



Original Research

Using Personality and Temperament to Predict Exercise Behavior: A Pilot Study of the Braverman Nature Assessment

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ABSTRACT

International Journal of Exercise Science 15(5): 341-357, 2022. The Braverman Nature Assessment (BNA) is intended to determine the dominant monoamine neurochemical that drives an individual's temperament and behavior. The measure has been colloquially praised for the ability to determine the most effective exercise protocols for an individual based on their "dominant nature." This study seeks to examine the proposed relationship between the Braverman Natures and exercise behavior. Seventy-three adults (57 females) between ages 18-65 (mean = 26 years) completed an online survey consisting of the BNA, Big Five Personality Inventory (BFI), and Aerobics Center Longitudinal Study Physical Activity Questionnaire (ACLSPAQ). All Natures showed significant correlations to unique sets of personality traits (BFI). Dopamine and Serotonin Nature scores (via BNA) showed positive correlations to total physical activity (PA) measures. Serotonin Nature had positive correlation with participation in resistance exercise ($r = .36, p < .01$) and showed the strongest correlations to PA participation. Dopamine was not associated with Extraversion as predicted; however, showed positive correlations to vigorous intensity exercise ($r = .26, p < .05$). The Natures demonstrate some low to moderate correlations between neurochemical scores and exercise behaviors such as preference for various exercise modalities. There is preliminary evidence to suggest that the BNA may be a useful tool for exercise prescription based on correlations between personality and exercise behavior found in this study. The results do not support colloquial literature on the use of BNA in exercise prescription.

KEY WORDS: Neurochemistry, fitness, psychology

INTRODUCTION

Physical inactivity is a global health phenomenon associated with dozens of common chronic diseases. Chronic sedentary behavior is a major issue for many Americans and is a major risk factor for cardiovascular disease (CVD) (8). Exercise has been shown to be a successful preventative measure for countless chronic diseases such as CVD, obesity, diabetes and stroke. Despite this, the American College of Sports Medicine, in conjunction with the Center for Disease Control (CDC), found that most Americans aren't meeting the recommended weekly physical activity guidelines (3, 8). The World Health Organization (WHO) in 2010 reported that 23% of adults worldwide are not exercising sufficiently (55). Furthermore, WHO states that physical inactivity is one of the leading risk factors for death worldwide (55). Physical inactivity

is a primary risk factor in the development of chronic disease such as obesity, cardiovascular disease, and metabolic disease (8). To combat this major health risk, physical activity initiatives have been put into place to encourage the American public to decrease sedentary behavior and exercise more frequently (11). Additionally, research into psychological factors that influence PA behavior, such as those discussed in the present study, may be useful for understanding how to reduce sedentary behavior and mitigate health risks across broad populations.

While educating the public about the many benefits of exercise may be a meaningful step towards getting people active, adherence to exercise programs remains low. Studies have shown that 50% of individuals who begin an aerobic exercise program will have quit within 6 months (1, 48). One possible explanation for this is that individuals are prescribed exercise programs that are not well suited for their unique psyche (9). To increase exercise adherence, many studies have sought to identify what characteristics, such as personality, may play a role in predicting and improving exercise adherence. Personality consists of a set of traits that are considered fairly stable throughout life and are responsible for an individual's unique patterns of thoughts, feelings and actions (46). The Big Five Personality inventory is commonly used to assess five major components of human personality (29). These components are Extraversion (talkative, assertive, energetic), Neuroticism (nervous, easily upset), Agreeableness (good natured, cooperative, trustful), Openness (intellectual, imaginative), and Conscientiousness (orderly, responsible, dependable) (29).

Most studies focus on Extraversion and Neuroticism as the most relevant personality components for predicting exercise behaviors (2, 9, 17, 46). This is largely because these components of personality can play a large role in predicting how likely a person is to be interested in interacting (and thus exercising) with others (9). Individuals with higher levels of positive emotionality (associated with Extraversion) may be more likely to engage in group exercise behaviors due to motivation for interpersonal interaction (9). Many studies have suggested that when compared to non-active individuals, people who exercise regularly tend to have higher levels of Extraversion (2, 9, 46). Conversely, lower levels of Agreeableness and high levels of Neuroticism may indicate a person is likely to engage in group exercise modalities (9). Additionally, one study found that (in addition to Extraversion), Conscientiousness and Openness to Experience were strongly associated with higher engagement in physical activity (2). Another study suggests that Neuroticism may be inversely related with preference for high exercise intensity and exercise adherence, while Extraversion and Conscientiousness were positively associated with high exercise intensity and adherence behaviors (17).

While many associations have been discovered and replicated, behavioral psychologists recognize that personality traits are not likely to directly influence our decision-making processes (46). Instead, more in accordance with Bandura's Social Cognitive Theory of behavior (4), personality informs perceptions, expectations and cognitions which then dictate how individuals choose to engage in specific behaviors such as exercise. Essentially, personality traits may have some predictive power in determining future exercise behaviors; however, they are not likely to be the direct psychological mechanism for the decision making that influences such behaviors. For example, the meta-analysis discussed above suggests that Extraversion and

Conscientiousness are likely to be strong correlates of self-efficacy and perceptions surrounding control over physical activity behavior (46, 54). This indicates that these personality traits may be indirectly influencing exercise behaviors via the components of Bandura's Social Cognitive Theory (4).

Temperament is a complex group of characteristics that are considered fairly stable throughout life and appear in infancy (13). Temperament is distinguished from other aspects of personality with the application of neurobiology, genetic inheritance and unique styles of automatic behavioral and emotional regulation that occur without self-awareness or intentional self-control (13). In other words, temperament is considered to be a highly predetermined feature of personality that impacts character, personality traits, and unconscious reactive behaviors. Components of temperament measured using the Adult Temperament Questionnaire (ATQ) (25), were shown to have correlations to exercise behavior. More specifically, "Orienting Sensitivity", a component of temperament associated with perceptual, perceptual affective, and associate sensitivity, was positively correlated with overall physical activity engagement in women (25, 34). Additionally, "Negative Affectivity", a component of temperament associated with fear and discomfort, was negatively correlated with overall physical activity engagement in men (25, 34). This study represents a relatively small body of research on the relationship between physical activity and temperament in adults; however, similar findings have been found in young children (32, 36). The culmination of research on the relationship between physical activity and temperament suggests that there are some components of the presently available temperament scales that show significant correlations to exercise behaviors. The findings align with research on the relationship between personality traits and physical activity behavior in that negative emotionality (Neuroticism) is negatively correlated with frequent participation in physical activity (34).

Recent research has investigated the genetic coding for specific neurotransmitters in the brain as significant determinants of such temperamental variability (13, 14, 20, 37, 47). Most fields of neuroscience focus on the most common mono-amine neurotransmitters as the most relevant chemicals for behavior regulation (43). These chemicals are Dopamine (DA), Serotonin (SE), Acetylcholine (ACh) and Gamma-aminobutyric acid (GABA). Each neurotransmitter can be traced to specific receptors and to specific groupings of neurons throughout the brain and are associated with specific behaviors, emotions and even diseases (43). Over the last 40 years, researchers have sought to analyze the exact role of these neurochemicals in a variety of functions. There are many difficulties in pinpointing the exact role of a single neurochemical in producing a downstream effect such as a behavior or a disease (47, 49). Regardless, some meaningful connections have been discovered and there is now emerging research to back the concept of using neurochemistry to predict cognitive functions particularly as precursors to expressed behaviors such as those discussed above (39, 42, 47). This is the underlying principle for the Braverman Nature Assessment (BNA) developed by Dr. Eric Braverman and published in his 2004 book *The Edge Effect* (10).

Braverman outlines how each neurotransmitter affects different areas of the brain and thus impacts unique systems that generate specific behaviors, temperament and physical outcomes

(10). Thus, Braverman suggests that the BNA can accurately predict which of the four neurochemicals listed above is most dominant in driving an individual's psychological and physiological functioning using prompts related to memory/attention, physical status, personality, and character. While the premise of using neurochemistry to predict temperament has been explored theoretically and empirically (14, 20, 59) with some disagreement about the merits of using a single neurochemical to make distinct evaluations about human behavior (47), there is little to no peer reviewed literature to support the validity of the BNA.

Lee et al. published a pilot study that compares the results of the BNA to Korean Sasang Constitutions (37). Sasang constitutions are a unique component of traditional Korean medicine that categorizes individuals into four constitutions: Taeyangin (TY), Soyangin (SY), Taeumin (TE), and Soeumin (SE), according to relative differences in temperament, body shape, physiology (37, 53, 58). Similar to the proposed BNA 'Natures', the Sasang constitutions represent a specific set of personality traits, temperaments, and physiological characteristics (33). Furthermore, the authors note that both the BNA and the Questionnaire for Sasang Constitution Classification (QSCC II) (57) incorporate physical, psychological and behavioral elements that demonstrate an understanding of holistic wellness that recognizes the connection between mental processes and physiological functioning (37). The study found significant correlations between the Dopamine Nature and SY Constitution and between the GABA Nature and TE and SE Constitutions. Yoon et al. noted that SY constitution is also associated with higher levels of Extraversion and that dopamine activation is associated with higher frequency of spontaneous exercise engagement (58). Stronger connections were found between BNA Natures and Yin and Yang types. Dopamine Natures were closely related to Yang types while GABA Natures were closely related to Yin types. While Yin and Yang types are not explicitly defined, the Yang type is associated with 'active and outgoing' characteristics while Yin type is associated with 'placid and careful' characteristics. (37). Overall, these correlations are promising for the validity of the BNA to predict some components of human temperament. Regardless, further research is needed to fully understand the internal validity and reliability of the test measure. Additionally, further research is needed in the field of neuroscience to establish more concrete understandings of what more and less mean in terms of measuring the effects of neurochemicals in the brain and their downstream effects on the body and behavior.

The goal of the present study is to examine the connection between personality and exercise behaviors. This investigation will serve as a pilot study for the BNA in its comparison to personality (BFI) and exercise behaviors. The BNA has been praised colloquially by fitness enthusiasts as a tool for predicting the most appropriate training styles for optimum performance (23, 45, 51). The utilization of BNA in exercise prescription was popularized by Olympic strength coach Charles Poliquin in 2018 (45). Poliquin compared the four Natures described in the BNA to the five traditional Chinese elements: fire, wood, earth, metal, and water. Poliquin suggests that each of the five types are associated with differences in dispositional physiological and psychological characteristics that affect how a person responds to exercise intensity, volume and variation. While no empirical evidence exists to support these proposed connections, it is hypothesized that the BNA Natures will show some correlations to

personality traits (BFI) and exercise engagement. Specifically, it is hypothesized that Dopamine will show the greatest correlation to trait extraversion and exercise engagement overall.

METHODS

Participants

The participants for this study were 73 adults (mean age = 26 years old). Fifty-seven of the participants were female-identifying and the remaining 26 were male-identifying. The participants were predominantly white with 58 of 73 participants identifying as “Caucasian or White”. Physical characteristics are listed below in Table 1. Participants were selected based on accessibility and prompted to complete the following test measures online via email or direct message and told that they would receive a \$10 Amazon e-gift card if they completed the entire survey. A majority of the participants were Elon University undergraduate students ($n = 48$); however, this sample also included international participants ($n = 6$) and participants within the U.S. (not affiliated with Elon; $n = 19$). All measurements and procedures were reviewed and approved by the Institutional Review Board (IRB) of Elon University.

Table 1. Physical Characteristics of Participants.

	Male ($N = 16$)	Female ($N = 57$)
Age (years)	29.0 ± 13.3	24.5 ± 9.6
Height (in.)	70.9 ± 2.7	64.7 ± 2.6
Weight (lbs)	179.7 ± 44.6	144.0 ± 36.8
BMI (kg/m ²)	24.9 ± 5.4	24.1 ± 5.8

Protocol

The following test measures were administered via online survey and recorded via Qualtrics. The participants were asked to complete the entire survey in one sitting to mitigate varying influence in responses from external factors such as drowsiness, stress, or affective states. All participants received and signed an informed consent document that outlined the purpose, goals, risks, and rewards of the study. The participants were informed that their participation in the study was voluntary and that they may choose to stop the survey at any time. Participants were also informed that doing so would forfeit their ability to receive the \$10 Amazon gift card. This research was carried out fully in accordance with the ethical standards of the International Journal of Exercise Science (40).

BNA: The Braverman Nature Assessment (BNA) is a 315-item true-false assessment developed by Dr. Eric Braverman and published in his book *The Edge Effect* (10). The first 200 questions are designed to determine the participants ‘dominant Nature’ based on questions related to memory/attention, physical status, personality, and character (10, 37). An example of a memory/attention loaded prompt is, “I become distracted because I do so many tasks at once” (10). An example of a physical status loaded prompt is, “My blood pressure is often elevated” (10). An example of a personality loaded prompt is, “I am very flexible” (10). An example of a character loaded prompt is “I try to please others the best I can” (10). There are 50 questions attributed to each of the four ‘Natures’ and each Nature is correlated with a monoaminergic neurochemical: The Powerful Dopamine Nature, The Creative Acetylcholine Nature, The Stable

GABA Nature, and The Playful Serotonin Nature (10, 37). The final 115 questions of the BNA are designed to identify neurochemical deficiencies. The questions are also true-false and scored the same as the previous section. There are 25 items correlated with each of the four neurochemicals mentioned above except for GABA which has 40 items. The items are also related to memory/attention, physical status, personality, and character.

Participants were not given any information about the importance or implications of each section. For the first 4 sections (200 items) participants are told only to answer each question true or false based on how they feel on average and told to focus less on their current state. For the final 4 sections (115 items) participants are asked to answer each question true or false based on how they feel currently and encouraged to report all symptoms they are experiencing even if it is for the first time or occurs rarely. The BNA is scored based on the number of true responses a participant provides in each neurochemical section.

BFI: The Big Five Personality inventory (BFI) assesses five major components of human personality (29). These components are Extraversion (talkative, assertive, energetic), Neuroticism (nervous, easily upset), Agreeableness (good natured, cooperative, trustful), Openness (intellectual, imaginative), and Conscientiousness (orderly, responsible, dependable) (29). The BFI has 44 items related to personality, temperament, and behavior. Each question corresponds with one of the 5 factors of personality and is thus scored accordingly to measure how dominant each factor is in an individual's personality. For example, a positively scored question loaded for Extraversion is, "is talkative." This prompt would therefore be scored from one to five based on the participants response and would contribute to their overall score for trait Extraversion. A similar process is completed for the scoring of the remaining prompts to generate a profile of scores for each of the five traits listed above.

ACLSPAQ: The Aerobics Center Longitudinal Study Physical Activity Questionnaire (ACLSPAQ) (35) is a survey instrument designed to capture leisure time physical activity participation. The questionnaire includes 12 explicit categories of physical activity (e.g., walking, running, vigorous sports, and lawn work or gardening) and one space available for the participants to write in a form of physical activity that they feel was not captured above. Each item also has follow-up prompts that ask the participants about the frequency and volume that they participate in that activity per week. Additionally, there is a final prompt that reads, "How many times in a week do you engage in vigorous physical activity long enough to work up a sweat" (35). Because this measure was not created with standardized response scales, the questions are highly individualized for examining participation in a specific activity. This survey will be utilized to examine exercise modality.

Statistical Analysis

This study is an exploratory, descriptive study to examine the constructs of the BNA and BFI in relation to physical activity behavior. Therefore, Pearson's correlations (r) were used to examine the relationships between variables. Due to the small numbers of participants who were classified in some of the Natures (via BNA), many of the analyses used total score on the Natures classification as opposed to dominant Natures. Significance was determined if $p < .05$.

RESULTS

Frequency of neurochemical dominance as measured by the BNA is shown by number of Participants in Table 2. The dominant Nature is determined by which neurochemical section an individual answers the *most* prompts as true. If a participant shows equal values in any two categories, the neurochemicals are organized based on brain wave activity through the regions of the brain (10). If a participant scored equally in two Natures, they were prioritized using the following progression: Dopamine first, GABA second, Acetylcholine third, and Serotonin fourth (10). For example, if a participant had equal scores from GABA and Serotonin then GABA would be their dominant Nature according to Braverman. Dopamine and Serotonin Natured individuals made up only 10% and 5% of the study population respectively. This is significantly lower than the expected distribution of approximately 17%. Conversely, Acetylcholine and GABA Natured individuals constituted 27% and 58% of the study population respectively. This is an overrepresentation of these Natures relative to expected norms of 17% and 50% for Acetylcholine and GABA Natures respectively.

Table 2. Braverman Nature Assessment Descriptive Outcomes.

	# of Participants	% of Total	Mean Score
Dopamine	7	10	25.8 ± 5.4
Acetylcholine	18	27	28.8 ± 6.4
GABA	38	58	31.7 ± 5.9
Serotonin	3	5	21.9 ± 6.4

Pearson correlation coefficients were calculated to assess the relationship between Natures (BNA) and personality (BFI) (Table 3). There were positive correlations between Acetylcholine and Extraversion ($r = .28, p < .05$) and Openness ($r = .37, p < .01$). Serotonin shared similar correlations as Acetylcholine to Extraversion ($r = .29, p < .05$) and Openness ($r = .39, p < .01$). There were positive correlations between Dopamine and Neuroticism ($r = .24, p < .05$) and Openness ($r = .24, p < .05$). Finally, GABA showed a positive correlation to Conscientious ($r = .51, p < .01$) and negative correlations to Neuroticism ($r = -.35, p < .01$) and Openness ($r = -.25, p < .05$). Overall, there were many low to moderate correlations observed between Natures and personality traits.

Table 3. Correlations Between Braverman Natures and Personality Traits.

	Dopamine	Acetylcholine	GABA	Serotonin
Extraversion	.22	.28*	.14	.29*
Agreeableness	-.22	.15	.22	.05
Conscientiousness	-.15	-.13	.51**	-.20
Neuroticism	.24*	.10	-.35**	-.02
Openness	.24*	.37**	-.25*	.39**

Note. * $p < .05$, ** $p < .01$.

Pearson correlation coefficients were calculated to assess the relationship between personality (BNA and BFI) and PA (ACLSPAQ) (Table 4). Dopamine was expected to be correlated with weightlifting; however, this was not observed in the present study. Dopamine was positively

correlated with the Sweat Question of the ACLSPAQ† ($r = .28, p < .05$). Serotonin showed positive correlations to weightlifting ($r = .36, p < .01$), the Sweat Question† ($r = .29, p < .05$) and total weekly METS of PA across all modalities ($r = .24, p < .05$). No significant relationships were found for Acetylcholine or GABA Natures and PA measured via the ACLSPAQ in the present study. Overall, Serotonin Nature showed the most significant relationship to PA engagement based on correlations between the Serotonin Nature and PA prompts from ACLSPAQ (Table 7). Only Neuroticism showed significant correlations to PA with low negative correlations to both weightlifting ($r = -.29, p < .05$) and total METS of weekly exercise ($r = -.28, p < .05$). No significant correlations were found between other personality traits and variables of PA from ACLSPAQ.

Table 4. Correlations Between Braverman Natures, BFI Personality Traits and PA (ACLSPAQ).

	Weightlifting	Sweat†	Total PA
Dopamine	.19	.28*	.14
Acetylcholine	.04	.03	-.01
GABA	.10	-.00	.12
Serotonin	.37**	.29*	.24*
Extraversion	.23	.11	.17
Agreeableness	.01	-.06	.01
Conscientiousness	.14	.11	-.01
Neuroticism	-.29**	-.16	-.28*
Openness	.02	.00	.06

Note. * $p < .05$, ** $p < .01$

†= Prompt from ALCSPAQ “How many times in a week do you engage in vigorous physical activity for long enough to work up a sweat?”

DISCUSSION

The Braverman Nature Assessment (BNA) is a novel test designed to measure individual differences in four major neurochemicals (10). The results and analysis of the test are based on findings that suggest that the monoamine neurochemicals dopamine, acetylcholine, GABA, and serotonin are directly related to physical and psychological characteristics (7, 15, 19, 27, 39, 43, 44, 56). One of these characteristics identified by Braverman (10) is temperament which is a nuanced component of personality (13). An emerging body of empirical evidence supports a relationship between certain components of temperament and physical activity behavior (25, 32, 34). Furthermore, colloquial literature suggests a relationship between the results of the BNA and exercise behaviors, preferences, and physiological adaptations (23, 45, 51). The present study sought to critically examine these claims and evaluate the strength of the relationship between the BNA, personality, and exercise behaviors.

Braverman (10) says that approximately 50% of people share a GABA Nature and that the remaining three Natures are all approximately equal in frequency (approximately 17%). The results of this study showed slightly higher percentages of GABA and Acetylcholine Natures than predicted and slightly lower occurrences of Dopamine and significantly lower occurrences of Serotonin Nature than expected (see Table 2). Given the gender demographics of the present investigation, this may suggest that certain Natures are more common among female-

identifying individuals than male-identifying individuals. For example, the GABA Nature was slightly overrepresented in this study compared to expected proportions (10). Based on the gender distribution of the present study, this may suggest that women are more likely to be GABA natured compared to other genders. This study will need to be replicated with a much larger population; however, to draw these conclusions.

Interestingly, each of the four Natures was correlated with a set of Big Five personality components (29). Dopamine was positively correlated to Neuroticism ($r = .24, p < .05$) and Openness ($r = .24, p < .05$). Acetylcholine was positively correlated to Extraversion ($r = .28, p > .05$) and Openness ($r = .37, p < .01$). GABA was positively correlated with Conscientiousness ($r = .51, p < .01$), and negatively correlated with Neuroticism ($r = -.35, p < .01$) and Openness ($r = -.25, p < .05$). Serotonin was positively correlated with Extraversion ($r = .29, p < .05$) and Openness ($r = .39, p < .01$). The fact that each Nature showed low and medium correlations to a unique set of personality characteristics suggests some internal validity of the BNA to measure individual differences in personality. Furthermore, the results are mostly in line with the proposed characteristics described by Braverman (10).

Dopamine Nature is characterized by Extraversion, high energy, and rational thinking (10). This does not align with the findings of this study. Neuroticism is characterized generally by negative affectivity and the predisposition to experience psychological distress (12). Dopamine has previously been found to be related to spontaneous exercise engagement and Extraversion (58). Furthermore, Lee et al. found that, when comparing Braverman Natures to Sasang Constitutional Medicine, Dopamine Nature showed a strong correlation with Yang constitution which is characterized by outgoing and active personality (37). The findings of this present study suggest a more complex understanding of Dopamine Nature measured by BNA. Dopamine scores were correlated with Neuroticism and Openness but not with Extraversion. While this is a novel finding for the BNA Natures, Openness and Neuroticism have been found to be positively related in the past due to their implications in plasticity (22). Additionally, the dopaminergic system is involved in approach behavior and exploration as well as the networks that give value to reward experiences (15, 21). These findings may explain the correlations between Dopamine, measured by the BNA, with Openness and Neuroticism measured by the BFI. The hypothesis of Dopamine Nature being correlated with Extraversion was not supported by the data. There was a weak correlation between Dopamine and Extraversion ($r = .22$), but it was not statistically significant. It is possible that this correlation may be due to sex-related biases in this study population. Women have been found to have higher levels of Neuroticism and lower levels of Extraversion than men (50). Due to the demographics of this study (77% female identifying participants), it is possible that the data is skewed towards higher responses for Neuroticism and lower levels of Extraversion. As this study was primarily composed of White and Caucasian participants, the potential impact of race on personality differences was also explored; however, previous research has not found racial differences in BFI scores (26).

Acetylcholine Nature is characterized by creativity, Openness and sociability (10). This characterization was supported by the data showing positive correlations in both Extraversion and Openness. Neurobiological explanations for this finding have not been substantiated; likely

due to the difficulty of locating ACh activity and its affected networks in the brain (43). Despite this, one possible explanation for the relationship between ACh and Openness is ACh's roles in learning and memory and reward saliency. ACh may play a role in focusing attention on novel reward behaviors and thus may be implicated in components of Openness (44). Similarly, GABA Nature was also correlated with personality characteristics similar to those identified by Dr. Braverman (10) and Lee et al. (37). According to Braverman, the GABA Nature measured by the BNA is associated with stability, organization, Conscientiousness, and level headedness (10). The correlations between BFI personality characteristics and GABA responses supports this hypothesis. GABA showed a moderate positive correlation to the trait of Conscientiousness which is explicitly mentioned by Braverman and discussed as a component of interpersonal caregiving tendencies. The relationship between GABA and caregiving is supported by literature on maternal care causing alterations in GABA receptors in the receiving offspring that can modulate future stress responses (30). Additionally, GABA has been reported to be related to components of emotional stability and more reserved, formal behavior (30). Interestingly, Goto et al. note that the impact of different GABA polymorphisms on personality vary greatly depending on the region of the nervous system affected and suggest no broad personality associations for global GABA levels (30).

Serotonin Nature was characterized by Braverman as the "playful nature" associated with responsiveness to sensory input, engagement in novel activities and sociability (10). The results of this study support this characterization with Serotonin responses showing positive correlations to both Extraversion and Openness traits. There is some evidence to support the relationship between specific serotonin allele expression and higher levels of Extraversion in patients with bipolar personality disorder (42). It is suggested that reduced serotonin levels are associated with increased impulsivity which is a component of Neuroticism and reduced Conscientiousness; however, Ni et. al. were not able to establish any links between these characteristics and serotonin allele expression (42). This may suggest that impulsivity, as it relates to personality is multifaceted and that certain components of impulsivity align more closely with novelty-seeking behavior and less with Neuroticism and negative affectivity. This approach is supported by Braverman's characterization of the Serotonin Nature as adventurous and thrill-seeking and by the lack of evidence to support correlations between Serotonin and Neuroticism (10, 42). Additionally, there are conflicting results to explain the relationship between Serotonin and trait Openness. Positron emission tomography (PET) imaging did not show a significant correlation to trait Openness; however, many studies have shown a longitudinal relationship between the use of serotonin-agonists such as classic psychedelics and significant increases in trait Openness (24, 52). There are certainly confounding factors in the psychedelic experience such as mystical states that may partially explain the increases in trait Openness (24). Despite this, if the BNA is accurate in measuring some degree of increased serotonin activity, the results of this study suggest a link between serotonin and trait Openness as measured by the BFI.

In summation, there are significant correlations between Natures and Big Five personality traits that suggest that the BNA is sensitive enough to measure individual personality traits. The personality findings generally aligned with Dr. Braverman's description of each Nature with

some irregularities (10). Regardless, the neurophysiological links between the actual neurochemicals themselves and the proposed personality characteristics remain unclear. This is in line with Robbins' suggestion that the measurement tools and understanding of global neurochemical levels are not yet able to accurately make broad generalizations and predictions about personality (47). The relationship between a single neurochemical and a very nuanced personality characteristic is very complex, especially given the interconnected nature of all major monoamine neurotransmitter systems. More research is needed to clarify specific systems within each neurotransmitter that have a proven and profound downstream effect on personality traits. Therefore, the results of this study, while they do demonstrate a significant link between the Braverman "Natures" and specific personality traits, do not necessarily indicate that the BNA is a sensitive tool for accurately measuring brain chemistry at any level.

To compare the relationship between the BNA "Natures" and physical activity (PA) measures, participants responded to questions related to overall physical activity participation and modality of physical activity (ACLSPAQ). The hypothesis was that Dopamine would be associated with higher levels of PA engagement and Extraversion. This hypothesis cannot be accepted in its entirety based on the results of this experiment. Interestingly, Dopamine showed a positive correlation to the Sweat Question from the ACLS-PAQ which asked, "How many times in a week do you engage in vigorous physical activity for long enough to work up a sweat?" (35). Furthermore, Dopamine Nature was related to the Soyang (SY) constitution in previous studies which was associated with higher levels of Extraversion and spontaneous exercise engagement (37, 58). The relationship between Dopamine and physical activity is well established in the literature (6, 18, 28). The proposed mechanism of behavioral regulation is via the reward-dependency system in which dopamine activity is highly involved (28). It is suggested that the established dopamine release resulting from exercise causes reward chasing behavior that reinforces exercise behaviors. Furthermore, studies in both mice and humans have shown significant relationships between dopaminergic receptor expression and exercise behaviors (28). Based on the results of the present study, this relationship is demonstrated via Dopamine Nature's correlation to vigorous PA via the Sweat Question (ACLSPAQ).

Serotonin Nature showed positive correlations to weightlifting, the Sweat Question and total METS of weekly PA (ACLSPAQ) (See Table 4). Interestingly, colloquial literature describes Serotonin Natures as non-athletic and generally disinterested in participation in PA (45). Despite this, the results of this study suggest that Serotonin may be the most associated with participation in PA. Specifically, Serotonin was related to weightlifting, vigorous intensity exercise volume and total exercise participation (ACLSPAQ). Serotonin showed more positive correlations to exercise behaviors than any other neurochemical.

Braverman does not include extensive information about Serotonin Nature and PA, however, literature demonstrates a complex relationship between the variables. Serotonin is involved in the downstream regulation of parasympathetic physiological functions such as sleep, circadian rhythm, and neuroendocrine function (27). Studies on the role of serotonin in exercise fatigue have incorporated it into the "central fatigue hypothesis" as an adaptive mechanism for preventing the body from overexertion and physiological damage from exercise (16, 41). This

may explain why serotonin levels appear to be elevated during and after exercise. This finding was supported by research on acute and prolonged stress that found increased serotonin levels in response to stressful stimuli (31). However, Lin and Kuo note that serotonin modulation during exercise is highly dependent on brain region and exercise intensity (38). Studies in mice have shown decreased serotonin levels over sustained moderate intensity exercise regimens and increased serotonin levels in shorter regimens of high intensity exercise (38). As suggested by Robbins, it is not effective to generalize global upregulation or downregulation of a neurotransmitter with specific behaviors because their effects are highly dependent on the brain region they innervate and the interconnectivity of multiple neurochemical systems (47). The generally accepted theory on the role of dopaminergic and serotonergic systems in exercise and stress is that the ratio of the two chemicals is the best predictor of outcomes (16, 31, 38). These findings may offer an explanation for the positive correlations found between Serotonin and PA.

In general, GABA and Acetylcholine Natures did not show significant correlations to PA. The relationship between acetylcholine as a precursor for PA engagement is unclear; however, acetylcholine is released peripherally at the neuromuscular junction allowing transmission of signals for muscular contraction (5). Additionally, Braverman does not suggest a strong connection between Acetylcholine or GABA Natures and PA engagement (10). The results of the present study generally support the notion that Acetylcholine and GABA Natures are not positively related to PA engagement. Despite this, the following section will discuss personality traits associated with each Nature and their correlations to PA.

Serotonin was positively correlated with trait Extraversion which has been found to be most positively correlated with participation in PA (2, 9, 46). Despite this, Extraversion was not found to be correlated with PA engagement in the present study, likely due to the sample size and previously noted gender disparities in the sample population. The relationship between Serotonin and personality should be further explored in the future to better understand what components of Serotonin Nature are related to PA engagement. One possible explanation may be found in temperament characteristics such as orienting sensitivity which is related to novelty experience seeking and somatic experience sensitivity (25). These components of temperament may be related to exercise behavior due to the willingness to engage in and enjoy novel physical activities.

Acetylcholine showed a positive correlation to Extraversion which, as discussed previously, is generally associated with more engagement in physical activity. Conversely, GABA showed a negative correlation to Neuroticism which is generally associated with an inverse relationship to exercise participation and adherence (2, 9, 46). The inverse relationship between trait Neuroticism and PA was supported by the results of the present study. Neuroticism was inversely correlated with self-reported weightlifting participation ($r = -.29, p < .05$) and total METs ($r = -.28, p < .05$). This suggests that GABA may show correlations with PA in a larger sample size. Neuroticism was the only of the BFI personality traits to show statistically significant correlations with PA measures (ACLSPAQ). Neuroticism was negatively correlated with weightlifting and total METS of PA (Table 4). Previous literature supports the inverse relationship between trait Neuroticism and PA engagement (46, 54). However, the lack of

support in the present study for relationships between Extraversion and Conscientiousness and PA was surprising and not in line with previous studies that have shown consistent positive correlations between these personality traits and PA (2, 9, 45, 54).

Conclusion: The hypothesis was that Dopamine Nature would be most associated with Extraversion and participation in PA. This hypothesis was largely rejected based on the findings of the present study. Serotonin, rather than Dopamine, was correlated with Extraversion and participation in multiple forms and intensities of PA. The results of the present study are not sufficient to support claims in colloquial literature that the BNA is an effective tool for predicting exercise behavior. Despite this, findings on the association between dopamine and serotonin and PA engagement suggest that the BNA may have some utility in the field of exercise science.

This study was limited by small sample size and demographics that are not representative of the general population. The population contained a high percentage of female participants and very few participants from non-White and non-Caucasian groups. In order to draw conclusions about the generalizability of the BNA, future research should be conducted with larger and more diverse populations. It is also suggested that future research should incorporate the adult temperament questionnaire (ATQ) (25) to capture components of personality that are not accounted for in the BFI. Furthermore, this study does not take into consideration the relationships between neurochemical deficiencies and PA and personality for the sake of scope and scale. Future studies should examine these relationships further to see if there is utility in using only the second portion of the BNA to gain insight into components of an individual's psychological and physiological characteristics. This portion of the BNA is approximately one third of the length of the entire test which may make it more appropriate for administration to a client in an exercise prescription setting. In conclusion, the BNA may have some utility for the purposes of understanding personality and exercise behavior pending further critical review of the test measure and the literature that supports the BNA's proposed merit.

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