



Positive associations of optimism–pessimism orientation with pro-environmental behavior and subjective well-being: a longitudinal study on quality of life and everyday behavior

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Abstract

Purpose The aim of the present study was to investigate associations of the balance of optimism and pessimism orientations as personal traits with pro-environmental behavior and subjective well-being, i.e., life satisfaction.

Methods A longitudinal questionnaire survey consisting of two waves were conducted with Japanese respondents within an interval of 3 months ($N = 770$, mean age 49.6 ± 15.23 years). Correlation analyses and structural equation modeling were conducted to identify relationships between pro-environmental behavior and positive and negative psychological states and orientations.

Results Results of both the two surveys indicated positive correlations of optimism–pessimism orientation (O/P ratio) and subjective well-being with pro-environmental behavior. Negative associations were also confirmed between depression, stress, and sleepiness and pro-environmental behavior. Structural equation modeling using the two-wave data revealed that O/P ratio is positively associated with pro-environmental behavior as longitudinal associations.

Conclusions These results suggest that O/P ratio can be related to current and future engagement in pro-environmental behavior and improvement in subjective well-being which could lead to an environmentally sustainable society with enhanced quality of life.

Keywords Pro-environmental behavior · Subjective well-being · Optimism · Pessimism · Sleepiness · Constructiveness · Cross-lagged study

Introduction

Pro-social behavior including pro-environmental behavior is known to be associated with positive psychological states such as subjective well-being [1] among other factors such as environmental awareness and demographic characteristics [2]. An earlier series of cross-sectional studies examined and verified that pro-environmental behavior is a positive correlate with subjective well-being [3–7]. Other studies also

suggest that pro-environmental behavior can be motivated by positive feelings such as intrinsic satisfaction [6, 8], positive affect [9], and a sense of warm glow or moral satisfaction, i.e., feeling good by contributing to a public good [10] by behaving green.

While the relationship between positive affects and pro-environmental behaviors has been investigated by quite a number of studies, its theoretical background is controversial. Some studies assumed a one-way causal path from subjective well-being or other positive feelings to pro-environmental behavior [9–11] or an opposite causal path (i.e., from pro-environmental behavior to subjective well-being or positive feelings) [3–7]. Other studies, however, suggest a two-way, or bidirectional, relationship between feelings and behavior because they should be inseparably linked each other [12–14]. This theoretical confusion perhaps arises due to cross-sectional investigation because it can only reveal the current state and cannot identify causal links between concerned factors. To investigate the causal links,

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longitudinal investigations should be more appropriate than cross-sectional ones. However, few studies have been done using longitudinal data to investigate bidirectional associations between subjective well-being and pro-environmental behavior.

Additionally, individual psychological factors studied in environmental behavior research are predominantly *states*, and few studies have been done on how *traits* can influence individual's behavior. While state affects are temporary feelings and emotion that depend on individual's situation and motives at a particular time, trait affects are stable and long-lasting moods that are related to personality.

In general, state affects are more influential to behavior than personality traits. For example, George studied influence of positive affect (as state) and affectivity (as trait) on pro-social behavior at work and concluded only the former was significantly associated with the behavior [15]. While the pro-social behavior involves positive social interactions such as with colleagues and customers, pro-environmental behavior does not always happen in social contexts nor exert instant and tangible reward. Moreover, pro-environmental behavior often requires a certain (often long) period of engagement to realize its impacts on the environment. Thus, in case of pro-environmental behavior, it is not only the state but, more importantly, the traits which psychological factors do matter to facilitate the behavior.

In fact, there are some cross-sectional studies that investigated the relationships between personality traits and pro-environmental behavior. For example, Milfont and Sibley [16] revealed that agreeableness, conscientiousness, and openness among the Big Five personality factors are positively linked with environmental engagement in the national sample of New Zealand. Somewhat similar results have been also found in other studies (agreeableness and openness on environmental concerns [17], openness, conscientiousness, and extraversion on organizational citizenship behavior for the environment [18]). Additionally, Basic-Sontic et al. [19] found significant influence of personality traits on domestic energy efficiency decision making, which requires high cost to make. On the other hand, such relationships depend on age probably because of different amount of knowledge acquired about environmental issues. Adolescents' personality was found only marginally associated with their environmental worldview [20]. Given these previous studies, personality traits in adults most likely influence environmental concerns and engagement, but cross-sectional studies cannot answer to the question of long-term causality between personality traits and pro-environmental behaviors. More investigations on personality and pro-environmental behavior are needed.

In the present study, we chose optimism and pessimism as personality traits because these traits are known to have influence on the behavior for adopting to the new situations [21]. Importantly, optimism and pessimism are not only

traits but they influence state affects and behavior [11, 22]. Optimistic mindset toward specific environmental issues, such as environmental hazards and climate change, has been studied as a bias factor that inhibits precautious decision making [23, 24]. Thus, it can be expected that the balance or orientation of optimism and pessimism is associated with pro-environmental behavior and subjective well-being as a mediator in the long term.

As to pro-environmental behavior, it generally refers to behavior that reduces, minimizes, or even reverses unfavorable pressures on environmental conditions with various degrees of frequency and cost. For example, energy saving behavior includes turning off the room lights not in use (i.e., daily, low cost), purchasing energy efficient products, and installing thermal insulation to a whole house (i.e., much less often, high cost). While adopting its general definition of the concept, pro-environmental behavior in the present study refers to behavior that can be practiced in daily life with relatively low cost for the sake of being able to detect the stability or change in the engagement over time.

Finally, in the present study, we also focused on the relationship between pro-environmental behavior and negative feelings such as stress and depression. Previous studies have suggested that stress *reduced* altruistic behavior and *increased* self-interest motives [25, 26]. Other studies have, however, implied that people experiencing stress or depression *increase* their pro-social behavior such as pro-environmental behavior [27, 28], possibly because people experiencing depression or stress might use pro-social behavior to counter their low mood. The possibility of counteracting the effects of stress and depression by pro-social behavior has not been consistently demonstrated, and therefore more studies are necessary.

The following tentative hypotheses were tested in this study: (1) pro-environmental behavior is positively associated with subjective well-being both at one period and over time; (2) optimism and pessimism orientations are associated with pro-environmental behavior and subjective well-being both at one period and over time; (3) negative states (i.e., depression, stress, and sleepiness) are negatively correlated with pro-environmental behavior and subjective well-being.

Methods

Respondents

The data were collected in two online questionnaire surveys conducted in the 1st week of September and December of 2016. We set the temporal window of 3 months based on the seasonal equivalence in the study area. September and December in Japan are within moderate summer (daytime

maximum/minimum temperature at about 32/22 degrees Celsius) and winter (12/5 degrees Celsius), respectively, which normally requires air-conditioning for cooling and heating at home. Respondents were recruited through an internet survey agency in Japan to which they had been pre-registered. Individuals residing in Tokyo and surrounding areas (i.e., Tokyo metropolitan area) were randomly sampled from the consumer panel owned by the survey agency according to the population distribution by sub-region in the study area. All respondents were aged 20 years and above, the age range in which they are legally recognized as adult in Japan. Their informed consent for participating in the study was obtained before they answered the questionnaire. Then, respondents were asked to respond to two surveys (T1 and T2) within an interval of 3 months. In the first and second surveys, 834 and 770 responses, respectively, were returned. The longitudinal data of 770 respondents (54.0% men) were analyzed. The mean age of the respondents was 49.6 years ($SD = 15.23$), and average household income was 6,174,026 yen (USD 56,000; $SD = 3,823,254$ yen, USD 34,700). We examined the percentage of respondents with university

degrees as an indication of the educational level of the respondents, which indicated that 53.2% had university degrees. The mean age and annual household income of the population in the study area are 45.24 years old and approximately 5,636,000 yen, respectively, which is moderately represented by the current sample. The socio-demographic characteristics of the respondents are shown in Table 1.

Ethical considerations regarding the present study were reviewed and approved by the Research Ethics Committee of the University of Tsukuba in compliance with the Helsinki Declaration.

Measures

Pro-environmental behavior

The questions regarding pro-environmental behavior inquired about the frequency at which a respondent performed the following behaviors: (1) I bring my own bag when I go shopping and refuse to use plastic bags from the

Table 1 Summary statistics

Variable	Mean	SD	Min	Max
Socio-demographic characteristics				
Sex (male%)	54.00			
Age (years)	49.60	15.23	20.00	79.00
Education (years)	14.54	1.81	9.00	16.00
Household income (annual yen)	6,174,026	3,823,254	2,000,000	20,000,000
Pro-environmental behavior				
Pro-environmental behavior (T1)	4.74	0.83	1.00	6.00
Pro-environmental behavior (T2)	4.72	0.88	1.00	6.00
Psychological factors				
Subjective well-being (T1)	3.84	1.42	1.00	7.00
Subjective well-being (T2)	3.79	1.40	1.00	7.00
Optimism (T1)	3.10	0.78	1.00	5.00
Optimism (T2)	3.07	0.81	1.00	5.00
Pessimism (T1)	2.69	0.83	1.00	5.00
Pessimism (T2)	2.68	0.86	1.00	5.00
O/P ratio (T1)	1.37	0.86	0.20	5.00
O/P ratio (T2)	1.37	0.87	0.20	5.00
Depression (T1)	13.74	7.64	0.00	40.00
Depression (T2)	13.33	7.63	0.00	42.00
Stress (T1)	1.94	0.60	1.00	3.97
Stress (T2)	1.92	0.62	1.00	4.00
Sleep				
Sleepiness (T1)	16.10	5.66	8.00	32.00
Sleepiness (T2)	15.94	5.87	8.00	32.00
Sleep time (T1)	379.38	68.24	150.00	600.00
Sleep time (T2)	385.23	85.06	10.00	1440.00

Mean scores of the scale items are presented for pro-environmental behavior and subjective well-being. O/P ratio indicates the optimism–pessimism orientation. T1 and T2 indicate the first and second surveys, respectively. $n = 770$

stores; (2) I frequently turn off the tap to save water; (3) I switch off room lights that are not in use; (4) I buy detergent and shampoo refills instead of bottles; (5) I refrain from using my car; (6) I set the temperature to a moderate level when I use the air conditioner; (7) I choose to buy environmentally friendly products; (8) I separate the garbage properly at home; and (9) I separate the garbage properly when I am out in public places. Respondents rated their usual behavior using a 6-point response scale ranging from 1 (*never*) to 6 (*always*). These items were partly adopted and modified based on previous research [29] and a few new items were added because they were relevant to Japanese society. For example, item (6) is widely recognized and practiced in the Japanese society as it has been promoted as part of nationwide campaigns during the last 10 years or so. All the above items were carefully selected to assess daily life pro-environmental practices with relatively low cost that enabled us to examine individual's pro-environmental engagement and its change and stability over time. The same set of items were used in the previous studies [6, 7, 30]. We scored each of the nine items and calculated the average score across all items as a respondent's summarized pro-environmental behavior performance score for correlation analyses. The Cronbach's alpha coefficients of the scale for these samples were 0.83 (T1) and 0.85 (T2).

Subjective well-being

Subjective well-being was assessed using the Satisfaction with Life Scale (SWLS, [31]). The SWLS consists of the following five items: (1) In most ways my life is close to my ideal; (2) The conditions of my life are excellent; (3) I am satisfied with my life; (4) So far, I have gotten the important things I want in my life; and (5) If I could live my life over, I would change almost nothing. A large number of studies in psychology, sociology, welfare economics, and behavioral sciences have employed the SWLS [32, 33]. In the present surveys, respondents were asked to rate their state of satisfaction with life on the original five items by using a 7-point Likert scale ranging between 1 (*strongly disagree*) and 7 (*strongly agree*). Cronbach's alpha coefficients of the scale for the samples were 0.93 (T1) and 0.94 (T2).

Optimism and pessimism

Optimism and pessimism were assessed using the Extended Life Orientation Test (ELOT, [34]), which consists of six items assessing optimism and nine items assessing pessimism. The 15 items of the ELOT were originally adopted from two different scales, the Life Orientation Test [35] and the Optimism and Pessimism Scale [36]. The ELOT includes items such as: (1) In uncertain times, I usually expect the best; (2) In general, things turn out all right in the end; (3)

Rarely do I expect good things to happen; and (4) Things never work out the way I want them to. Respondents were asked to rate their state of optimism and pessimism based on the 15 ELOT items, using a 5-point Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). Cronbach's alpha coefficients of the scale were 0.96 (T1) and 0.96 (T2) for optimism, and 0.95 (T1) and 0.95 (T2) for pessimism.

In addition to calculating optimism and pessimism as separate variables, we also calculated the balance between the two factors (i.e., the optimism/pessimism; O/P ratio) because we were concerned with attitudes toward the future as a combination of optimistic and pessimistic attitudes, rather than separately with either optimism or pessimism [21]. The O/P ratio was calculated by dividing optimism score by pessimism one and entered into analysis to examine its potential influence on pro-environmental behavior.

Stress

Stress was assessed using psychological stress items of the New Brief Job Stress Questionnaire (New BJSQ, [37]). The New BJSQ was originally developed in Japanese to assess mental health status at work, and it consists of four sections comprising 84 items. Three sections of the New BJSQ have been designed specifically to evaluate job engagement, but one section with 29 items has been designed and validated to comprehensively assess psychological stress and related physical symptoms in daily life (i.e., not specifically at work). In this study, we employed the following 29 items of the section related to stress: (1) Vigor; (2) Filled with energy; (3) Lively; (4) Angry; (5) Inwardly infuriated; (6) Irritated; (7) Seriously tired; (8) Exhausted; (9) Dull; (10) Tense; (11) Anxious; (12) Restless; (13) Depressed; (14) Too lazy to do anything; (15) Unable to concentrate; (16) Blue; (17) Overwhelmed with work; (18) Sad; (19) Dizzy; (20) Have body aches; (21) Have headache; (22) Neck and shoulders are stiff; (23) Have a backache; (24) Have eye-strain; (25) Have palpitations and breathlessness; (26) Have a bad stomach; (27) Have no appetite; (28) Have diarrhea or constipation; and (29) Unable to sleep well. Respondents were asked to rate their condition with respect to each item during the past month using a 4-point scale consisting of 1 (*almost never*), 2 (*sometimes*), 3 (*often*), and 4 (*almost always*). Cronbach's alpha coefficients for our samples were 0.96 (T1) and 0.96 (T2).

Depression

Depression was assessed using the Center for Epidemiological Studies-Depression Scale, the CES-D [38]. The CES-D consists of 20 items to rate depressive symptoms experienced over the past week on a 4-point scale consisting of: 0 (*rarely or none of the time*), 1 (*some or little of the time*),

2 (*moderately or much of the time*), and 3 (*most or almost all the time*). This study used 14 items as opposed to all 20 items to maintain the cross-cultural validity of the scale because some of the items were not suitable for non-western cultures [39, 40]. The items used in the present study included the following: (1) I was bothered by things that usually do not bother me; (2) I did not feel like eating; my appetite was poor; (3) I felt that I could not shake off the blues even with help from my family or friends; (4) I felt that I was just as good as other people (reverse item); (5) I had trouble keeping my mind on what I was doing; (6) I felt depressed; (7) I felt that everything I did was an effort; (8) I felt hopeful about the future; (9) My sleep was restless; (10) I was happy; (11) I felt lonely; (12) I enjoyed life; (13) I felt sad; and (14) I could not get “going.” The score on this scale can range from 0 to 60, with higher scores indicating greater depressive symptoms. Cronbach’s alphas for these samples were 0.82 (T1) and 0.83 (T2).

Subjective sleepiness

The present study also examined subjective sleepiness as one of the negative psychological states based on a previous study that found sleepy individuals were more pessimism oriented and engaged in pro-environmental behavior less frequently compared with less sleepy individuals, who appeared more optimism oriented [30]. We included this item to retest the negative associations of sleepiness with the O/P ratio and pro-environmental behavior and also because sleep is an essential foundation to both psychological and physical health. The Epworth Sleepiness Scale or ESS [41] was employed to assess everyday situations of subjective sleepiness. The ESS is a widely used self-report scale used to assess the tendency to fall asleep in various situations during the daytime, such as: (1) Sitting and reading; (2) Watching TV; (3) Sitting inactively in a public place; (4) As a passenger in a car for an hour without a break; (5) Lying down to rest in the afternoon when circumstances permit; (6) Sitting and talking to someone; (7) Sitting quietly after a lunch without alcohol; and (8) In a car, while stopped for a few minutes in the traffic. Respondents were asked to evaluate their sleepiness in eight situations using a 4-point Likert scale consisting of 0 (*would never doze*), 1 (*slight chance of dozing*), 2 (*moderate chance of dozing*), and 3 (*high chance of dozing*). Higher scores indicate greater subjective sleepiness. Cronbach’s alphas for these samples were 0.90 (T1) and 0.91 (T2). Self-reported sleep time (min) data were also collected to supplement the subjective daytime sleepiness.

Data analysis

The correlation coefficients between the variables were calculated separately for datasets of T1 and T2. For this

analysis, the nine pro-environmental behavior items and five subjective well-being items were summarized as a mean, respectively. Structural equation modeling was then conducted to examine associations between the O/P ratio, pro-environmental behavior, and subjective well-being over the two time points. In the structural equation modeling, missing data estimation was performed using maximum likelihood imputation procedures for cross-lagged survey data recommended by Schafer and Graham [42] and Graham [43]. Structural paths were drawn based on the following assumptions: (1) positive associations of pro-environmental behavior, subjective well-being, and O/P ratio, respectively, between the two time points, (2) positive cross-sectional associations between pro-environmental behavior and subjective well-being, and (3) a positive cross-sectional and longitudinal associations between O/P ratio, pro-environmental behavior, and subjective well-being with O/P ratio as a mediator. In the structural equation modeling, we set pro-environmental behavior and subjective well-being as latent variables, respectively, to include measurement errors while we applied O/P ratio as an observed variable because we assumed that the balance of the two sub-indicators, i.e., optimism and pessimism, rather than its separate effects or interaction was more implicative [30]. The latent variables of pro-environmental behavior and subjective well-being consisted of the nine and five Likert scale items, respectively, that were explained in the Measures section. We also included in the modeling covariances between error terms of each indicator of a latent variable at T1 and the corresponding indicator at T2. All data preparation and analyses were conducted using Stata14. The significance level was set at $p < 0.05$.

Results

Correlation analysis of T1

The results of the cross-sectional correlation analysis are shown in Table 2. In the first survey (T1), pro-environmental behavior was significantly and positively correlated with subjective well-being ($r = 0.19$), optimism ($r = 0.18$), and the optimism/pessimism ratio (O/P ratio; $r = 0.17$), whereas it was negatively correlated with pessimism ($r = -0.16$), depression ($r = -0.18$), stress ($r = -0.17$), and sleepiness ($r = -0.09$). Moreover, sleepiness was positively correlated with pessimism ($r = 0.27$), depression ($r = 0.35$), and stress ($r = 0.43$), whereas it was negatively correlated with subjective well-being ($r = -0.12$), optimism ($r = -0.10$), and O/P ratio ($r = -0.14$). Optimism and pessimism were highly negatively correlated ($r = -0.64$), and the mean O/P ratio was 1.37 (Table 1), which falls within the reasonable range of balance [21].

Table 2 Correlation coefficients of variables analyzed in T1 and T2

		T1									
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	
(1)	PEB	1.00									
(2)	SWB	0.19	1.00								
(3)	Optimism	0.18	0.69	1.00							
(4)	Pessimism	-0.16	-0.49	-0.64	1.00						
(5)	O/P ratio	0.17	0.56	0.76	-0.83	1.00					
(6)	Depression	-0.18	-0.41	-0.43	0.60	-0.46	1.00				
(7)	Stress	-0.17	-0.42	-0.40	0.58	-0.44	0.74	1.00			
(8)	Sleepiness	-0.09	-0.12	-0.10	0.27	-0.14	0.35	0.43	1.00		
(9)	Sleep time	-0.01	0.12	0.10	-0.12	0.13	-0.12	-0.19	-0.23	1.00	
		T2									T1 to T2
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	
(1)	PEB	1.00									0.70
(2)	SWB	0.22	1.00								0.73
(3)	Optimism	0.24	0.70	1.00							0.74
(4)	Pessimism	-0.04	-0.45	-0.53	1.00						0.67
(5)	O/P ratio	0.18	0.55	0.74	-0.80	1.00					0.75
(6)	Depression	-0.13	-0.40	-0.42	0.58	-0.49	1.00				0.70
(7)	Stress	-0.13	-0.39	-0.37	0.56	-0.44	0.72	1.00			0.73
(8)	Sleepiness	-0.02	-0.10	-0.09	0.25	-0.14	0.32	0.41	1.00		0.61
(9)	Sleep time	0.05	0.05	0.04	-0.12	0.08	-0.09	-0.15	-0.16	1.00	0.68

PEB and SWB indicate pro-environmental behavior and subjective well-being, respectively, summarized as a mean using the respective set of scale items. Coefficients presented in “T1 to T2” indicate correlations of the same items over the first survey to the second [e.g., PEB (T1) and PEB (T2)]. Bold fonts indicate statistical significance at $p < 0.01$ except PEB-Sleepiness (T1), and O/P ratio-Sleep time (T2) ($p < 0.05$). $n = 770$

Correlation analysis of T2

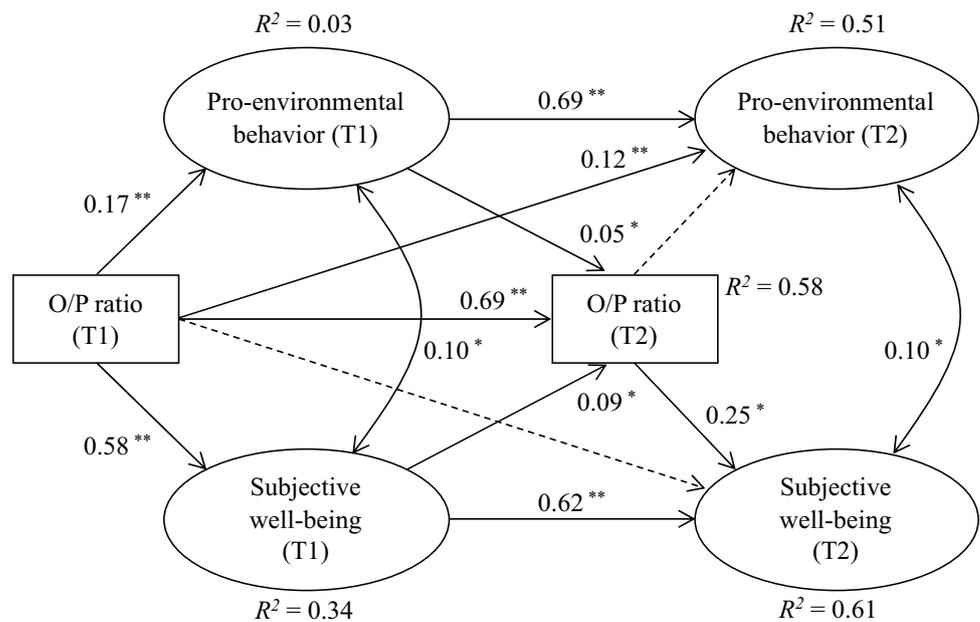
The data of the second survey (T2) produced results that were largely comparable to those of T1. Pro-environmental behavior was positively correlated with subjective well-being ($r = 0.22$), and optimism ($r = 0.24$) and O/P ratio ($r = 0.18$), whereas it was negatively correlated with depression ($r = -0.13$) and stress ($r = -0.13$). Moreover, pro-environmental behavior was not significantly correlated with pessimism ($r = -0.04$) or sleepiness ($r = -0.02$), although the direction of the correlation coefficients was consistent and negative. Optimism and pessimism were highly negatively correlated ($r = -0.53$), and the mean O/P ratio was 1.37 (Table 1), again within the reasonable range.

Furthermore, sleepiness was positively correlated with pessimism ($r = 0.25$), depression ($r = 0.32$), and stress ($r = 0.41$), whereas it was negatively correlated with subjective well-being ($r = -0.10$), optimism ($r = -0.09$), and the O/P ratio ($r = -0.14$). The correlation of sleepiness with other subjective factors at T2 perfectly replicated the results of T1. Also, as shown in Table 2, the correlation coefficients of all identical items between T1 and T2 were high ($r_s > 0.61$).

Longitudinal relationships on the O/P balance to pro-environmental behavior and subjective well-being

Results of the structural equation modeling are depicted in Fig. 1. Overall goodness of fit for the model was acceptable [$\chi^2(380, N = 770) = 1891.947, p < 0.001, RMSEA = 0.072, CFI = 0.919$]. Stability index (< 0.001) based on eigenvalues for each modulus in the stability analysis on non-recursive simultaneous equation systems indicated that the model satisfied the stability condition (stability index < 1.0). The endogenous variables were explained to a medium to large extent ($R^2 > 0.30$), while the explained variance was marginal in pro-environmental behavior at T1 ($R^2 = 0.03$). All the assumed paths including measurement parameters were significant except two paths that will be explained later. Strong positive longitudinal associations were observed between pro-environmental behavior ($\beta = 0.69, t = 31.34, p < 0.01$), subjective well-being ($\beta = 0.62, t = 23.36, p < 0.01$), and O/P ratio ($\beta = 0.69, t = 29.95, p < 0.01$). Moreover, there were cross-sectional associations of covariance between pro-environmental behavior and subjective well-being ($\beta = 0.10$ for T1, $t = 2.55, p < 0.05$; $\beta = 0.10$ for T2,

Fig. 1 Longitudinal structural associations between pro-environmental behaviors, subjective well-being, and O/P. *Note* Estimated path coefficients significant at $p < 0.05$ (*) and $p < 0.01$ (**). Dotted arrows indicate insignificant paths. Standardized path coefficients are presented beside the causal paths. Observed variables and their coefficients to the latent variables and covariances between the variables are not reported for clarity purposes. Goodness of model fit: $\chi^2(380) = 1891.947$, $p < 0.001$, RMSEA = 0.072, CFI = 0.919. $n = 770$



$t = 2.47$, $p < 0.05$). The significantly positive cross-sectional relationships between the O/P ratio and pro-environmental behavior ($\beta = 0.17$, $t = 4.50$, $p < 0.01$) and subjective well-being ($\beta = 0.58$, $t = 25.64$, $p < 0.01$) were confirmed for T1. The same structure for T2 was found significant for subjective well-being ($\beta = 0.24$, $t = 6.72$, $p < 0.01$) but not significant for pro-environmental behavior ($\beta = -0.03$, $t = -0.77$, $p = 0.44$). Longitudinal associations between pro-environmental behavior (T1) ($\beta = 0.05$, $t = 2.06$, $p < 0.05$) as well as subjective well-being (T1) ($\beta = 0.09$, $t = 2.99$, $p < 0.01$) and the O/P ratio (T2) were also confirmed. A positive longitudinal association between O/P ratio (T1) and pro-environmental behavior (T2) was confirmed ($\beta = 0.12$, $t = 2.93$, $p < 0.01$), while that with subjective well-being (T2) was found not significant ($\beta = 0.01$, $t = 0.28$, $p = 0.78$).

Discussion

This study was designed to clarify relationships between state (positive and negative emotional states) and trait (optimism and pessimism) psychological facets and pro-environmental behavior. The results confirmed that an optimism-oriented trait (O/P ratio) facilitated pro-environmental behavior over the two survey periods. Additionally, the cross-sectional correlation analyses conducted on T1 and T2, respectively, both confirmed that pro-environmental behavior was positively associated with subjective well-being as a positive state and negatively associated with stress, depression, and sleepiness as negative states at each survey period. These findings are in line with previous studies (Kasser and Sheldon [44] on stress) including ours [30] that revealed

sleepiness hinders daily practice of pro-environmental behavior. Overall, the results suggest that pro-environmental behavior is associated not only with the state but also with trait psychological status. Particularly, the finding that pro-environmental behavior can be predicted by optimism-oriented trait is among the original results from our study. Although the explained variance was small (3%), this finding should provide important implications for designing long-term engagement in the behavior, adding the O/P ratio as a factor that explains and predicts pro-environmental behavior among many others.

Further interestingly, we in fact found that cross-sectional and longitudinal associations of the O/P ratio with pro-environmental behavior and subjective well-being were not uniform. In the current sample, the O/P ratio was positively associated to pro-environmental behavior over time but there was no significant cross-sectional association between the two at T2. On the other hand, the O/P ratio was not directly associated with subjective well-being over time, while the cross-sectional and indirect longitudinal associations were confirmed between the two. These results imply an intriguing discussion point, that is, traits and states may need to be analyzed as two distinctive psychological factors that potentially influence engagement in pro-environmental behavior as longitudinal associations. This matter should be an interesting topic for future research.

The present results are consistent with those of other studies in which the value for pro-environmental behavior has remained stable over time [13, 45]. Taking into consideration this and other findings including positive correlations between pro-environmental behavior, subjective well-being, and optimism at each time point and longitudinal positive

associations between the O/P ratio to pro-environmental behavior, it is suggested that, overall, positive states and traits contribute to facilitating pro-environmental behaviors in daily life; and that such behaviors, in turn, would induce further enhancement of the positive state. Therefore, positively spiraling associations can be assumed between morally good behaviors and well-being, which could lead to habitually maintaining such behaviors. The idea that behavioral changes in a more pro-environmental direction could be facilitated through well-being or positive affective attitudes is supported by the literature [12, 46, 47], and several empirical and experimental studies [9, 48, 49]. Therefore, it is reasonable to assume that repetitive positive interactions between pro-environmental behavior and well-being could strengthen and establish those behaviors, which is suggested by the present findings. This strategy could be used in policy making for facilitating pro-environmental behavior.

The correlation analyses indicated that subjective well-being and optimism tendency (i.e., O/P ratio) were positively correlated with pro-environmental behavior. Individuals that foresee an optimistic future might tend to be more motivated and engaged in pro-environmental behavior because they are determined to realize such a future by doing helpful activities (i.e., constructive optimism). On the other hand, it has been reported that constructive pessimistic view for future is also related to pro-environmental behavior [7]. This controversial observation might be because of the possibility of interpreting optimism and pessimism in multiple ways. When individuals anticipate a pessimistic future of environmental issues, they would encourage themselves in pro-environmental behavior to prevent such undesirable future [7]. This can happen when individuals consider the situation constructively even though they foresee it negatively (i.e., constructive pessimism). On the other hand, when individuals anticipate a better future of the environment as a result of engaging themselves in the improvement, pro-environmental behavior should be also enhanced by an optimistic standpoint. This can happen, again, if individuals take the situation positively with a constructive view and seek for the better (i.e., constructive optimism). The important standpoint to be recognized in this regard is “constructiveness” rather than optimism or pessimism themselves. The constructiveness can be a more important facilitator of pro-environmental behavior than simply optimistic or pessimistic traits as suggested by Epstein and Meier [50] for coping and other behaviors in different situations. The topic is out of reach of the present surveys because we did not measure constructiveness of optimism and pessimism, but it would be an interesting topic for a future study.

A couple of practical implications for policy makers can be drawn from the present findings. Pro-environmental behavior policies can be better designed and implemented

in conjunction with psychological health and well-being programs. Coupling environmental and human well-being will lead to realizing sustainability at both individual and social levels [51–53]. Integrated well-being policies joined by relevant policy sectors such as environment, welfare, and education should create more significant policy outcomes. Policies in such ways would be implemented more effectively and efficiently.

Several limitations of the present study should be noted. Firstly, the findings of this study are based on correlation analysis and path analysis over longitudinal survey data without any interventions. Therefore, we could not identify any causal relationships. Secondly, we did not use objective measures of pro-environmental behavior but concentrated only on self-reported data. Observational and experimental data should be used to eliminate possible bias arising from the use of questionnaire and survey data, as well as to increase the reliability of results. This limitation is also related to possible inflated correlations within the survey data of each time point due to common method bias [54], while we believe that our cross-lagged survey design avoided internal inflation tendency of the responses over the two time point survey data. Yet, our present cross-lagged sample may be biased due to a reduced number of respondents, dropping out (7.67%) after the first wave survey. Lastly, we applied the O/P ratio only to examine the relationship of psychological traits with pro-environmental behavior. While we believe that O/P ratio as describing the balance of optimism and pessimism is a plausible parameter for our research purpose, there may be other parameters that could better represent the traits and explain the relationship, including other forms of the O/P balance parameter. Also, we used the pro-environmental behavior items that had not been validated. Proper measure development and its evaluation on the O/P ratio and pro-environmental behavior should be a priority for future studies.

In conclusion, we found positive relationships between positive feelings and pro-environmental behavior, and that optimism orientation can be related to current and future pro-environmental behavior. These findings support the role of trait psychological orientation in the domain of environmental behavior, suggesting that optimism provides individuals with behavior patterns favorable to the future, which also contributes to their subjective well-being. The accumulation of similar positive outcomes would help enhance quality of life at both individual and societal levels, as well as facilitate policies that encourage pro-environmental behaviors toward environmentally sustainable society.

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Compliance with ethical standards

Conflict of interest The authors declare no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the University of Tsukuba Research Ethics Committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

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