094, RMSEA =0.065). However, 3 path coefficients indicated insignificant relationships (extraversion → physical activity, P=0.257; agreeableness → physical activity, P=0.818; neuroticism → physical activity, P=0.092), which indicated that the initial model needed to be modified.

Thus, we removed the variables that were not significantly associated with physical activity (i.e., extraversion, agreeableness, and neuroticism). The new model (*Figure 2*) had a good fit (χ^2/df=2.167, SRMR =0.085, RMSEA =0.063), and all the path coefficients were statistically significant (P<0.05), except 1 path coefficient that did not have a significant relationship (conscientiousness → physical activity, P=0.064). As conscientiousness was not significantly correlated with physical activity, we removed this variable from the model. The modified model (*Figure 3*) had a good fit (χ^2/df=2.226, SRMR =0.084, RMSEA =0.064), and all the path coefficients were statistically significant (P<0.001).

The parametric model estimates suggest that openness had a significant positive effect on physical activity (0.491). Physical activity exerted significant negative effects on the traits of curiosity (–1.000), challenging (–0.993), risk-taking (–0.972), and imagination (–0.850). Thus, the college students with the trait of openness were more inclined to

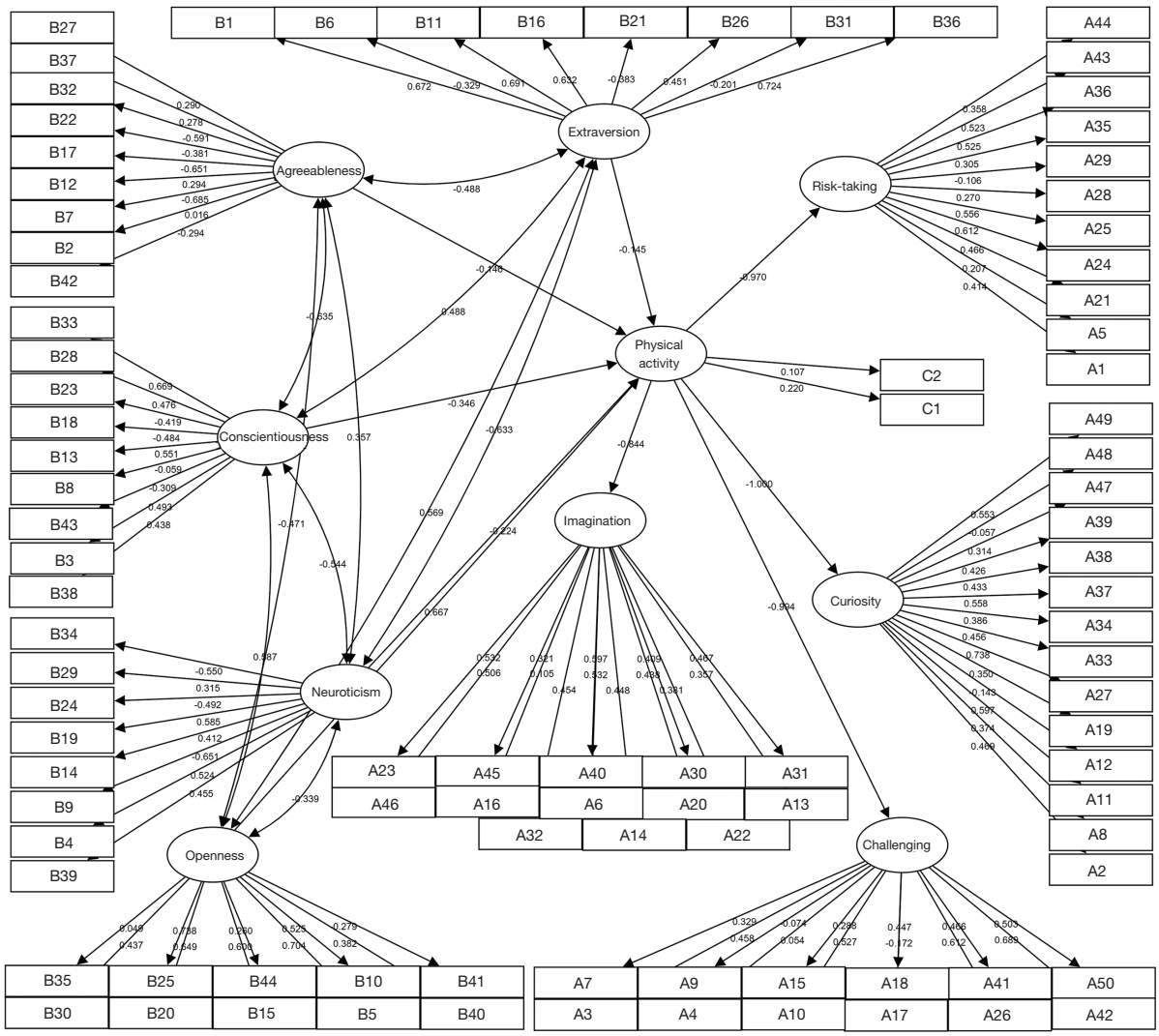

Figure 1 The initial model according to the theoretical hypothesis.

engage in physical activities, but those who engaged in more physical activities had worse trait creativity (i.e., curiosity, challenging, risk-taking, and imagination).

Discussion

This study used a SEM framework to assess the interrelationships among personality, physical activity, and trait creativity among university students. The results showed that physical activity had significant negative effects on all dimensions of trait creativity (i.e., curiosity, challenging, risk-taking, and imagination). Thus, the college students who engaged in more physical activities were more likely to have lower trait creativity.

Feist and Barron proposed that both cognitive and trait creativity are effective predictors of creative achievement (1). However, trait creativity may exceed cognitive ability as an indicator of creative achievement in life (33). Previous studies suggests that trait creativity is associated with specific personal traits, such as persistence, self-confidence, willingness to take risks, impulsiveness, ambition, skepticism, and imagination (12,34). Physical activity is fast becoming a predictor of complex cognitive processes. A randomized controlled trial has shown that 15 minutes of enjoyable physical activity (dancing) at the end of the day can significantly improve both divergent and convergent creative thinking (35). A case study also reported that dancing significantly improved the originality of graduate

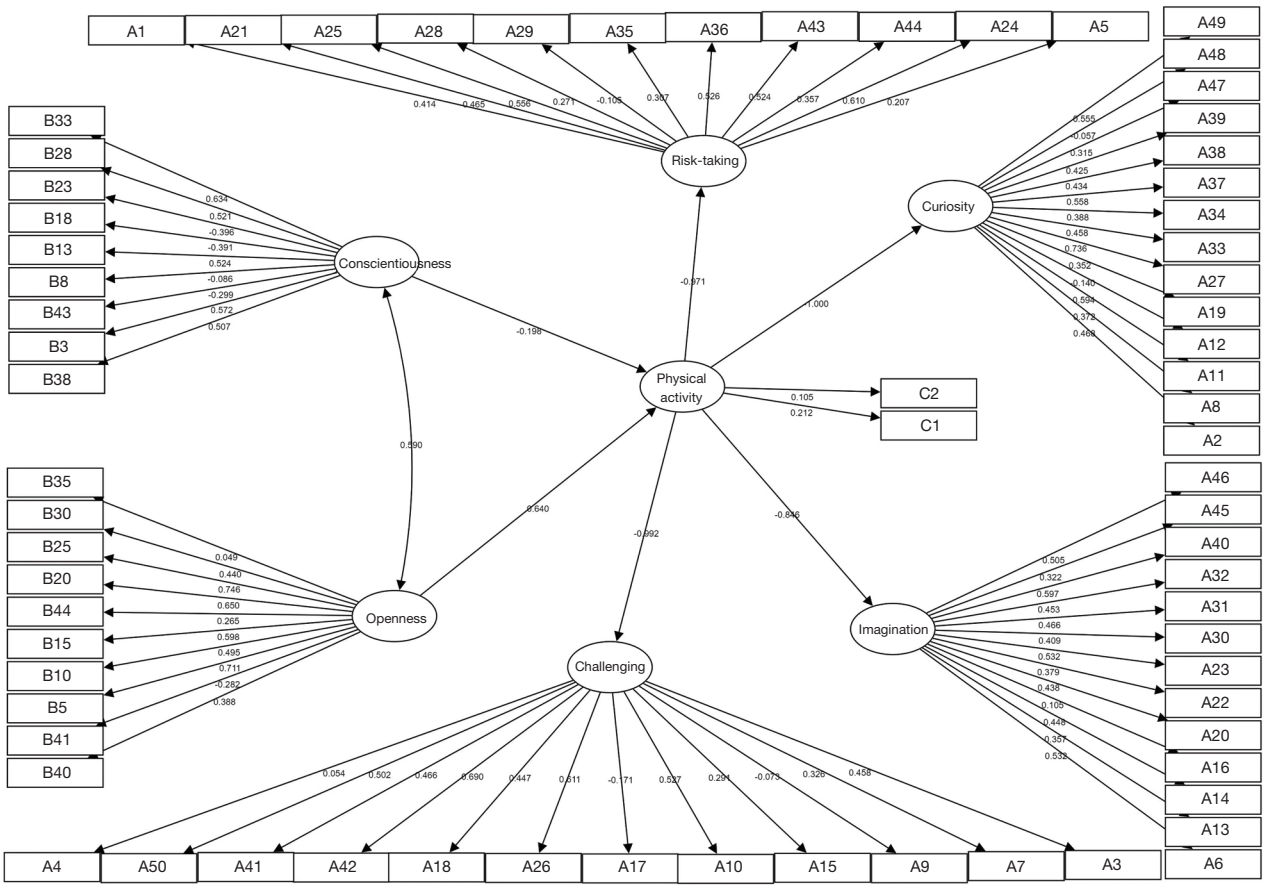

Figure 2 The modification model after removing the variables (extraversion, agreeableness, and neuroticism).

business administration students (29).

The effect of physical activity on creativity using virtual reality showed that participants who experienced movement in virtual reality before engaging in problem solving performed as well or better than those who engaged in walking on all design tasks and on all designer emotions (36). Previous study showed that physical activity for pleasure enhances creativity (36). However, the present study found that physical activity does not enhance trait creativity. In this study, moderate physical activity and walking were used as latent variables to observe their association with students' creativity tendency. Physical activity was found to be negatively correlated with creativity tendency; however, this does not mean that physical activity cannot promote creativity.

Personality traits have been investigated as predictors of physical activity (moderate physical activity and walking). A meta-analysis showed that conscientiousness, extraversion, and openness were positively associated with physical activity in individuals (37). Bidirectional associations between personality and physical activity in adulthood suggest that conscientiousness and openness predict subsequent increases in physical activity, while agreeableness predicts subsequent decreases in physical activity (38). Extraversion and openness significantly moderate the relationship between physical activity and subjective well-being (39). These findings suggest that insufficient physical activity is associated with a long-standing detrimental personality trajectory (40). Personality may stimulate the beginning and end of physical activity. This study also confirmed that the personality trait of openness significantly affects physical activity. These findings suggest that the effects of physical activity interventions may depend on personality traits. Interventions may be improved if individuality is taken into account when designing the program. Previous studies have shown that personality predicts physical activity (37,39,41) and that physical activity positively affects creativity (29,35,42). This study

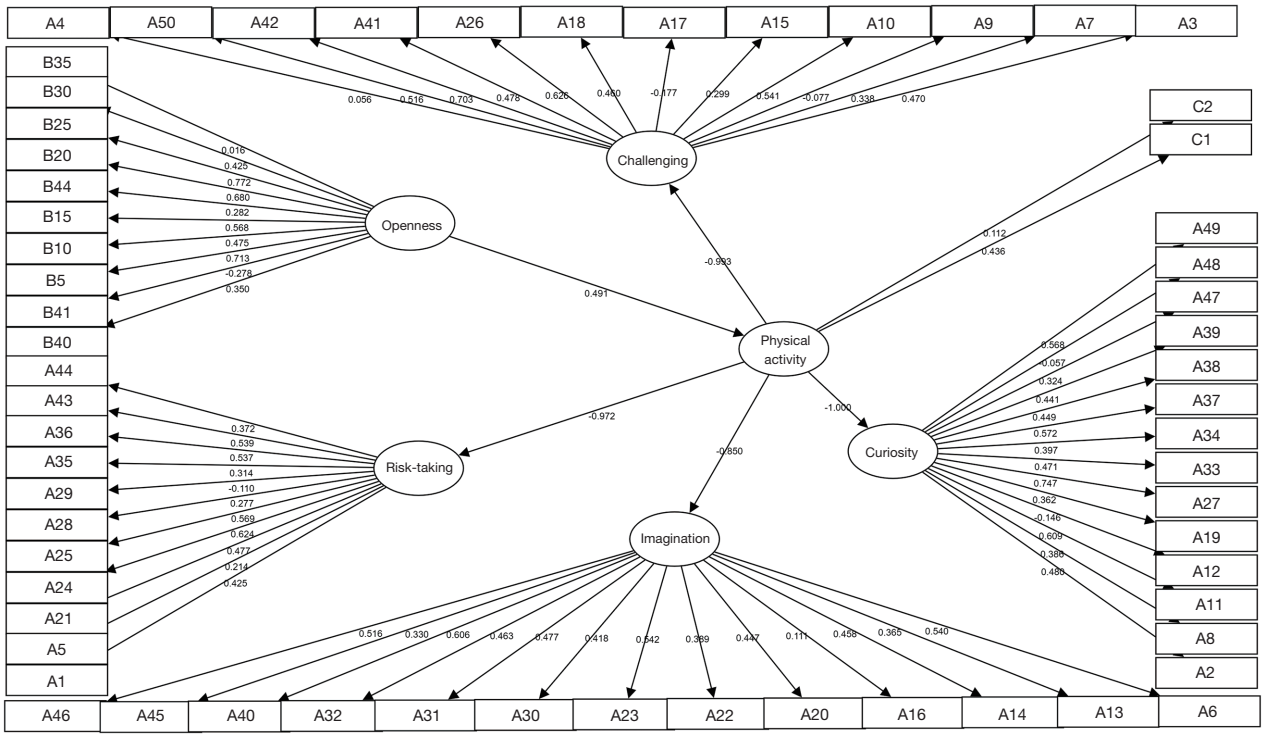

Figure 3 The modification model after removing the variables of extraversion, agreeableness, conscientiousness, and neuroticism.

also showed that openness had a positive effect on physical activity but a negative effect on creativity.

This study had certain limitations. First, the cross-sectional design employed in this study revealed correlations among the variables, but it does not allow for causal inferences to be drawn about the relationships among the variables tested. Future investigators could conduct longitudinal studies to determine whether measured physical activity effectively represents actual changes in trait creativity. Second, we targeted university students from the same university, and a gender balance of the sample was not achieved due to short time interval between samples. In the future, the external validity of the results of this study should be tested by selecting subjects from different backgrounds and the gender ratio of the cohort should be more balanced. Third, this study only focused on the moderating role of physical activity between personality and trait creativity. Future research should explore the effect of other dimensions on trait creativity. Finally, this study did not examine the effects of other factors, such as major, gender, parental education level, and family annual income, on the three variables. Future research should include control variables to further clarify the relationships among the three variables.

Conclusions

In sum, the negative effect of physical activity on trait creativity is a significant finding of this study. The question of whether to include physical activity criteria to ensure the selection of more creative talents represents a new research direction. The personality trait of openness has a profound positive effect on physical activity. Therefore, according to the different personalities of medical students, the classification management and different physical activities are carried out to enhance the trait creativity of medical students. Our data suggest that personality assessments may help to identify individuals with low levels of physical activity. This study reveals the relationship between trait creativity, personality and physical activity.

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Footnote

Reporting Checklist: The authors have completed the SURGE reporting checklist. Available at https://apm.amegroups.com/article/view/10.21037/apm-22-1310/rc

Data Sharing Statement: Available at https://apm.amegroups.com/article/view/10.21037/apm-22-1310/dss

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://apm.amegroups.com/article/view/10.21037/apm-22-1310/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. Verbal informed consent was obtained from all the individual participants in this study. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by ethics board of Affiliated Hospital of Taizhou University.

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Supplementary

Table S1 The measurement factors of trait creativity

Variable	Measurement
A1	In school, I liked to try to guess things or answers, even if I didn't always get them right.
A2	I like to look at things I haven't seen to get the details.
A3	I like to hear varied and imaginative stories.
A4	When I paint, I like to copy other people's works.
A5	I like to make all kinds of fun things out of junk like old newspapers, old calendars and old cans.
A6	I like to fantasize about things I want to know or do.
A7	If something can't be done at once, I'll keep trying until I succeed.
A8	When I do my homework I like to refer to a variety of sources in order to get a multi-faceted understanding.
A9	I like to do things the same way. I don't like to find new ways.
A10	like to find out if things are true or not.
A11	I like to do many new things.
A12	I don't like making new friends.
A13	I like to think of things that won't happen to me.
A14	I like to imagine being an artist, musician and poet one day.
A15	I get so excited that I forget everything else.
A16	I would rather live on the space station than on the earth.
A17	I think all questions have fixed answers.
A18	I like different things.
A19	I always want to know what other people are thinking.
A20	I like things that are described in stories or TV shows.
A21	I like to get together with my friends and share my ideas with them.
A22	If the last page of a storybook is torn out, I make up my own story and fill in the ending.
A23	When I grow up, I want to do something that no one else has ever thought of.
A24	It's fun to try new games and activities.
A25	I don't like too many rules.
A26	I like to solve problems, even if there is no right answer.
A27	There are a lot of things I would love to try myself.
A28	I like to sing new songs that no one knows.
A29	I don't like to air my opinions in front of my classmates.
A30	When I read a novel or watch TV, I like to think of myself as the character in the story.
A31	I like to imagine what human life was like 200 years ago.
A32	I've often wanted to make up a new song myself.
A33	I like to rummage around and see what's in there.
A34	I love changing the colors and shapes of things when I'm drawing.
A35	I'm not sure I'm right about everything.
A36	It is interesting to guess something first and then see if you are right.
A37	It's fun to play puzzles and things like that because I want to know what the outcome is.
A38	I was interested in machines, and I wanted to know what it looked like inside and how it worked.
A39	I like toys that can be taken apart.
A40	I like to think of new ideas, even if I don't need them.
A41	A good article should contain many different opinions or points of view.
A42	It is exciting to find answers to questions that may arise in the future.
A43	I like to try new things, just to see what the result will be.
A44	When I play a game, I'm usually interested in participating, not in winning.
A45	I like to think of things that other people often talk about.
A46	When I see a picture of a stranger, I like to guess what kind of person he is.
A47	I like to flip through books and magazines, but I just want to know what they're about.
A48	I don't like to look at all the reasons why things happen.
A49	I like to ask questions that no one else has thought of.
A50	Whether at home or at school, I always like to do many interesting things.

Table S2 The measurement factors of physical activity

Variable	Measurement
C1	how much time (minutes) do you typically spend in moderate physical activity on one of the last seven days?
C2	In the last 7 days, how many days have you walked for at least 10 minutes at a time?

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