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## Neuroticism and extraversion moderate the relationship between physical activity enjoyment and habit

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### ABSTRACT

The aim of this study was to examine whether certain personality traits moderate the relationship between physical activity enjoyment and habit. Seven hundred twenty-four participants ( $M_{age} = 31.29$  years; 54.7% female) completed an online survey that included measures of physical activity enjoyment, physical activity habit, personality factors (neuroticism, extraversion, and conscientiousness), and emotional style dimensions (outlook and resilience). The data were analysed using Hayes' PROCESS macro for SPSS (controlled for demographic variables and engagement duration for the selected physical activity behaviour) with habit as the dependent variable. Results indicate that physical activity enjoyment was positively related to habit. Neuroticism was negatively related to habit, while the other personality traits examined were positively related to habit. Moderation analyses revealed that the relationship between physical activity enjoyment and habit was stronger for individuals with higher levels of neuroticism and extraversion, however, the effects were very small. The other tested moderation effects were not significant. These findings suggest that increasing physical activity enjoyment may be crucial for reinforcing habit regardless of the personality traits analysed in this study. In nuances, physical activity enjoyment could be particularly important for less emotionally stable and more extraverted individuals as a reward that promotes habit.

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### KEYWORDS

Personality factors;  
emotional style; affect-  
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Embracing a physically active lifestyle holds merit, but reaping its maximum benefits lies in its sustenance: committing to consistent physical activity and achieving, if not exceeding, the minimum recommended physical activity threshold, which can result in a multitude of health advantages and serve as a protective buffer to chronic illnesses (Haskell

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et al., 2007; Powell et al., 2011). According to recent dual-process theories (e.g., Strobach et al., 2020), in addition to intentions, habit is considered to be a key variable for the maintenance of physical activity (for reviews see Feil et al., 2021; Gardner et al., 2011). Habit is not just the frequency of a behaviour, but a process whereby a cue prompts behaviour initiation after a cue-behaviour association has been learned (Gardner, 2015; Wood & R nger, 2016). As habit forms, automaticity becomes a key characteristic of it, which means that habitual behaviour is efficiently instigated without thinking, having to consciously remember it, and awareness (Gardner et al., 2012).

## Relation between physical activity enjoyment and habit

Affect-related constructs (for a narrative review on affect-related constructs as determinants of physical activity see Stevens et al., 2020) can influence habit formation, i.e., encourage initiation and repetition of the behaviour or promote learning of cue-behaviour associations (Gardner & Lally, 2018). In the context of physical activity, a number of affect-related constructs have been examined in relation to habit (e.g., Kaushal et al., 2017; Kaushal & Rhodes, 2015). For example, Kaushal and Rhodes (2015) concluded that affective judgement was a relevant determinant especially at the beginning of habit formation. Other work has shown that the affective attitude towards sufficient exercise predicted exercise habit measured two weeks later, in addition to previous behaviour and social-cognitive variables (de Bruijn et al., 2014). Further, research demonstrated that the acute affective response to physical activity was related to future physical activity (Rhodes & Kates, 2015), and, in particular, habit strength (Weyland et al., 2020; Weyland et al., 2022).

From both a theoretical and a practical perspective, it is important to emphasize that the strength of the association between affect-related constructs and habit may not be equal for everyone. The acute affective response to a behavioural outcome, such as the experience of enjoyment, may lead to the experience of reward and at the next opportunity to show the behaviour again, the likelihood that it will be performed increases because it is now associated with a reward (de Wit & Dickinson, 2009). However, individuals differ in their reward sensitivity, and thus in their enthusiasm for approaching the behaviour in the face of the anticipated reward (Lucas et al., 2000). Consistent with these theoretical assumptions, it is important to examine potential moderators of the relationship between enjoyment and habit at the between-person level. This need is also supported by Teixeira et al. (2022) who found that the relationship between enjoyment and habit was moderated by the exercise intensity traits agreement (i.e., preference for and tolerance of exercise intensity). The authors propose that while recent literature emphasizes the role of enjoyment in regular physical activity, it has neglected to examine traits that moderate the “enjoyment effect” on outcomes like habit. For this reason, the present study focuses on personality factors of the Five-Factor Theory and emotional style dimensions as potential moderators of the postulated enjoyment-habit relationship.

## Personality and habit

Personality refers to the dynamic psychological organization that orchestrates perception and action and can be inferred from consistent and enduring patterns of thinking, feeling, and behaving (McCrae & Costa, 2008). In the “Five-Factor Theory”, the following

five personality factors are regarded as a core component of the universal personality system or as basic tendencies: neuroticism (i.e., when highly expressed, the tendency to be worrying, nervous, emotionally unstable, and vulnerable), extraversion (i.e., when highly expressed, the tendency to be sociable, affectionate, energetic, and talkative), openness (i.e., when highly expressed, the tendency to be original, creative, perceptive, and reflective), agreeableness (i.e., when highly expressed, the tendency to be soft hearted, forgiving, and generous), and conscientiousness (i.e., when highly expressed, the tendency to be careful, well organized, reliable, and hardworking; McCrae & Costa, 1987, 2008).

These abstract potentials can manifest concretely; for instance, in the case of extraversion, the preference for social interactions can reflect in the characteristic adaption of engaging in sports (McCrae & Costa, 2008). Much like how personality factors manifest in tangible adaptations to the environment, precipitating habitual thoughts or actions, the automatic nature inherent in habits can perpetuate the repetition of such behaviours (see also McCloskey & Johnson, 2021; McCrae & Costa, 2008).

The emotional style theory is another approach to describing the consistent pattern of responding to life experiences that is based on neuroscience (Jekauc et al., 2021; Davidson, 1993; Davidson & Begley, 2012). It posits that a person's emotional style is determined by an individual combination of six dimensions. Outlook involves the skill to maintain a positive emotional state, whereas resilience entails the ability to swiftly recover from negative emotions. Social intuition encompasses the capacity to accurately interpret nonverbal cues in social interactions. Self-awareness refers to the adeptness in correctly understanding bodily signals associated with emotions. Sensitivity to context highlights the capability to adapt emotion regulation according to the prevailing social environment. Attention denotes the skill to effectively concentrate one's focus. Additionally, Davidson and Begley (2012) postulate a relation between certain personality factors and emotional style dimensions. Kesebir et al. (2019) found that outlook and resilience were the two dimensions that particularly correlated with neuroticism (negatively) and extraversion (positively).

## The present study

In summary, affect-related constructs and habit have been shown to be positively related in the context of physical activity (e.g., Teixeira et al., 2022; Weyland et al., 2020). However, it is not conclusive that the strength of this relationship is the same for everyone. The purpose of the present study was to explore whether personality factors and emotional style dimensions moderate the relationship between physical activity enjoyment and habit. We hypothesized that physical activity enjoyment would be positively related to habit. In examining whether personality moderates the relation between physical activity enjoyment and habit, neuroticism and conscientiousness seem particularly relevant because they are associated with habit (McCloskey & Johnson, 2021), and extraversion, as one of the affective personality factors associated with reward sensitivity (Lucas et al., 2000), could also have a moderating effect. In terms of emotional style, in the present study we focus on the two dimensions of outlook and resilience because, by definition, they are related to the duration of emotions (Davidson & Begley, 2012). Therefore, we predicted that the enjoyment-habit relation would be moderated by neuroticism,

extraversion, and conscientiousness as well as by the emotional style dimensions outlook and resilience.

### **Neuroticism**

High levels of neuroticism are generally associated with lower levels of physical activity (Rhodes & Pfaeffli, 2012; Rhodes & Smith, 2006; Sutin et al., 2016; Wilson & Dishman, 2015) and lower levels of physical activity enjoyment (Engels et al., 2022). Furthermore, Courneya and Hellsten (1998) found individuals exhibiting high levels of neuroticism displayed an increased propensity to experience apprehension over potential embarrassment during assessments of physical fitness and were more likely to be motivated by concerns about physical appearance, rather than deriving enjoyment from the activity. That individuals high in neuroticism are less physically active, but when they are, it is to avoid feelings of guilt, fits with the explanations by McCloskey and Johnson (2021) that these individuals are more likely to habituate negatively reinforcing behaviours, such as eating unhealthy snacks to relieve tension. Notably, neuroticism positively correlates with sensitivity to rewards (Torrubia et al., 2001). In general, individuals sensitive to rewards are more motivated to approach potentially rewarding stimuli (see also Gray, 1970). However, for individuals high in neuroticism, these rewards not only mean the removal of negative circumstances. Rather, they may also react with pleasure to the satisfaction of psychological needs, as demonstrated in the study by Engels et al. (2022). In this study, neuroticism moderated the relationship between perceived competence and physical activity enjoyment. Therefore, if neurotic individuals experience physical activity enjoyment under certain conditions, this could represent an unexpected reward for them, which might be especially important for overcoming adverse circumstances such as barriers or suboptimal motivation (see also Baumeister et al., 2001). Thus, the relationship between physical activity enjoyment and habit may be stronger for individuals high in neuroticism than for those low in neuroticism.

### **Extraversion**

Individuals scoring high on extraversion tended to enjoy physical activity regardless of whether the physical activity satisfied the psychological need of social relatedness in the study by Engels et al. (2022). In line with this, it is assumed that extraverts do not explicitly seek out social situations, but generally seek out rewarding situations due to their reward sensitivity (Lucas et al., 2000). However, if extraverts are more likely to experience positive affect in general (see also Costa & McCrae, 1980), and a cue for these individuals is associated with many different rewarding behaviours, then it might be harder for a habit to form because the cue is not consistently leading to the same behaviour. As such, the cue-behaviour association that would characterize habit may not strengthen. For example, if a person could exhibit many different behaviours in response to the end of the workday, all of which are potentially rewarding, such as going swimming or going out with friends, none of these behaviours would become habitually instigated if not repeated on a consistent, regular basis (see also Gardner & Lally, 2018). Consequently, the relationship between physical activity enjoyment and habit may be weaker for individuals high in extraversion and stronger for those low in extraversion.

## **Conscientiousness**

Findings on conscientiousness have shown that although this has been positively associated with physical activity (Rhodes & Smith, 2006), this factor was negatively related to habit in a study that analysed various behaviours, including exercise (McCloskey & Johnson, 2021). Gardner et al. (2021) discussed this finding in relation to the overlap between conscientiousness and self-control (O’Gorman & Baxter, 2002). On one hand, consistent with the finding that conscientiousness was associated with lower habit strength, it can be concluded that people high in self-control might be less likely to initiate their behaviour in an automatic way because self-control is more of an explicit process (see also Strobach et al., 2020). On the other hand, habits should be more likely to be facilitated by self-control, since the formation of “beneficial habits” might help people high in self-control in progressing towards desired life goals (Galla & Duckworth, 2015). Upon further analysis, McCloskey and Johnson (2021) found that the negative relationship between conscientiousness and exercise automaticity weakened when individuals high in conscientiousness perceived exercising as more rewarding. They conclude that while more conscientious people have lower automaticity, presumably because they are more inclined to deliberate, the perception of reward may facilitate their automaticity formation. Thus, the relationship between physical activity enjoyment and habit may be stronger for individuals high in conscientiousness than for those low in conscientiousness.

## **Outlook**

Regarding outlook, Kesebir et al. (2019) describe that this dimension refers to acute positive affective responses that can be sustained over time. Thus, for an individual high in outlook, positive affective responses might be longer processed, rather than fading quickly, and referred to as affective judgements (see also Stevens et al., 2020). Moreover, outlook refers to a generally optimistic view. Therefore, individuals high in outlook may be more likely to anticipate enjoyment in relation to future physical activity (see also Feil et al., 2022). Both affective judgements and anticipated enjoyment may be related to habit strength. Thus, the relationship between physical activity enjoyment and habit may be stronger for individuals high in outlook than for those low in outlook.

## **Resilience**

With regard to individuals low in resilience, it can be assumed that they do not quickly overcome negative affective experiences, such as embarrassment during physical activity. This negative experience may constitute a barrier for future physical activity, similar to individuals high in neuroticism (see also Courneya & Hellsten, 1998). Assuming that enjoyment is all the more important for them, the relationship between physical activity enjoyment and habit may be stronger for individuals low in resilience than for those high in resilience.

## **Materials and methods**

### **Procedures**

The present cross-sectional observational study was registered with an analysis plan at open science framework (OSF) prior to the data analysis on December 14, 2022

(<https://osf.io/8w6cf>). Data collection was ongoing at the time of registration; it had started at the end of December 2021 and lasted until August 2023. The study was conducted as an online survey consisting of 65 items and lasted approximately 15 minutes. We used the online tool SoSci Survey. The link could be opened on various devices, such as smartphones, laptops or tablets. There were no incentives offered for participation. The study was reviewed and approved by the ethics committee and data security commissioner at Karlsruhe Institute of Technology. Informed consent was obtained from all participants. Participants were informed of data protection measures and the voluntary and anonymous nature of their participation in the study.

## **Participants**

Participants were recruited through social media, personal outreach, and spreading the participation link in university courses. This recruitment sought a diverse sample. Anyone who clicked on the link to the online questionnaire could participate in the study. Participants were instructed to relate enjoyment and habit to a specific physical activity behaviour they participate in, regardless of how often they do it, to ensure that enjoyment and habit refer to the same physical activity. Thus, individuals who could not specify a particular physical activity behaviour were asked in the introductory text to the survey not to participate in the study. In addition, the participants had to be over 18 years old to be included. Mean age was 31.29 years ( $SD = 13.22$ , range from 18 to 79 years), and 54.7% said their gender was female, 44.5% said it was male, .6% said it was diverse, and two persons preferred not to provide any information on gender.

## **Measures**

We measured physical activity enjoyment, physical activity habit, personality factors, and emotional style dimensions in a cross-sectional study design. As for possible covariates, demographic variables (gender and age) and self-reported engagement duration for the selected physical activity behaviour that could be entered in an open entry response field were also collected.

### **Physical activity enjoyment**

Physical activity enjoyment was measured with PACES-S (Chen et al., 2021). This short version of the Physical Activity Enjoyment Scale (PACES, Kendzierski & DeCarlo, 1991) focuses on the subjective experience of enjoyment. Fritsch et al. (2022) reported good psychometric properties of PACES-S in German adult populations. The scale included four items related to the item stem "Practicing my activity ..." (e.g., "I enjoy it") to be answered on a five-point Likert scale, ranging from (1) strongly disagree to (5) strongly agree. Physical activity enjoyment was calculated as the mean of the four items, whereby higher values indicate greater levels of enjoyment. Cronbach's alpha was  $\alpha = .86$  in the present study and ranged from .82 to .88 in previous research (Chen et al., 2021).

### **Physical activity habit**

Physical activity habit was measured with the SRBAI (Gardner et al., 2012). This automaticity subscale of the Self-Report Habit Index (SRHI, Verplanken & Orbell, 2003) measures



automatic activation of a behaviour as the central feature of habit that was found to be related to future behaviour (Gardner et al., 2012; Phillips & Gardner, 2016). As such, the SRBAI showed predictive validity, and also, its reliability and convergent validity were reported (Gardner et al., 2012). A German version of the original SRHI was also validated (Thurn et al., 2014). The SRBAI included four items related to the item stem “Deciding to practice my activity is something ... ” (e.g., “I do automatically”) to be answered on a seven-point Likert scale, ranging from (1) strongly disagree to (7) strongly agree. In this study, the item stem was chosen to capture the so-called instigation habit, i.e., the degree to which the decision to initiate a behaviour is automated, which was found to predict the frequency of exercise (Phillips & Gardner, 2016). Physical activity habit was calculated as the mean of the four items, whereby higher values indicate greater levels of habit. Cronbach’s alpha was  $\alpha = .85$  in the present study and ranged from .68 to .97 in previous research (Gardner et al., 2012).

### *Personality factors*

Personality factors were measured with the NEO-FFI-30 (Körner et al., 2008). This short version of the German translation of the 60-item NEO-Five-Factor Inventory (Borkenau & Ostendorf, 1993; Costa & McCrae, 1989) is based on the Five-Factor Model of personality (Costa & McCrae, 1989). Satisfactory reliability, factorial and construct validity of the NEO-FFI-30 were reported for a German population (Körner et al., 2008). The whole inventory includes 30 items evenly distributed among the five personality factors to be answered on a five-point Likert scale, ranging from (1) strong rejection to (5) strong agreement. After reverse-coding, the scores for each personality factor were calculated as the mean of the respective five items, with higher scores indicating greater levels of the factor. In this study, the personality factors under investigation were neuroticism, extraversion, and conscientiousness. We did not analyse the other two personality factors openness and agreeableness in our pre-registered main analyses, but report the results of additional analyses in the supplemental material. Cronbach’s alpha was  $\alpha = .85$  for neuroticism,  $\alpha = .74$  for extraversion, and  $\alpha = .74$  for conscientiousness in the present study and ranged from .67 to .81 in previous research (Körner et al., 2008).

### *Emotional style dimensions*

Emotional style dimensions were measured with the Emotional Style Questionnaire (ESQ, Kesebir et al., 2019). Its validity and reliability were also supported for the German population (Jekauc et al., 2021). The whole inventory includes 24 items evenly distributed among the six emotional style dimensions to be answered on a seven-point Likert scale, ranging from (1) strongly disagree to (7) strongly agree. After reverse-coding, the scores for each emotional style dimension were calculated as the mean of the respective four items, with higher scores indicating greater levels of the dimension. In this study, the emotional style dimensions under investigation were outlook and resilience. We did not analyse the other four emotional style dimensions social intuition, self-awareness, sensitivity to context, and attention. Cronbach’s alpha was  $\alpha = .76$  for outlook and  $\alpha = .71$  for resilience in the present study and .85 for outlook and .82 for resilience in previous research (Jekauc et al., 2021).



## Statistical analyses

An a priori power analysis using G Power 3.1.9.7 (program written by Franz Faul, Kiel university, Germany; Faul et al., 2007) indicated that when using linear multiple regression (fixed model;  $R^2$  increase) with six predictors, and an alpha error level of .05, a sample of 395 participants would be sufficient to detect a small effect of  $f^2 = .02$ , with a power of .80. For each personality factor or emotional style dimension, we calculated separate regression models. In each separate regression, the individual six predictors were: the main effect of the independent variable enjoyment, the main effect of the moderator (personality factor/emotional style dimension), the interaction between the two main effects, and the three covariates age, gender, and engagement duration for the selected physical activity behaviour.

As a preliminary analysis, we checked patterns of missing values with Little's MCAR test (Little, 1988) to decide on imputation. In this study, z-scores were utilized to standardize the individual scores. The z-scores were calculated by subtracting the mean from individual scores and dividing the result by the standard deviation (Field, 2013).

To test whether physical activity enjoyment and physical activity habit were positively related and to test personality factors and emotional style dimensions as a moderator of this relationship, we applied Hayes' PROCESS macro (Hayes, 2022) for SPSS (IBM SPSS Statistics 26, IBM Corp., Armonk, N.Y., USA). This macro uses ordinary least squares regression and unstandardized coefficients are reported for all effects using approaches akin to path analysis or hierarchical regression analysis. In all regressions, we used physical activity habit as the dependent variable and we included age, gender, and engagement duration for the selected physical activity behaviour as covariates. We examined whether the interaction between physical activity enjoyment and the personality factors/emotional style dimensions independently contributed to variance explanation in addition to the main effects and covariates. Model 1 specification was chosen, which included a single moderator (either personality trait or emotional style dimension) between the independent variable (i.e., physical activity enjoyment) and the dependent variable (i.e., physical activity habit). In cases where the interaction was a significant predictor, conditional effects of the focal predictor (physical activity enjoyment) were analysed at the following values of the moderator: mean and plus/minus one standard deviation from the mean. In this way, it was possible to determine whether the relationship between physical activity enjoyment and habit was stronger or weaker depending on the moderator's level.

Since only six individuals indicated either being diverse or not wanting to specify gender, we dichotomized the variable gender for purely statistical reasons and ran all regressions without these six cases. We additionally ran all regressions without the three covariates age, gender, and engagement duration for the selected physical activity behaviour, thus, including these six cases, and found that the significant effects were the same as those observed in the regression analyses which included the covariates. The assumptions for a moderation analysis, namely independence of errors in estimation, linear relationships between the variables, normal distribution of errors, and homoscedasticity (Hayes, 2022), were checked beforehand. For this purpose, the regressions were calculated manually using SPSS (IBM SPSS Statistics 26, IBM Corp., Armonk, N.Y., USA), so that the Durbin-Watson statistic was calculated for each regression to verify the assumption of independence; further, partial plots to check the linearity assumption, histograms to

check normality, and scatter plots with unstandardized predicted values and studentized residuals to check homoscedasticity were created (see also Field, 2013). The threshold for significance was .05 for all analyses.

## Results

### *Descriptive analyses*

The questionnaire was clicked on 3015 times. A total of 764 respondents completed the survey. Among them, 29 were under the age of 18 and were therefore not included in the analysis. Moreover, individuals who could not state any physical activity behaviour were not included in the analysis. This was the case for nine persons.

To test the pattern of missing data of the remaining 726 participants, Little's MCAR test was performed. Descriptive analyses of missing values (item-nonresponses) revealed that for the PACES-S (4 items), 0 values were missing; for the SRBAI (4 items), 6 values (.21%) distributed among 4 subjects were missing; for the NEO-FFI (30 items), 4 values (.02%) distributed among 4 subjects were missing; for the ESQ (24 items), 52 values (.30%) distributed among 5 subjects were missing. While Little's MCAR tests were not significant for the PACES-S, SRBAI, and NEO-FFI items, indicating that missingness in the data was not related to the data, it was significant for the ESQ items ( $\chi^2 = 89.66$ ,  $df = 68$ ,  $p = .040$ ), indicating that for these items, missingness in the data was related to the data. Regarding unit-nonresponse (two individuals who had no values for any ESQ items), we applied list-wise deletion, while we imputed values for the remaining participants with missing values using the expectation-maximization algorithm (EM algorithm; Jekauc et al., 2012; Little & Rubin, 2019). The complete dataset included information from 724 participants. Thus, the minimum required sample size based in the power analysis was exceeded.

The largest proportion of participants (19.5%) identified fitness activities (e.g., exercising at the gym or doing workouts at home) as the preferred physical activity to which the individual related the survey, followed by 14.4% soccer, and 10.5% jogging or walking. The remainder included a diverse range of physical activities such as volleyball, bouldering, gymnastics, dancing, or tennis. On average, the participants had been doing their chosen physical activity for 12.82 years ( $SD = 10.99$ ; range from .08 to 68.08 years) and were doing it 9.52 days a month ( $SD = 5.90$ , range from 0 to 30 days) for 88.27 minutes per session ( $SD = 52.92$ , range 1–480 minutes). The descriptive results and correlations among all study variables are shown in Table 1.

### *Moderator analyses*

Regarding personality factors, consistent with the pre-registered analysis, we considered only neuroticism, extraversion, and conscientiousness as potential moderators of the relationship between physical activity enjoyment and habit. The results for openness and agreeableness can be found in the supplemental material.

### *Neuroticism*

First, we examined whether neuroticism moderated the relationship between physical activity enjoyment and physical activity habit (see Table 2). In this model ( $F(6,707) =$

**Table 1.** Means, standard deviations, and correlations among all included study variables.

	1	2	3	4	5	6	7	8	9	10
1. Gender	–									
2. Age	–.05	–								
3. Duration	–.14***	.53***	–							
4. Enjoyment	.00	.01*	.17***	–						
5. Habit	–.09*	–.01	.21***	.47***	–					
6. Neuroticism	.22***	–.11**	–.12**	–.22***	–.20***	–				
7. Extraversion	.02	–.09*	.08*	.34***	.31***	–.36***	–			
8. Conscientiousness	.17***	.05	.02	.17***	.17***	–.33***	.20***	–		
9. Outlook	–.00	.05	.04	.24***	.21***	–.59***	.52***	.23***	–	
10. Resilience	–.15***	.09*	.07	.22***	.22***	–.61***	.40***	.17***	.66***	–
M (%)	54.7 <sup>a</sup>	31.29	12.82	4.44	4.69	2.55	3.49	4.06	4.91	4.38
SD		13.22	10.99	.66	1.50	.80	.59	.54	1.12	1.07
Skewness	–.21	1.47	1.65	–1.39	–.58	.57	–.23	–.58	–.47	–.13
Kurtosis	–1.96	1.12	3.93	1.97	–.37	–.17	.26	.51	–.20	–.49

Note:  $N = 724$ . Regarding gender, masculine was coded as 1, thus, column 1 pertains solely to  $N = 718$  subjects. <sup>a</sup>percentage female. \* $p < .05$ ; \*\* $p < .01$ ; \*\*\* $p < .001$ .

47.54,  $R^2 = .29$ ,  $p < .001$ ), physical activity enjoyment was significantly positively related to physical activity habit ( $b = .42$ ,  $SE = .03$ ,  $p < .001$ ), and neuroticism was significantly negatively related to physical activity habit ( $b = -.09$ ,  $SE = .03$ ,  $p = .005$ ). Further, the interaction between physical activity enjoyment and neuroticism was significantly positively related to physical activity habit ( $b = .06$ ,  $SE = .03$ ,  $p = .026$ ). The interaction effect explained .5% of the variance of physical activity habit ( $F(1,707) = 4.97$ ,  $p = .026$ ). For individuals approximately one standard deviation higher than average on neuroticism, the relationship between physical activity enjoyment and physical activity habit was stronger ( $b = .48$ , 95% CI [.40, .56]) than for individuals approximately one standard deviation lower than average on neuroticism ( $b = .35$ , 95% CI [.26, .44]). Thus, we concluded that neuroticism moderated the relationship between physical activity enjoyment and physical activity habit with a very small effect.

**Table 2.** Results of the moderation analyses.

	B	SE	t	p	Model summary
<i>Results of the moderation analysis with neuroticism as the moderator variable</i>					
Constant	.28	.09	3.03	.003	$F(6,707) = 47.54$ , $R^2 = .29$ , $p < .001$
Enjoyment	.42	.03	12.59	<.001	
Neuroticism	-.09	.03	-2.81	.005	
Interaction	.06	.03	2.23	.026	
Age	-.02	.00	-5.30	<.001	
Gender	-.12	.07	-1.85	.064	
Duration	.02	.00	6.06	<.001	
<i>Results of the moderation analysis with extraversion as the moderator variable</i>					
Constant	.18	.09	2.01	.044	$F(6,707) = 49.93$ , $R^2 = .30$ , $p < .001$
Enjoyment	.42	.03	12.08	<.001	
Extraversion	.15	.03	4.49	<.001	
Interaction	.07	.03	2.53	.012	
Age	-.01	.00	-4.18	<.001	
Gender	-.16	.06	-2.54	.011	
Duration	.02	.00	5.56	<.001	
<i>Results of the moderation analysis with conscientiousness as the moderator variable</i>					
Constant	.29	.09	3.20	.001	$F(6,707) = 46.91$ , $R^2 = .28$ , $p < .001$
Enjoyment	.43	.03	13.06	<.001	
Conscientiousness	.11	.03	3.31	.001	
Interaction	.00	.03	.03	.979	
Age	-.01	.00	-5.19	<.001	
Gender	-.19	.07	-2.96	.003	
Duration	.02	.00	6.05	<.001	
<i>Results of the moderation analysis with outlook as the moderator variable</i>					
Constant	.29	.09	3.21	.001	$F(6,707) = 47.79$ , $R^2 = .29$ , $p < .001$
Enjoyment	.41	.03	12.14	<.001	
Outlook	.11	.03	3.31	.001	
Interaction	-.06	.03	-1.83	.068	
Age	-.02	.00	-5.32	<.001	
Gender	-.16	.06	-2.53	.012	
Duration	.02	.00	6.19	<.001	
<i>Results of the moderation analysis with resilience as the moderator variable</i>					
Constant	.27	.09	3.01	.003	$F(6,707) = 48.04$ , $R^2 = .29$ , $p < .001$
Enjoyment	.41	.03	12.42	<.001	
Resilience	.12	.03	3.56	<.001	
Interaction	-.04	.03	-1.51	.132	
Age	-.02	.00	-5.33	<.001	
Gender	-.13	.07	-1.95	.052	
Duration	.02	.00	6.15	<.001	

### Extraversion

Second, we examined whether extraversion moderated the relationship between physical activity enjoyment and physical activity habit (see Table 2). In this model ( $F(6,707) = 49.93$ ,  $R^2 = .30$ ,  $p < .001$ ), physical activity enjoyment ( $b = .42$ ,  $SE = .03$ ,  $p < .001$ ) and extraversion ( $b = .15$ ,  $SE = .03$ ,  $p < .001$ ) were significantly positively related to physical activity habit. Further, the interaction between physical activity enjoyment and extraversion was significantly positively related to physical activity habit ( $b = .07$ ,  $SE = .03$ ,  $p = .012$ ). The interaction effect explained .6% of the variance of physical activity habit ( $F(1,707) = 6.38$ ,  $p = .012$ ). For individuals approximately one standard deviation higher than average on extraversion, the relationship between physical activity enjoyment and physical activity habit was stronger ( $b = .49$ , 95% CI [.39, .59]) than for individuals approximately one standard deviation lower than average on extraversion ( $b = .35$ , 95% CI [.27, .42]). Thus, we concluded that extraversion moderated the relationship between physical activity enjoyment and physical activity habit with a very small effect.

### Conscientiousness

Third, we examined whether conscientiousness moderated the relationship between physical activity enjoyment and physical activity habit (see Table 2). In this model ( $F(6,707) = 46.91$ ,  $R^2 = .28$ ,  $p < .001$ ), physical activity enjoyment ( $b = .43$ ,  $SE = .03$ ,  $p < .001$ ) and conscientiousness ( $b = .11$ ,  $SE = .03$ ,  $p = .001$ ) were significantly positively related to physical activity habit. However, the interaction between physical activity enjoyment and conscientiousness was not significantly related to physical activity habit ( $b = .00$ ,  $SE = .03$ ,  $p = .979$ ). Thus, we concluded that conscientiousness did not moderate the relationship between physical activity enjoyment and physical activity habit.

### Outlook

Fourth, we examined whether outlook moderated the relationship between physical activity enjoyment and physical activity habit (see Table 2). In this model ( $F(6,707) = 47.79$ ,  $R^2 = .29$ ,  $p < .001$ ), physical activity enjoyment ( $b = .41$ ,  $SE = .03$ ,  $p < .001$ ) and outlook ( $b = .11$ ,  $SE = .03$ ,  $p = .001$ ) were significantly positively related to physical activity habit. However, the interaction between physical activity enjoyment and outlook was not significantly associated with physical activity habit ( $b = -.06$ ,  $SE = .03$ ,  $p = .068$ ). Thus, we concluded that outlook did not moderate the relationship between physical activity enjoyment and physical activity habit.

### Resilience

Finally, we examined whether resilience moderated the relationship between physical activity enjoyment and physical activity habit (see Table 2). In this model ( $F(6,707) = 48.04$ ,  $R^2 = .29$ ,  $p < .001$ ), physical activity enjoyment ( $b = .41$ ,  $SE = .03$ ,  $p < .001$ ) and resilience ( $b = .12$ ,  $SE = .03$ ,  $p < .001$ ) were significantly positively related to physical activity habit. However, the interaction between physical activity enjoyment and resilience was not significantly associated with physical activity habit ( $b = -.04$ ,  $SE = .03$ ,  $p = .132$ ). Thus, we concluded that resilience did not moderate the relationship between physical activity enjoyment and physical activity habit.

### Explorative analysis

Given that two significant moderators (i.e., neuroticism and extraversion) of the relationship between physical activity enjoyment and habit emerged in this study, which were significantly correlated ( $r(723) = -.36, p < .001$ ), we conducted an exploratory analysis in which we included both moderators in a regression (Model 2 specification in Hayes' PROCESS macro; Hayes, 2022). This allowed us to test the independence of the moderators' influence on the relationship between physical activity enjoyment and habit. In this regression, the predictors were the main effects of physical activity enjoyment, neuroticism, and extraversion, as well as the interaction between physical activity enjoyment and neuroticism and between physical activity enjoyment and extraversion, and the three covariates.

In this model ( $F(8,705) = 39.44, R^2 = .31, p < .001$ ), physical activity enjoyment ( $b = .40, SE = .03, p < .001$ ) and extraversion ( $b = .14, SE = .04, p < .001$ ) were significantly positively related to physical activity habit, while neuroticism was not significantly related to physical activity habit ( $b = -.04, SE = .04, p = .206$ ). Further, the interaction between physical activity enjoyment and neuroticism was significantly positively related to physical activity habit ( $b = .09, SE = .03, p = .002$ ), as was the interaction between physical activity enjoyment and extraversion ( $b = .09, SE = .03, p = .002$ ). Both interaction effects explained 1.5% of the variance of physical activity habit ( $F(2,705) = 7.66, p < .001$ ). Regarding the conditional effects of the focal predictor at values of the moderators, the effect of physical activity enjoyment on habit was the strongest for individuals approximately one standard deviation higher than average on neuroticism and extraversion ( $b = .58, 95\% \text{ CI } [.47, .70]$ ). Thus, we concluded that both neuroticism and extraversion moderated the relationship between physical activity enjoyment and physical activity habit.

### Discussion

The purpose of this study was to explore whether relevant personality factors (neuroticism, extraversion, and conscientiousness) as well as emotional style dimensions (outlook and resilience) moderate the relationship between physical activity enjoyment and habit. As hypothesized, physical activity enjoyment and habit demonstrated a positive association in the tested models. With the exception of neuroticism, which correlated negatively, all personality factors and emotional style dimensions examined in the present study correlated positively with physical activity habit. Moderation tests revealed significant, but very small effects only for neuroticism (in the hypothesized direction) and extraversion (not in the hypothesized direction). The hypotheses regarding the moderation effects of conscientiousness, outlook and resilience were not supported.

Findings of the present study showed a positive relationship between physical activity enjoyment and physical activity habit, which is consistent with previous research, demonstrating a relationship between a wide variety of affect-related constructs and habit (e.g., Teixeira et al., 2022; Weyland et al., 2022). Physical activity enjoyment may serve to sustain behaviour and accelerate the learning of a cue-behaviour association, both of which are stages in habit formation (de Wit & Dickinson, 2009; Gardner & Lally, 2018). Phillips and Mullan (2022) even suggest that persistent and intrinsic rewards are necessary ingredients for sustained habit formation of complex behaviours such as exercise (but see also Gardner & Lally, 2022).

The positive relationship between extraversion, conscientiousness, outlook, and resilience and physical activity habit as well as the negative relationship between neuroticism and physical activity habit can be integrated into research and considerations that these constructs are also related to physical activity. Regarding the personality factors extraversion, neuroticism, and conscientiousness, research shows that they are related to physical activity (Rhodes & Smith, 2006; Sutin et al., 2016; Wilson & Dishman, 2015). Given the relation between habit and physical activity (Feil et al., 2021), it is reasonable to suspect that these personality factors might also be relevant for habit strength. With regards to outlook and resilience, it can be assumed that individuals high in these dimensions experience more positive and less negative emotions (Davidson & Begley, 2012). This overall heightened propensity to encounter positive emotions and in particular the ability associated with outlook to maintain these emotions, could potentially elucidate why these individuals are more inclined to develop a habit. Yet, some studies also suggest that there may be no consistent pattern between personality and habit (e.g., Judah, 2015; Wood et al., 2002).

However, an exploratory analysis revealed that the main effect of neuroticism was no longer significant when extraversion was included in the model. Thus, the contribution of neuroticism to explaining variation in habit can be expected to be explained by its relationship with extraversion. It may be that the lower habit strength of individuals high in neuroticism can be explained by the fact that these individuals are less extraverted. As in the present study, other studies also showed a negative relationship between extraversion and neuroticism (e.g., Engels et al., 2022). Neurotic extraverts, on the other hand, are assigned to the impulsivity dimension of personality, so future studies could examine how the interaction of these two personality factors affects habit strength (see also Gray, 1970; Torrubia et al., 2001).

Further, in this study, the relationship between physical activity enjoyment and habit was found to be stronger for individuals high in neuroticism than for individuals low in neuroticism. This finding is consistent with our hypothesis, although the effect is very small. One explanation for this finding could be that individuals high in neuroticism are generally more dependent on enjoying their activity to build a habit. Neuroticism is associated with less physical activity enjoyment (e.g., Engels et al., 2022), and more negative affect in general (Costa & McCrae, 1980). However, it was shown that it requires certain circumstances, such as the satisfaction of basic psychological needs, for individuals high in neuroticism to experience enjoyment (Engels et al., 2022). Further, in a momentary assessment study, neuroticism did not moderate the relation between physical activity and positive affect, but rather, the positive effect of physical activity on positive affect was also present in people with high neuroticism scores (Wichers et al., 2012). It can be assumed that the experience of enjoyment is a pleasant exception to their otherwise rather negative affectivity and that this enjoyment is an unexpected and therefore particularly effective reward (see also Wood & Neal, 2016). Moreover, individuals high in neuroticism are also more likely to be afraid of embarrassment in the face of physical evaluation (Courneya & Hellsten, 1998). Considering Lewin's force-field analysis (Lewin, 1951), physical activity enjoyment can represent a driving force drowning out restraining forces such as fear of embarrassment in relation to being physically active or not (see also Brand & Ekkekakis, 2018). Thus, one can conclude that physical activity enjoyment is all



the more important to strengthen their habit when it tips the balance of forces in favour of the driving forces.

Additionally, the present study found that the relationship between physical activity enjoyment and habit was stronger for individuals high in extraversion than for individuals low in extraversion, which was contrary to our hypothesis. Given the habit process, which includes the formation of cue-behaviour associations (Gardner & Lally, 2018), it has been assumed that individuals with positive affectivity and susceptibility to rewards do not necessarily link a cue to a single behaviour. Rather, they may anticipate and approach many rewarding behavioural options. However, the habit measure in the present study focused on instigation habit which describes the habitual initiation of physical activity. It is possible that extraverted individuals form higher order physical activity instigation habits (see also Phillips & Mullan, 2022), while executing physical activity differently each time. For example, they may habitually decide to go cycling, but choose different routes each time.

Given the small effect found in the present study, future studies could examine whether other variables moderate the enjoyment-habit relationship. For example, need for affect (Maio & Esses, 2001) and other factors associated with extraversion such as reward responsiveness or fun seeking (Carver & White, 1994) or its finer facet traits such as sensation seeking and activity (see also Rhodes & Pfaeffli, 2012; Rhodes & Smith, 2006) could be investigated. According to the results of the present study, i.e., very small effects of the moderators neuroticism and extraversion, it would otherwise be reasonable to conclude that the relationship between physical activity enjoyment and habit is a very robust one that exists for all individual personality types and differs only in nuances. Therefore, the results of this study need to be further investigated to determine whether individuals with high scores in neuroticism and extraversion show greater effects of affect-based interventions to promote physical activity habits. Standard approaches that do not take personality into account have often proven ineffective (e.g., Engels & Freund, 2020; Weyland et al., 2022).

This study further showed that outlook, resilience, and conscientiousness did not significantly moderate the relationship between physical activity enjoyment and habit. Regarding outlook, the longevity of positive emotions implies emotional stability, and for people high in resilience, recovery from negative emotions is rapid, so that they are not often hampered by adversity (Jekauc et al., 2021; Davidson & Begley, 2012; Kesebir et al., 2019). As such, for individuals who tend to experience long-lasting positive emotions, the additional benefit of physical activity enjoyment may be less relevant if they are not characterized by a constant need for rewards, as in the case of extraversion.

Regarding conscientiousness, individuals who tend to be well-organized and dutiful may not benefit more or less from physical activity enjoyment as they may form cue-behaviour associations, simply because of the consistent repetition of behaviour in stable settings. In their work on the individual difference factor "grit", Duckworth et al. (2007) found that conscientiousness was associated with grit, i.e., persistence and craving for long-term goals. As mentioned by Woolley and Fishbach (2017), this could mean that for gritty or conscientious individuals, enjoyment as an immediate reward is less important because they stay the course regardless of any affective experiences (see also Duckworth et al., 2007). Other determinants, such as health benefits of physical activity, may be more critical for their habit strength (Courneya & Hellsten, 1998).

However, Ingledew et al. (2004) found that conscientiousness was positively related to intrinsic regulation and speculate that individuals high in conscientiousness seek to discover a way to make health-related behaviours satisfying. This highlights the need for future studies that longitudinally examine how the relationships between enjoyment, habit, and personality develop along the different stages of habit formation.

Effects from covariates revealed interesting insight to the model findings. The results suggest that younger participants and male individuals tend to have higher physical activity habit scores, which also appear to be higher for individuals who have been physically active for a longer period of time. As age increases, the context undergoes changes; for instance, Wood et al. (2005) discovered that transitioning to a different university can lead to a decrease in the engagement of habitual behaviours. In terms of gender, research shows that male individuals are more likely to meet physical activity guidelines compared to their female counterparts (e.g., Finger et al., 2017), so that this could be associated with them also having higher physical activity habit scores. With regard to the engagement duration for the selected physical activity behaviour, it should be noted that mere repetitions of the behaviour over a long period of time do not necessarily lead to the formation of a habit, but that consistent repetitions of the behaviour contribute to the formation of cue-behaviour associations (Gardner & Lally, 2018).

### **Strengths and limitations**

This study presents notable strengths as it examined two constructs relevant to the maintenance of physical activity, enjoyment (e.g., Fritsch et al., 2022) and habit (e.g., Feil et al., 2021), in a sufficiently large sample and incorporates a new approach to describing personality, the emotional style theory (Davidson & Begley, 2012). However, the cross-sectional design only allows for an analysis of the relationship between the current level of physical activity enjoyment and ongoing automaticity. Additionally, participants reflected an active/athletic sample as they reported high average values for physical activity enjoyment, which was also evident in other studies (e.g., Chen et al., 2021; Fritsch et al., 2022). It should also be noted that the long period of data collection can be seen as a limitation. Over such a long period, external factors such as weather conditions change, which could moderate the relationship between affect and physical activity (Timm et al., 2023).

### **Conclusions**

The present study explored the relationship between physical activity enjoyment, physical activity habit, and the personality factors neuroticism, extraversion, and conscientiousness as well as the emotional style dimensions outlook and resilience. Our findings suggest that physical activity enjoyment has a strong association with habit. Further, the positive relationship between physical activity enjoyment and habit appears to be generalizable, with no moderating effect of any personality trait reversing the relationship to the negative. Among individuals high in neuroticism or extraversion, the relationship between physical activity enjoyment and habit was stronger than for individuals scoring low on neuroticism or extraversion. Thus, affect-based interventions can be

beneficial for all personality types and future investigations are encouraged to identify the extent to which these are particularly effective for certain personality types.

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## Disclosure statement

No potential conflict of interest was reported by the author(s).

## Data availability statement

The data that support the findings of this study are available from the corresponding author, SW, upon reasonable request.

## Transparency and openness

We report how we determined our sample size, all data exclusions, and all measures in the study. Data were analysed using Hayes’ PROCESS macro (Hayes, 2022) for SPSS (IBM SPSS Statistics 26, IBM Corp., Armonk, N.Y., USA). This study’s design and its analysis were pre-registered.

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