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Association of personality with habituation of physical and non-physical activities among Japanese adults: Results from questionnaire research before COVID-19 pandemic.

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Abstract**Background**

Physical activity has benefits for public health as it reduces the risk of non-communicable diseases and improves the quality of life. Previous studies have shown that health conditions, lifestyle, and socioeconomic status influence one's tendency to engage in physical activity. However, the influence of psychological traits on engagement in physical activity is not yet fully understood. In this study, we explored personality traits associated with the habituation of physical activity and compared them with personality traits associated with the habituation of non-physical activity.

Methods

We recruited 1600 Japanese adult volunteers and conducted an online survey just before the spread of COVID-19. We collected data for the prevalence of physical and non-physical activities, and various aspects of personality traits including the Big Five personality traits, sensitivity to behavioral activation, dark triad personality, levels of internal locus of control, and the degree of just-world belief.

Findings

The results demonstrated that high levels of extraversion, sensitivity to behavioral activation, and an internal locus of control had a positive influence on the habituation of physical activity. Moreover, our results were contradictory as they also showed that high levels of openness, sensitivity to behavioral activation, and just world belief related to the habituation of non-physical activity.

Interpretation

These results suggest that the personality traits that influenced the habituation of activities depend on the characteristics of the activity and reveal extraversion and internal locus of control as the personality traits specific to the habituation of physical activity.

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Journal Pre-proof

Introduction

Physical inactivity has a negative effect on the quality of life. There is accumulating evidence which shows that physical inactivity increases the risk of non-communicable diseases, such as heart disease, diabetes, breast cancer, and colon cancer (e.g., Guthold et al., 2018; Kim et al., 2021; Lee et al., 2012; Rahman et al., 2020; Wen et al., 2011). Currently, the lower prevalence of sufficient physical activity during adulthood is a global issue as it is common across more than 160 countries and has not been improved over the past decades (Guthold et al., 2018; Kim et al., 2021; Rahman et al., 2020). Hence, exploring the factors that increase as well as decrease the prevalence of physical activity is of interest world wide.

Some studies have investigated the factors among individuals' lifestyles, living practices, or living environments that have negative influences on the habituation of sufficient physical activity in their daily lives (Gregg et al., 2003; Guthold et al., 2018; Irwin et al., 2008; Lee et al., 2012; Wen et al., 2011). Physical activity encompasses a variety of activities such as activities for work, activities for transportation, exercise, and sports during leisure time, but most focus on the last two (e.g. Guthold et al, 2018; Kim et al, 2021). Previous studies have focused on the relationships between baseline health conditions, lifestyle (e.g., drinking or smoking), education, occupation, and socioeconomic status. For example, Guthold et al. (2018) revealed that socioeconomic status had a significant effect on the habituation of physical exercise; the prevalence of physical activity in high-income countries was less than half of that in low-income countries. However, there is also a large variance in the prevalence of physical activity even among high-income countries (Seo et al., 2012; South Korea et al., 2018), which implies that factors other than health conditions, lifestyle, and socioeconomic status also influence people's tendency to engage in physical activity.

Individual differences in engagement in physical activities are also associated with mental and psychological status. Previous studies have shown a relationship between engagement in physical activity and various personality traits (e.g., Courneya et al., 1999; Ebstrup et al., 2013; Schneider & Graham, 2009; Stephan et al., 2013; Stephan et al., 2014). For example, the amount of physical activity correlated positively with extraversion and conscientiousness and negatively with neuroticism of Big Five personality traits (Courneya et al., 1999; Stephan et al., 2013; Stephan et al., 2014). Ebstrup et al. (2013) showed that people with high

scores in extraversion and conscientiousness and low scores in neuroticism had a longer duration of sitting-time during leisure. Schneider and Graham (2009) examined the relationships between participation in physical activity (i.e., the degree of enjoyment and tolerance of exercise) and the sensitivities for punishment and reward using behavioral activation (BAS) and behavioral inhibition (BIS) scales. They found that high sensitivities for punishment were related to low levels of exercise tolerance, and high sensitivities for reward were related to high levels of enjoyment of exercise.

Although these studies demonstrated substantial influence of psychological traits on engagement in physical activity, the measurements mainly addressed the amount or frequency of physical activity rather than the presence/absence of habituation of physical activity (Courneya et al., 1999; Ebstrup et al., 2013; Schneider & Graham, 2009; Stephan et al., 2013; Stephan et al., 2014). Therefore, the psychological factors that enable people to continue the engagement in physical activity in daily life regardless of the amount of activity is less understood. Since even a minimum amount of engagement in physical activity is beneficial in public health¹, it would be important to explore the psychological factors that determine whether people engage in continuous physical activity regardless of amount. Thus, we measured the presence/absence of continuing engagement in physical activity rather than the amount of engagement and examined the factors influencing the presence of engagement.

Regarding the habituation of physical activity, apart from the general public, sports psychology research has implied that a higher score on narcissism traits is associated with athlete samples (Elman & McKelvie; Roberts et al., 2012; Roberts et al., 2014). As it is obvious that becoming an athlete requires continuing effortful engagement in physical activity, these results allow us to further understand the habituation of physical activity. However, it is unclear whether these factors lead to continuous exercise in non-athletes.

It would also be intriguing to investigate whether the factors influencing the habituation of physical activity and those influencing other non-physical activities are common. Oerlemans et al. (2011) investigated the association between subjective happiness, the Big Five personality traits, and the amount of social, physical, restful, household, and cognitive activities. Although the correlation between psychological traits and the amount of activities was not the main focus, they reported that extraversion positively correlated with

¹ US Department of Health and Human Services (2018) states “even 5 minutes of physical activity has real health benefits” in their guideline. Physical activity guidelines for Americans, ODPHP Publication No. U0036, Retrieved from <https://health.gov/paguidelines/pdf/paguide.pdf>

the amount of social but not physical activity. Stephan et al. (2014a) assessed the frequency of participation in different types of activities, i.e., games, developmental activities, and social activities, in addition to physical activities, and found that personality traits correlated with the amount of activities depended on the type of activity. Thus, the factors influencing the amount of physical and non-physical activities are partly separable. However, since most previous studies regarding the relationship between personality traits and the amount of physical activity did not necessarily contrast physical activities with other activities, it is unclear whether these factors modulate the habit of physical activity or influence the attitudes of habituation in general, including non-physical activities. The contrast between these two types of habituation will be insightful in understanding and increasing the motivation for continuous participation in physical activity.

In the present study, we aimed at comprehensively understanding how various personality traits would relate to habituation of physical activity during adulthood in Japan. We also compared the personality traits related to habituation of physical and non-physical activities to dissociate the personality traits related to physical activity habituation from the general attitudes toward habituation regardless the types of activity. Although the umbrella term "physical activity" includes a wide variety of activities (e.g. Koch et al., 2020), we defined the term as exercise and sports that are intentionally habituated to improve physical fitness while the physical activities that occur in daily life, such as walking the dog or walking to work, was not regarded as "physical activity" in the present study. We also defined the term "non-physical activity" as any hobbies, leisure activities, or learning activities other than exercise or sports (e.g., Oerlemans et al., 2011; Stephan et al., 2014a). In addition, we defined "a habituation" as "the continuous engagement in physical activity longer than 6 months in daily life". This definition is based on the concept of "Stages of Change" proposed by Prochaska & DiClemente (1983). This concept refers to time criteria for adapting a new behavior as a routine of daily life; a behavior that is sustained longer than 6 months can be considered a habituation. Originally developed in the study of smoking behavior, the concept has been applied to the study of exercise as a criterion for habituation to physical activity (e.g. Laforge et al., 1999; Plotnikoff et al., 2001; Spencer et al., 2006). Accordingly, we asked Japanese adult volunteers whether they had continuously participated in physical and non-physical activities longer than the past six months. In addition, following the previous studies (e.g., Courneya et al., 1999; Roberts et al., 2014; Schneider & Graham, 2009), we measured various aspects of personality traits comprising Big Five personality (extraversion, agreeableness, openness, conscientiousness,

and neuroticism), sensitivities for punishment and reward, dark triad personality (narcissism, psychopathy, and Machiavellianism), levels of an internal locus of control, and the degree of just-world belief. By subjecting these measurements to the multiple logistic regression analysis, we examined which psychological factors influence the habituation of physical and non-physical activities.

Methods

Participants

An online survey was conducted in Japan in January, 2020. This period was just before the widespread of COVID-19 in Japan, and people's lives had not yet been affected by COVID-19. The sample consisted of 1600 adults (800 men and 800 women), all of whom were native Japanese speakers. The mean age was 41.7 years ($SD = 13.92$). All participants were registered members of a commercial marketing research company in Japan and voluntarily participated in the online study. This study was performed in accordance with the ethical standards of the Declaration of Helsinki and the marketing company's regulations. Before participating in the survey, all the participants provided informed consent for their participation and publication of anonymized data on an online open-access platform. Before being administered the following scales, the participants were asked about their conditions of current continuous participation in physical activity as screening; "Do you currently engage in any exercise or sport that you have been doing continuously for more than 6 months?". We defined participants who had continuous engagement in any exercise or sports activity for longer than six months as the sample with habituation of physical activity. Here, we did not provide examples or definitions of exercise or sports activity or the amount of activity, and hence, the measurements indicate whether participants would self-judge that they were continuing the engagement in such activity. Based on this screening question, we recruited 400 male and 400 female individuals with habituation of physical activity and 400 male and 400 female individuals without habituation of physical activity. We also asked whether they were engaged in non-physical activities, such as handicrafts, volunteer work, and gardening among others; "Do you currently have any hobbies, leisure time activities, or study activities other than exercise or sports that you have been doing continuously for at least 6 months? (e.g., gardening, handicrafts, volunteer work, study language, chess, photography, etc.)". Table 1 shows the number of

participants with and without these two types of activities. We also asked questions regarding the preference for physical activities, types of physical activities, and some other items, but were not submitted to the analyses since they were not related to the main purpose of the current study.

Table 1. The number of participants with and without two types of habituation of activity.

		The habituation of non-physical activity	
		Yes	No
Male			
	The habituation of physical activity		
	Yes	263	137
	No	145	255
Female			
	The habituation of physical activity		
	Yes	284	116
	No	185	215

Measurements

Participants answered the Japanese version of the six psychological scales: TIPI-J, BIS/BAS, DTDD-J, LOC, JWS, and modified BREQ-2. The modified BREQ-2 (Markland & Tobin, 2004) was not included in further analyses because the scale has not been validated yet.

The Japanese version of the Ten-Item Personality Inventory (TIPI-J)

We used the Japanese version of the Ten-Item Personality Inventory (TIPI-J; Oshio et al., 2012). The TIPI-J is a short version of the Big Five scale that assesses personality traits in five domains: extraversion, agreeableness, openness, conscientiousness, and neuroticism. This questionnaire contained 2 items per domain, with a total of 10 items, on a 7-point Likert scale. Each item was scored from 1 to 7 points. The scores of each domain ranged from 1 to 7 points and the total score of the two items was divided by two (Oshio et al., 2012).

The Japanese version of the Behavioral Inhibition/Activation Systems (BIS/BAS) Scale

We used the Japanese version of the Behavioral Inhibition/Activation Systems (BIS/BAS) Scale (Takahashi et al., 2007). This scale assesses the magnitude of sensitivities on the Behavioral Inhibition System (BIS) and Behavioral Activation System (BAS), which contains 20 items on a 4-point Likert scale ranging from “disagree” to “agree.” The BIS contains 7 items assessing sensitivity to potentially punishing stimuli. The BAS indicates the sensitivity to behavioral activation and contains 13 items in three sub-domains: Drive, Fun Seeking, and Reward Responsiveness. The Drive domain contains four items regarding the persistent pursuit of desired goals. The Fun Seeking domain contains four items that are based on both a desire for new rewards and a willingness to approach a potentially rewarding event at the spur of the moment. The Reward Responsiveness domain contains five items assessing positive responses to the occurrence or anticipation of rewards. The possible scores of the BIS scale ranged from 7 to 28 points, and those of the BAS scale ranged from 13 to 52 points. We used the total BAS score rather than the scores of subscales in the main regression analysis

The Japanese version of the Dark Triad Dirty Dozen (DTDD-J)

We also used the Japanese version of the Dark Triad Dirty Dozen (DTDD-J; Jonason & Webster, 2010; Tamura et al., 2015). The DTDD-J is a 12-item measure of the Dark Triad, which assess individual levels in three domains: narcissism, psychopathy, and Machiavellianism. This scale contained 4 items per domain on a 5-point Likert scale ranging from “strongly disagree” to “strongly agree.” The possible scores of each domain ranged from 4 to 20 points with a total score of 60 points.

The Locus of Control (LoC-J)

We used the Japanese version of the Locus of Control Scale (LoC-J; Kamahara et al., 1982; Rotter, 1966). The LoC-J assesses individual differences in generalized expectancies for internal and external controls. Internal control is the tendency to perceive personal events as dependent on one's behavior or relatively enduring personal factors, while external control is the tendency to perceive personal events as dependent on external factors over which one has no control, such as luck, fate, the dominance of powerful others, or the environment (Marsh & Richards, 1982; Rotter, 1966). The LoC-J contains 18 items on a 4-point

Likert scale ranging from “agree” to “disagree.” The possible total scores ranged from 18 to 72 points. A high score indicated a high level of internal control (Kamahara et al., 1982).

The Japanese version of the Just World Scale (JWS)

We used the Japanese version of the Just World Scale (JWS; Konno & Hori, 1998). This scale assesses individual differences in just-world beliefs in two domains: a retribution for one's unfaithfulness and attitudes toward an unjust situation. This scale has four items, with two items for each domain, on a 5-point Likert scale ranging from “definitely no” to “definitely yes.” The possible scores for each domain ranged from 2 to 10 points. We used the total JWS score in the main regression analysis, rather than the subscale scores.

Analysis

Statistical analysis was conducted using R version 4.0.5 for Mac OS (R Foundation for Statistical Computing, Vienna, Austria) with tidyverse version 1.3.1 (Wickham et al., 2019). The main purpose of this study was to examine the influence of various psychological traits on the rate of habituation of physical and non-physical activities. For this purpose, we performed a multiple logistic regression analysis using the measurements of psychological scales as the independent variables and the habituation of physical and non-physical activities as the dependent variable. Regression analysis was performed separately for physical and non-physical activities. Notably, our purpose was not to build or evaluate a psychological model that could explain habituation; instead, our main focus was to evaluate the psychological factors that would influence the habituation of each activity by inspecting the odds ratio of the logistic regression analysis.

Results

The reliability and descriptive statistics of all scales

Table 2 summarizes the descriptive statistics of all scales for all participants: mean score, standard deviation, kurtosis, and skewness. We also evaluated the reliability of each sub-scale by calculating the Cronbach's alpha. The internal consistency measures (Cronbach's alpha) indicated that not all scales had acceptable levels of reliability.

Table 2. Results of reliability and descriptive statistics of all scales.

	Mean	SD	Skewness	Kurtosis	Cronbach's α
TIPI-J					
Extraversion	7.213	2.632	0.148	-0.289	0.522
Agreeableness	9.298	2.165	-0.188	0.291	0.283
Conscientiousness	7.753	2.430	-0.091	0.152	0.510
Neuroticism	8.226	2.398	0.071	0.229	0.376
Openness	7.495	2.245	0.009	0.389	0.265
BIS/BAS					
BIS	19.473	4.057	0.175	-0.118	0.814
BAS	34.114	6.499	-0.004	0.659	0.880
BAS Drive	10.273	2.472	0.011	0.125	0.801
BAS Reward	14.010	2.776	-0.263	0.460	0.775
BAS Seeking	9.831	2.311	-0.126	0.047	0.699
DTDD					
DTDD	29.401	8.154	-0.155	-0.330	0.874
Machiavellian	9.074	3.410	0.116	-0.798	0.843
Psychopathy	10.239	2.969	-0.150	-0.021	0.675
Narcissism	10.088	3.436	0.058	-0.395	0.820
LOC					
LOC	45.563	5.844	-0.138	1.645	0.721
JWS					
JWS	10.777	2.749	-0.533	0.419	0.560
Karma	5.901	1.820	-0.167	-0.168	0.639
Injustice	4.846	1.833	0.242	-0.376	0.734

Note: BIS = Behavioral Inhibition Systems Scale; BAS = Behavioral Activation Systems Scale; DTDD = Japanese version of the Dark Triad Dirty Dozen; LoC = Locus of Control; JWS = Japanese version of the Just World Scale.

Figure 1. The distribution of scores of psychological scales as a function of the habituation of physical activity and non-physical activity.

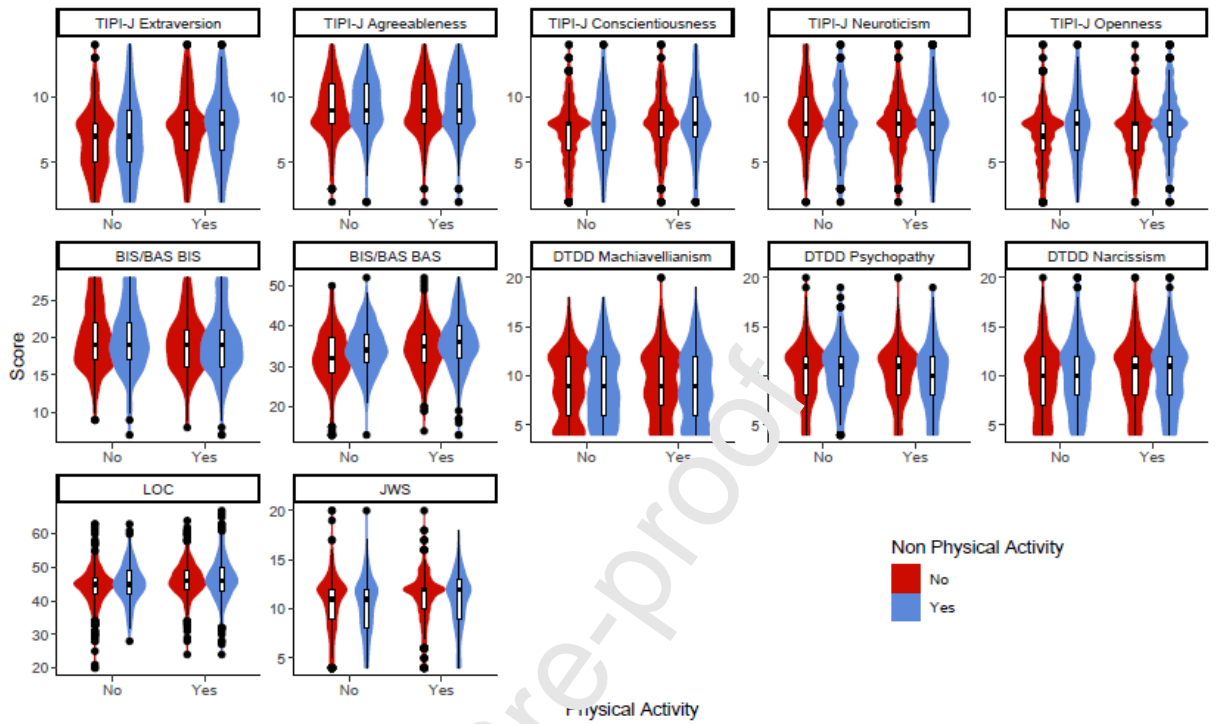


Table 3. The results of multiple logistic regression analysis (adjusted odds ratio and 95% confidence intervals).

	Physical Activity			Non-Physical Activity		
	OR	95%CI	VIF	OR	95%CI	VIF
TIPI-J						
Extraversion	1.256 ***	1.110 1.422	1.38	0.996	0.881 1.127	1.44
Agreeableness	0.948	0.837 1.072	1.44	1.039	0.919 1.176	1.44
Conscientiousness	1.115	0.984 1.265	1.43	1.093	0.965 1.239	1.44
Neuroticism	1.005	0.873 1.158	1.84	0.903	0.783 1.040	1.86
Openness	0.946	0.835 1.072	1.43	1.294 ***	1.142 1.469	1.42
BIS/BAS						
BIS	0.906	0.784 1.047	1.95	1.077	0.932 1.244	1.97
BAS	1.373 ***	1.211 1.560	1.42	1.260 ***	1.111 1.429	1.42
DTDD						
Machiavellianism	1.018	0.874 1.185	2.23	0.891	0.765 1.037	2.22
Psychopathy	0.914	0.791 1.055	1.98	1.023	0.886 1.182	1.98
Narcissism	1.027	0.893 1.182	1.85	1.057	0.919 1.216	1.86
LOC						
LOC	1.171 *	1.026 1.339	1.55	1.099	0.963 1.255	1.63
JWS						
JWS	0.974	0.863 1.097	1.34	0.855 *	0.758 0.964	1.38

P-value sig: * < 0.05, ** < 0.01, *** < 0.001

The relation between psychological scales and habituation

Figure 1 illustrates the distribution and summary statistics of the scores of each psychological scale among the four samples, and Table 3 shows the results of the multiple logistic regression analysis. The analyses of odds ratios indicated that the extraversion of the Big Five scale (TIPI-J extraversion), behavioral approach traits (BAS), and LoC had a positive influence on the habituation of physical activity. In contrast, the openness of the Big Five scale (TIPI-J openness) and BAS had a positive effect, and JWS had a negative influence on habituation of non-physical activity.

Discussion

In the present study, we examined the influence of personality traits on the habituation of physical activity. Our results demonstrated that people with habituation of physical activity showed high scores on the

extraversion, behavioral approach, and LoC scales. Furthermore, people with habituation of non-physical activity showed higher scores on the openness, behavioral approach, and JWS scales. Thus, the personality traits associated with people with habituation of physical and non-physical activities were partially common but partially different.

Our results showed that higher extraversion was associated with habituation of physical activity but not with that of non-physical activity. While the association between extraversion and physical activity is in line with findings of previous studies (Courneya et al., 1999; Ebstrup et al., 2013; Stephan et al., 2013; Stephan et al., 2014), they have also suggested the relationships with other personality traits, such as conscientiousness and neuroticism, which did not impact the habituation of physical activity in our study. The reason for this discrepancy could be due to the difference in the assessment of individuals' participation in physical activity. In our study, the habituation of physical activity included the exercise and sports that are intentionally habituated to improve physical fitness while the daily activities such as housework or activities in transportation were not included. Moreover, we focused on the absence or presence of habituation so that our measurement was not sensitive to the amount, frequency, and strength of physical activities. Courneya et al. (1999) found that extraversion, conscientiousness, and neuroticism are significantly related to engagement in physical activity. However, in their study, the sample was female university students and the physical activity in their Study 2 was defined as number of aerobic exercise classes attended by the participants, which related to conscientiousness. Physical activity in their Study 1 was assessed using the Leisure Score Index (LSI) (Godin et al., 1986), an index for the mild, moderate, and strenuous exercise in a typical week. As this index includes transportation or locomotion, it is sensitive to the strength and amount of daily physical activity regardless of whether the activity was voluntary. Ebstrup et al. (2013) investigated more than 3,000 individuals aged 18–69 years; thus, the sample was similar to that in our study. They also found a significant association between extraversion, conscientiousness, neuroticism, and openness with the amount of physical activity, assessed using the Physical Activity Scale 2 (PAS2) (Andersen et al., 2010). This measurement, similar to LSI, is sensitive to the amount and strength of physical activities in daily life and involves transportation of involuntary activity duration. Furthermore, Stephan et al. (2014a) assessed the frequency of participation in some specific exercise, which is a similar measure to our study, for large samples of the US and French people and found several Big Five scales associated with the frequency of physical activity.

However, after adjusting for sociodemographic factors and merging the US and French samples, only extraversion was significantly related to engagement in physical activities. Taken together, extraversion is a significant factor that was robustly associated with the voluntary habituation of physical activity, regardless of the amount and strength of the activity.

We also found that the LoC had a positive influence on the habituation of physical activity but not on that of non-physical activity. Higher LoC scores indicate that individuals tend to attribute the cause of their life events to their own behavior, namely internal attribution; this tendency is consistent with previous studies (Gregg, 1996; Mercer et al., 2018). Our results would extend these findings by replicating the relationship between internal LoC and habituation of physical activity, regardless of the amount. Moreover, the contrast results between physical and non-physical activity on the LoC score provide a suggestion for promoting the habituation of physical activity. Some studies have suggested that LoC can be considered as a state and then can be changed (Galvin et al., 2018; Johnson et al., 2016; Ryon and Gleason, 2014). Johnson et al. (2016) showed that ratings of locus of control can be changed when the participants were instructed to think about the situation that the work environment offers them control (e.g., Johnson et al., 2016). This indicates that manipulating the perception of the surrounding environment affects the individual's state of locus of control. Therefore, if people come to attribute the cause of their life events to their own behavior, they may show interest in the habituation of physical activity.

Behavioral activation, namely BAS, was also an influential factor in habituation of physical activity. Previous studies have shown that BAS scores predicted self-reported physical activities among female university students (Wilson et al., 2015). Another study demonstrated that the BAS, in particular the sensitivity scores for reward, are related to the amount of physical activity among adolescents (Schneider & Graham, 2009). As our study investigated a wider range of ages, the individuals' way of participating in physical activities was expected to be more diverse. Further, the BAS scores robustly associated with the amount and habituation of physical activity. However, it is noteworthy that the BAS scores were also associated with habituation of non-physical activity. Higher BAS scores is thought to be related to greater proneness to goal-directed behavior (Carver & White, 1994). Given the results of non-physical activity and concepts of BAS, we conjectured that BAS is associated with the voluntary habituation of any goal-directed activities, regardless of the contents of activity.

Contrary to our prediction, we found no significant relation of DTDD with habituation of physical or non-physical activity. However, previous studies have demonstrated a relationship of these traits with the amount of physical activity. For example, a sample of athletes showed higher levels of narcissism and lower levels of psychopathy (Elman et al., 2002; Vaughan et al., 2018). This discrepancy could be due to the differences in sample characteristics and measurements. While we defined the habituation of physical activity as continuing participation for more than half a year regardless of the amount and frequency, a more effortful and long-lasting engagement is required to become athletes. Thus, narcissism and psychopathy would not be sensitive to the habituation of modest engagement in physical activity. Another potential cause of the discrepancy is the difference in measurement. We subjected several psychological scales to the regression analysis as independent variables and inspected the adjusted odds ratios. The influence of each variable tends to be smaller when the variables correlate with each other (see Table A1 for the correlation matrix). As previous studies mainly focused on narcissism, psychopathy, and a few related scales, the influences of DTDD in the previous studies might have been overestimated or mediated by other factors such as extraversion or BAS.

Notably, we found a significant influence of openness of the Big Five personality traits and the Just World Scale (JWS) on the habituation of non-physical activities. To the best of our knowledge, no study has addressed the relationship between JWS and the habituation of physical or non-physical activities. The scores of the JWS reflect the degree to how strongly people believe that reward and punishment come from one's past behavior (e.g. Konno & Iori, 1998). Therefore, our results imply that the stronger belief in a just world, the less likely people have the habit of non-physical activities. We speculate that the chance that something unjust happens may be higher during participation in non-physical than physical activity, which may make people with a stronger belief in a just world distance from such activity. The results of openness were partly consistent with a previous study (Stephan et al., 2014a). They assessed the frequency of participation in games, developmental activities, and social activities, in addition to some specific exercise, and found that openness, after adjustment for sociographic demographics, was significantly related to the developmental activity, such as reading and writing, attending public lectures, or educational courses. Thus, extraversion and openness were related to the habituation of physical and non-physical activities, respectively. As speculated, openness is associated with traits seeking something novel, which is one of the purposes of participation in non-physical

activities. However, the goal of the continuing physical activity would be less novel and more obvious, i.e., getting healthy, and openness may not be related to the habituation of physical activity. The contrast of the subscales of the Big Five personality traits corresponding to the habituation of physical and non-physical activity would be intriguing and warrants further investigation.

In summary, the current study demonstrated novel findings regarding the relationship between habituation of physical activity and personality traits. Our results indicated that habituation of physical activity is significantly related to high levels of extraversion, BAS, and LoC, among which BAS is also related with habituation of non-physical activity. These results indicate that the sensitivity to reward responsiveness and fun-seeking as assessed by the BAS can predict regardless of the type of activity, as long as the activity is voluntarily habituated and goal-directed. On the other hand, whether an individual perceives the surrounding environment as controllable has a significant impact on the habituation of physical activity. Given our findings, the next step is to explore the psychological process that enables people to engage in physical activity without habituation.

References

- Andersen, L. G., Groenvold, M., Jørgensen, T., & Aadahl, M. (2010). Construct validity of a revised Physical Activity Scale and testing by cognitive interviewing. *Scandinavian Journal of Public Health*, 38(7), 707–714. <https://doi.org/10.1177/1403494810380099>
- Carver, C. S., & White, T. L. (1994). Behavioral inhibition, behavioral activation, and affective responses to impending reward and punishment: The BIS/BAS Scales. *Journal of Personality and Social Psychology*, 67(2), 319–333. <https://doi.org/10.1037/0022-3514.67.2.319>
- Courneya, K. S., Bobick, T. M., & Schinke, R. J. (1999). Does the theory of planned behavior mediate the relation between personality and exercise behavior? *Basic and Applied Social Psychology*, 21(4), 317–324. https://doi.org/10.1207/S15324834BASP2104_5
- Duncan, L. R., Hall, C. R., Wilson, P. M., & Jenny, O. (2010). Exercise motivation: A cross-sectional analysis examining its relationships with frequency, intensity, and duration of exercise. *International Journal of Behavioral Nutrition and Physical Activity*, 7(1), 7. <https://doi.org/10.1186/1479-5868-7-7>
- Ebstrup, J. F., Aadahl, M., Eplöv, L. F., Pisinger, C., & Jørgensen, T. (2013). Cross-sectional associations

- between the five factor personality traits and leisure-time sitting-time: The effect of general self-efficacy. *Journal of Physical Activity and Health*, 10(4), 572–580. <https://doi.org/10.1123/jpah.10.4.572>
- Elman, W. F., & McKelvie, S. J. (2003). Narcissism in football players: Stereotype or reality? *Athletic Insight*, 5(1), 38–46
- Galvin, B. M., Randel, A. E., Collins, B. J., & Johnson, R. E. (2018). Changing the focus of locus (of control): A targeted review of the locus of control literature and agenda for future research. *Journal of Organizational Behavior*, 39(7), 820–833. <https://doi.org/10.1002/job.2275>
- Godin, G., Jobin, J., & Bouillon, J. (1986). Assessment of leisure time exercise behavior by self-report: A concurrent validity study. *Canadian Journal of Public Health*, 77(5), 359–362
- Gregg, E. W., Cauley, J. A., Stone, K., Thompson, T. J., Bauer, D. C., Cummings, S. R., Ensrud, K. E., & Study of Osteoporotic Fractures Research Group (2005). Relationship of changes in physical activity and mortality among older women. *JAMA*, 289(18), 2379–2386. <https://doi.org/10.1001/jama.289.18.2379>
- Gregg, E. W., Kriska, A. M., Narayan, K. M., & Knowler, W. C. (1996). Relationship of locus of control to physical activity among people with and without diabetes. *Diabetes Care*, 19(10), 1118–1121. <https://doi.org/10.2337/diacare.19.10.1118>
- Guthold, R., Stevens, G. A., Riley, L. M., & Bull, F. C. (2018). Worldwide trends in insufficient physical activity from 2001 to 2015: A pooled analysis of 358 population-based surveys with 1.9 million participants. *The Lancet. Global Health*, 6(10), e1077–e1086–e1086. [https://doi.org/10.1016/S2214-109X\(18\)30357-7](https://doi.org/10.1016/S2214-109X(18)30357-7)
- Ingledeu, D. K., Markland, D., & Sheppard, K. E. (2004). Personality and self-determination of exercise behaviour. *Personality and Individual Differences*, 36(8), 1921–1932. <https://doi.org/10.1016/j.paid.2003.08.021>
- Irwin, M. L., Smith, A. W., McTiernan, A., Ballard-Barbash, R., Cronin, K., Gilliland, F. D., Baumgartner, R. N., Baumgartner, K. B., & Bernstein, L. (2008). Influence of pre- and postdiagnosis physical activity on mortality in breast cancer survivors: The health, eating, activity, and lifestyle study. *Journal of Clinical Oncology*, 26(24), 3958–3964. <https://doi.org/10.1200/JCO.2007.15.9822>
- Jonason, P. K., & Webster, G. D. (2010). The Dirty Dozen: A concise measure of the Dark Triad.

Psychological Assessment, 22(2), 420–432

- Johnson, R. E., Rosen, C. C., Chang, C.-H. (Daisy), & Lin, S.-H. (Joanna). (2016). Assessing the status of locus of control as an indicator of core self-evaluations. *Personality and Individual Differences*, 90, 155–162. <https://doi.org/10.1016/j.paid.2015.11.002>
- Jung, Y. S., Park, J. H., Park, D. I., Sohn, C. I., Lee, J. M., & Kim, T. I. (2018). Physical inactivity and unhealthy metabolic status are associated with decreased natural killer cell activity. *Yonsei Medical Journal*, 59(4), 554–562. <https://doi.org/10.3349/ymj.2018.59.4.554>
- Kamahara, M., Higuchi, K., & Shimizu, N. (1982). New locus of control scale: Its reliability and validity. *Japanese Journal of Education Psychology*, 30, 302–307 (in Japanese)
- Kim, S.-H., Cha, S., Kang, S., Han, K., Paik, N.-J., & Kim, W.-S. (2021). High prevalence of physical inactivity after heart valve surgery and its association with long-term mortality: A nationwide cohort study. *European Journal of Preventive Cardiology*, 28(7), 749–757. <https://doi.org/10.1177/2047487320903877>
- Koch, E. D., Tost, H., Braun, U., Gan, G., Giorgi, M., Reinhard, I., Zipf, A., Meyer-Lindenberg, A., Ebner-Priemer, U. W., & Reichert, M. (2020). Relationships between incidental physical activity, exercise, and sports with subsequent mood in adolescents. *Scandinavian Journal of Medicine & Science in Sports*, 30(11), 2234–2250. <https://doi.org/10.1111/sms.13774>
- Konno, H., & Hori, H. (1998). Effects of justice beliefs on injustice judgement. *Tsukuba Psychological Research*, 20, 157–162
- Laforge, R. G., Velicer, W. F., Richmond, R. L., & Owen, N. (1999). Stage Distributions for Five Health Behaviors in the United States and Australia. *Preventive Medicine*, 28(1), 61–74. <https://doi.org/10.1006/pmed.1998.0384>
- Lee, I. M., Shiroma, E. J., Lobelo, F., Puska, P., Blair, S. N., & Katzmarzyk, P. T., & Lancet Physical Activity Series Working Group (2012). Effect of physical inactivity on major non-communicable diseases worldwide: An analysis of burden of disease and life expectancy. *The Lancet*, 380(9838), 219–229. [https://doi.org/10.1016/S0140-6736\(12\)61031-9](https://doi.org/10.1016/S0140-6736(12)61031-9)
- Markland, D., & Tobin, V. (2004). A modification to the behavioural regulation in exercise questionnaire to include an assessment of amotivation. *Journal of Sport and Exercise Psychology*, 26(2), 191–196

- Marsh, H. W., & Richards, G. E. (1986). The Rotter locus of control scale: The comparison of alternative response formats and implications for reliability, validity, and dimensionality. *Journal of Research in Personality*, 20(4), 509–528. [https://doi.org/10.1016/0092-6566\(86\)90129-7](https://doi.org/10.1016/0092-6566(86)90129-7)
- Mercer, D. A., Ditto, B., Lavoie, K. L., Campbell, T., Arsenault, A., & Bacon, S. L. (2018). Health locus of control is associated with physical activity and other health behaviors in cardiac patients. *Journal of Cardiopulmonary Rehabilitation and Prevention*, 38(6), 394–399. <https://doi.org/10.1097/HCR.0000000000000350>
- Oshio, A., Abe, S., & Cutrone, P. (2012). Development, reliability, and validity of the Japanese version of Ten Item Personality Inventory (TIPI-J). *The Japanese Journal of Personality*, 21(1), 40–52. <https://doi.org/10.2132/personality.21.40>
- Plotnikoff, R. C., Hotz, S. B., Birkett, N. J., & Cournoyer, K. S. (2001). Exercise and the Transtheoretical Model: A Longitudinal Test of a Population Sample. *Preventive Medicine*, 33(5), 441–452. <https://doi.org/10.1006/pmed.2001.0914>
- Prochaska, J. O., & DiClemente, C. C. (1983). Stages and processes of self-change of smoking: Toward an integrative model of change. *Journal of Consulting and Clinical Psychology*, 51(3), 390–395. <https://doi.org/10.1037/0022-006X.51.3.390>
- Rahman, Md. E., Islam, Md. S., Biswas, Md. S., & Moonajilin, M. S., & Gozal, D. (2020) Physical inactivity and sedentary behaviors in the Bangladeshi population during the COVID-19 pandemic: An online cross-sectional survey. *Heliyon*, 6(10), e05392. <https://doi.org/10.1016/j.heliyon.2020.e05392>
- Roberts, R., Woodman, T., Hardy, L., Davis, L., & Wallace, H. M. (2013). Psychological skills do not always help performance: The moderating role of narcissism. *Journal of Applied Sport Psychology*, 25(3), 316–325. <https://doi.org/10.1080/10413200.2012.731472>
- Roberts, R., Woodman, T., Lofthouse, S., & Williams, L. (2015). Not all players are equally motivated: The role of narcissism. *European Journal of Sport Science*, 15(6), 536–542. <https://doi.org/10.1080/17461391.2014.987324>
- Rotter, J. B. (1966). Generalized expectancies for internal versus external control of reinforcement. *Psychological Monographs*, 80(1), 1–28. <https://doi.org/10.1037/h0092976>
- Ryon, H. S., & Gleason, M. E. J. (2014). The Role of Locus of Control in Daily Life. *Personality and Social*

- Psychology Bulletin, 40(1), 121–131. <https://doi.org/10.1177/0146167213507087>
- Schneider, M. L., & Graham, D. J. (2009). Personality, physical fitness, and affective response to exercise among adolescents. *Medicine and Science in Sports and Exercise*, 41(4), 947–955. <https://doi.org/10.1249/MSS.0b013e31818de009>
- Seo, D. C., Torabi, M. R., Chin, M. K., Huang, S. F., Chen, C. K., Mok, M. M. C., Wong, P., Chia, M., Lee, C. G., & Wang, C. (2012). A comparison of factors associated with physical inactivity among East Asian college students. *International Journal of Behavioral Medicine*, 19(3), 316–323. <https://doi.org/10.1007/s12529-011-9167-4>
- Spencer, L., Adams, T. B., Malone, S., Roy, L., & Yost, E. (2006). Applying the Transtheoretical Model to Exercise: A Systematic and Comprehensive Review of the Literature. *Health Promotion Practice*, 7(4), 428–443. <https://doi.org/10.1177/1524839905278993>
- Stephan, Y., Boiché, J., Canada, B., & Terracciano, A. (2014a). Association of personality with physical, social, and mental activities across the lifespan: Findings from US and French samples. *British Journal of Psychology*, 105(4), 564–580. <https://doi.org/10.1111/bjop.12056>
- Stephan, Y., Sutin, A. R., & Terracciano, A. (2014b). Physical activity and personality development across adulthood and old age: Evidence from two longitudinal studies. *Journal of Research in Personality*, 49, 1–7. <https://doi.org/10.1015/j.jrp.2013.12.003>
- Takahashi, Y., Yamagata, S., Kijima, N., Shigemasu, K., Ono, Y., & Ando, J. (2007). Continuity and change in behavioral inhibition and activation systems: A longitudinal behavioral genetic study. *Personality and Individual Differences*, 43(6), 1616–1625
- Tamura, A., Oshio, A., Tanaka, K., Masui, K., & Jonason, P. K. (2015). Development, reliability, and validity of the Japanese version of the Dark Triad Dirty Dozen (DTDD-J). *The Japanese Journal of Personality*, 24(1), 26–37. doi: 10.2132/personality.24.26
- Vaughan, R., Carter, G. L., Cockroft, D., & Maggiorini, L. (2018). Harder, better, faster, stronger? Mental toughness, the dark triad and physical activity. *Personality and Individual Differences*, 131, 206–211. <https://doi.org/10.1016/j.paid.2018.05.002>
- Wen, C. P., Wai, J. P. M., Tsai, M. K., Yang, Y. C., Cheng, T. Y. D., Lee, M. C., Chan, H. T., Tsao, C. K., Tsai, S. P., & Wu, X. (2011). Minimum amount of physical activity for reduced mortality and extended

life expectancy: A prospective cohort study. *The Lancet*, 378(9798), 1244–1253.

[https://doi.org/10.1016/S0140-6736\(11\)60749-6](https://doi.org/10.1016/S0140-6736(11)60749-6)

Wickham, H., Averick, M., Bryan, J., Chang, W., McGowan, L. D. A., François, R., ... & Yutani, H. (2019).

Welcome to the Tidyverse. *Journal of Open Source Software*, 4(43), 1686

Wilson, K. E., Das, B. M., Evans, E. M., & Dishman, R. K. (2015). Personality correlates of physical activity in college women. *Medicine and Science in Sports and Exercise*, 47(8), 1691–1697.

<https://doi.org/10.1249/MSS.0000000000000570>

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Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

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