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On the impulsivity path: Examining the unique and conjoint relations between emotion- and non-emotion-related impulsivity, internalizing symptoms, alcohol use, and physical health parameters

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Abstract

Background: Researchers have increasingly differentiated trait-like tendencies toward impulsivity occurring during emotional states (emotion-related impulsivity [ERI]) from impulsivity not tied to emotion (non-ERI). Relative to non-ERI, ERI has shown robust correlations with psychopathology and mild to moderate associations with physical health parameters (e.g., physical activity, poor sleep quality, body mass index [BMI]). Therefore, we first aimed to investigate the unique contributions of ERI and non-ERI to psychopathology symptoms while controlling for neuroticism. Second, we sought to explore the combined associations of physical health parameters with several impulsivity forms.

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AUTHOR CONTRIBUTIONS
Florian Javelle, Kiara R. Timpano, Jutta Joormann, Philipp Zimmer, and Sheri L. Johnson have formulated the research questions. Florian Javelle, Kiara R. Timpano, Jutta Joormann, Philipp Zimmer, and Sheri L. Johnson have designed the study. Florian Javelle has carried out the study. Florian Javelle, Marit L. Schlagheck, and Hannah C. Broos have analyzed the data. Florian Javelle, Marit L. Schlagheck, Hannah C. Broos, Kiara R. Timpano, Jutta Joormann, Philipp Zimmer, and Sheri L. Johnson wrote the article.

CONFLICT OF INTEREST STATEMENT
The authors declare no conflict of interest.

SUPPORTING INFORMATION
Additional supporting information can be found online in the Supporting Information section at the end of this article.

Methods: German-speaking adults ($N = 350$, 35.9 ± 14.6 years, 69.1% female, BMI: 24.0 ± 4.8 kg/m^2, mostly students or employees) completed measures of impulsivity, psychopathology symptoms, neuroticism, and physical health. We gathered measures of two ERI forms: Feelings Trigger Action and Pervasive Influence of Feelings. As a control comparison, we gathered a measure of non-ERI, the Lack of Follow-Through scale. We conducted separate path models for Aims 1 and 2.

Results: For Aim 1, Pervasive Influence of Feelings showed strong links with internalizing symptoms. Feelings Trigger Action and Lack of Follow-Through showed small links with alcohol use. For Aim 2, poor sleep quality was related to all three impulsivity factors, while physical activity was only related to Pervasive Influence of Feelings and Lack of Follow-Through. BMI showed a curvilinear association with impulsivity.

Conclusions: ERI is more directly relevant than non-ERI for psychopathology symptoms, emphasizing the need to differentiate between the two ERI types. The association of ERI and non-ERI with physical activity and poor sleep quality may serve as potential treatment targets for impulsivity-related problems.

Keywords

alcohol use; emotion; exercise; impulsivity; internalizing; sleep

1 | INTRODUCTION

Impulsivity has been defined as acting on a moment-to-moment basis without precognition or prior consideration of adverse repercussions (Whiteside & Lynam, 2001). It negatively affects many facets of daily life (Sharma et al., 2014) and has been tied to various psychopathologies (Johnson et al., 2017). Nonetheless, it is a multidimensional psychological construct that has historically been captured using heterogeneous definitions and measures. Despite this, researchers have statistically and conceptually differentiated impulsivity triggered by states of heightened emotion (Carver et al., 2011; Whiteside & Lynam, 2001). Emotion-related impulsivity (ERI) is defined as a reflexive responding to strong emotions of either positive or negative valence (e.g., reacting without thinking when upset) (Carver et al., 2008) and is frequently contrasted with non-ERI (e.g., lack of follow-through or distractibility, without reference to emotion).

Compared with other impulsivity dimensions, ERI has shown stronger links with a large spectrum of psychopathologies, including bipolar disorder, borderline personality disorder, substance abuse disorder, post-traumatic stress disorder, and major depressive disorder (for meta-analysis; Berg et al., 2015). Often, these psychopathologies have been studied independently without considering comorbidity profiles. However, promising research indicates that ERI is also robustly tied to both internalizing (e.g., major depressive disorder, anxiety disorder) and externalizing disorders (e.g., disruptive behavior disorders, alcohol use disorder) (Johnson et al., 2013, 2017). This line of work, which has measured impulsivity with the well-validated Three-Factor Impulsivity Index, also highlights the importance of considering two different forms of ERI (Johnson et al., 2013, 2017).

The first subscale, Feelings Trigger Action, captures a lack of constraint over speech and behavior in the context of positive and negative emotional states, and is comprised largely of two well-validated scales called Positive Urgency and Negative Urgency (Cyders et al., 2007; Whiteside & Lynam, 2001) indexing impulsive responses to positive and negative emotions, respectively. The second subscale, Pervasive Influence of Feelings, explores how emotions (mostly negative) tend to shape motivations and thoughts (Carver et al., 2011). Feelings Trigger Action has exhibited a stronger association with externalizing symptoms compared to other impulsivity factors (Johnson et al., 2013, 2017). This is consistent with findings that Positive and negative urgency show correlations with problematic alcohol use (for meta-analysis; Stautz & Cooper, 2013), which is the most common externalizing symptom (Kessler, 1997). On the other hand, Pervasive Influence of Feelings has shown a stronger association with internalizing symptoms, such as depression and anxiety, compared to other impulsivity factors (Johnson et al., 2013, 2017). Accordingly, here, we differentiated these two forms of ERI, and we considered Lack of Follow-Through (covering issues such as lack of perseverance and distractibility without reference to emotion), to capture key facets of impulsivity.

Despite the potential import of findings for these two forms of ERI, previous studies measuring these two dimensions have focused on college students in the United States (Carver et al., 2011; Johnson et al., 2013, 2017). Given that cross-cultural and cross-national differences have been shown in impulsivity and mental health symptoms (Khemiri et al., 2021; Krendl & Pescosolido, 2020; Ziada et al., 2018), it is important to consider how these previous findings generalize to other populations. Thus, the first aim of this study is to explore the joint and unique ties of the two facets of ERI on internalizing symptoms and alcohol use behavior within a European adult sample.

ERI has been argued to be distinct from tendencies toward heightened affectivity in that it is conceptualized as reflecting poor control in the face of those affective states, frequently leading to maladaptive behavior (Carver & Johnson, 2018). As neuroticism is also closely linked with many forms of psychopathology (Lahey, 2009) and is correlated to impulsivity (Sharma et al., 2014), it is essential to consider the contributions of ERI to psychopathology above and beyond the latter (Smith et al., 2020). However, as noted previously (Carver & Johnson, 2018), the unique contributions of neuroticism and ERI have rarely been tested conjointly. Therefore, to extend previous work, we have investigated impulsivity in relation to psychopathology symptoms, including internalizing symptoms and alcohol use symptoms, while controlling for neuroticism.

Beyond the association with mental health, a novel body of work indicates that impulsivity has important links with physical health parameters. These links may rely on shared underlying biomarkers. While some of those are invariant (i.e., genetic) (Carver et al., 2008; Javelle, Löw, et al., 2022), others may fluctuate dynamically after more (i.e., structural and epigenetic biomarkers)(Iurescia et al., 2017; Pan et al., 2021) or less (i.e., circulating biomarkers) time (Javelle et al., 2021; Sutin et al., 2012). For instance, chronic inflammation, dysregulation in the kynurenine pathway, or impairments in monoamine synthesis/release have been documented in various impulsivity-related disorders and among highly impulsive individuals (Gassen et al., 2019; Javelle et al., 2021; Sutin et al., 2012;

Tricklebank & Daly, 2018). Further, impulsivity is correlated with higher body mass index (BMI) (Sanchez-Roige et al., 2019) and sleep disturbance (Miller & Rucas, 2012), which in turn have both been associated with increased chronic inflammation, overactivity of the kynurenine pathway, and dysregulation of the serotonergic and dopaminergic systems (Bhat et al., 2020; Cussotto et al., 2020; van Galen et al., 2021; Jouvet, 1999).

Intriguingly, regular physical activity may also have links with impulsivity and many of these related biomarkers. For example, less self-reported engagement in physical activity was correlated with ERI and non-ERI (Gunten et al., 2020; Javelle, Vogel, et al., 2022; Javelle et al., 2020). In one randomized controlled trial, participants who took part in 8 weeks of physical exercise intervention demonstrated postintervention reductions in ERI and non-ERI (Javelle et al., 2021). Consistent with the aforementioned biological hypothesis, physical activity has also been shown to be related to lower chronic inflammation, better regulation of the kynurenine pathway and monoaminergic systems (Deslandes et al., 2009; Joisten et al., 2021; Nunes et al., 2019; Paahoo et al., 2021), lower BMI (Hemmingsson & Ekelund, 2007), and improved sleep quality (Kline, 2014). Therefore, it is important to take a biobehavioral perspective on understanding the links of physical health with impulsivity and mental health. Based on this literature, our second aim was to investigate the interrelationships of BMI, poor sleep quality, and physical activity levels with ERI and non-ERI.

In considering the links of impulsivity with psychopathology, it is important to note that there are important age and gender effects on both variables. Indeed, although men are often observed to have more sensation-seeking and risk-taking behaviors than women (Cross et al., 2011), some recent work indicates that women tend to obtain lower scores on delay-discounting tasks (Weafer & de Wit, 2014) and self-report higher ERI levels (Javelle, Vogel, et al., 2022; Javelle et al., 2020). Age was also considered, given evidence that impulsivity tends to decline during adulthood (Eysenck et al., 1985). Given these findings, we decided to control for gender and age over this second analysis.

We conducted two separate path models to consider (1) the unique and conjoint associations of ERI and non-ERI on psychopathology symptoms and (2) the associations of physical health variables on the different forms of impulsivity. For our first aim, we hypothesized that ERI would be more strongly related to both internalizing symptoms and alcohol use behavior than non-ERI, controlling for neuroticism. More accurately, we expected Feeling Trigger Action to show the strongest ties with alcohol use behavior, while Pervasive Influence of Feelings would have more substantial associations with internalizing symptoms. For our second aim, we hypothesized that poorer indices of physical health, including high BMI, poor sleep quality, and low levels of global physical activity, would contribute to higher ERI and non-ERI, controlling for age and gender. Understanding which variables are most directly tied to impulsivity is key to considering better preventive solutions and treatments in a broad range of impulsivity-related psychopathologies.

2 | METHODS

All study procedures complied with the Helsinki Declaration and were approved by the University Institutional Review Board (Nr. 014/2019) before data were collected. The protocol of this study (including directional hypotheses) was preregistered on Open Science Framework (March 12, 2020), where the data set has been uploaded and is freely available.

Participants were recruited through online advertising on social networks (i.e., Facebook and LinkedIn), on Amazon Mechanical Turk (MTurk) in exchange for 1.5 euros, and by mailing individuals who had expressed interest in studies from our working group. The only inclusion criterion was to be a native-German speaker or to be able to speak and understand German fluently. Informed consent and questionnaires were administered using the online platform Qualtrics (Qualtrics®). The survey took 25–30 min to complete.

2.1 | Sample

Of 393 participants, we excluded 43 from analyses: 31 did not complete all measures used in the path modeling, seven answered catch items incorrectly, and five brought insufficient care to their answers (Section 2.4). Of the remaining 350 participants, 12 reported being non-native speakers but fluent in German. Because non-native speakers did not differ from native speakers in questionnaire responses, their data were retained in the analyses. The descriptive characteristics of participants are reported in Table 1.

2.2 | Measures

All measures were well-validated German language self-report indices. To assess demographic variables, participants were asked to provide their age, gender (female, male, or non-binary), weight, height, employment status (i.e., student, retired, self-employed, employed, and unemployed / housewife/husband), and if they were native German speakers. When gender was included in the path modeling, the single person who endorsed non-binary status was excluded from the analysis.

2.2.1 | Three-Factor Impulsivity Index (Carver et al., 2011; Javelle et al., 2020)

—The Three-Factor Impulsivity Index was developed by Carver et al. (2011). It is a composite measure designed to cover multiple dimensions of impulsivity. It consists of 54 items rated on a Likert scale ranging from 1 (*I strongly disagree*) to 5 (*I strongly agree*). The index covers eight different impulsivity components that have been shown to load onto three distinct factors (Carver et al., 2011), labeled Pervasive Influence of Feelings (e.g., “When I feel sad, it paralyzes me”), Lack of Follow-Through (e.g., “I am easily distracted by stray thoughts”), and Feelings Trigger Action (e.g., “It is hard for me to resist acting on my feelings”). Test–retest correlations suggest acceptable reliability. The German version was validated by Javelle et al. (2020). In this data set, Cronbach’s α were .891 for Pervasive Influence of Feelings, .924 for Lack of Follow-Through, and .913 for Feelings Trigger Action. As shown in previous studies with the German and the English versions of the Three-Factor Impulsivity Index (Javelle et al., 2020; Johnson et al., 2017), subscales were highly correlated: $r_{\text{Factors 1 vs. 2}} = .59$, $p < .001$, $r_{\text{Factors 1 vs. 3}} = .54$, $p < .001$, and $r_{\text{Factors 2 vs.3}} = .43$, $p < .001$.

2.2.2 | Symptom Checklist 27-plus (SCL-27-plus) (Hardt, 2008)—The SCL-27-plus was developed in German by Hardt (2008). It is a short, multidimensional questionnaire designed to assess internalizing psychopathology symptoms. It consists of 27 items rated on a Likert scale ranging from 1 (*Never*) to 5 (*Very often*). It contains five scales evaluating pain (e.g., "Headache"), depressive (e.g., "Loss of joy"), vegetative (e.g., "Heart palpitations"), agoraphobic (e.g., "Fear in crowds"), and social phobic (e.g., "Feeling unwanted") symptoms. A mean score is computed for each scale and for a Global Internalizing Severity Index reflecting all items (SCL-27-plus$_{GSI}$). Test-retest correlations suggest acceptable reliability. In this data set, SCL-27-plus' Cronbach's α was .885.

2.2.3 | Big Five Inventory-10 (BFI-10) neuroticism subscale (Gosling et al., 2003; Rammstedt et al., 2012)—The BFI-10 was developed by Gosling and et al. (2003). It is a 10-item scale based on the 44-item BFI (John & Srivastava, 1999). We focus on the neuroticism (e.g., "I see myself as someone who gets nervous easily") subscale, which consists of two items rated on a Likert scale ranging from 0 (*entirely true*) to 4 (*completely untrue*). The German version was validated by Rammstedt et al. (2012). Test–retest correlations suggest acceptable reliability (Gosling et al., 2003). The validity of the BFI-10 has been supported by expected correlations with other Big Five tools and demographic variables, as well as high correlations between self- and peer ratings (Rammstedt et al., 2012). Cronbach's α was low (.455), as one would expect for a two-item scale, consistent with previous reports (Gosling et al., 2003).

2.2.4 | Alcohol Use Disorders Identification Test (AUDIT) (Babor et al., 2001; Dybek et al., 2006)—The AUDIT is a 10-item questionnaire developed by the World Health Organization (WHO) to assess past year alcohol consumption, drinking behaviors, and alcohol-related problems (Babor et al., 2001). Seven questions are rated on a five-point scale ranging from "Never" to "Four times a week or more", or "Never" to "Daily or almost daily." One question is answered on a five-point scale with response options ranging from "1–2" to "10 or more." Two questions are answered by one out of three potential responses; "No," "Yes, but not during the past year," or "Yes, during the past year." Items are summed, and a score equal to or greater than 8 (out of a total score of 40) is considered to indicate harmful alcohol use (Babor et al., 2001). The AUDIT has been validated across genders and racial/ethnic groups and is well suited for use outside of mental health care settings (Babor et al., 2001). The German version was validated by Dybek et al. (2006). In this data set, the AUDIT sum score's Cronbach's α was .770.

2.2.5 | Pittsburgh Sleep Quality Index (PSQI) (Backhaus & Riemann, 1996; Buysse et al., 1989)—The PSQI was developed by Buysse et al. (1989). It is the most widely used measure of sleep disturbance, with seven subscales covering subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction. It consists of five short-answer questions and 14 questions answered on a four-point scale assessing sleep characteristics. The PSQI has demonstrated good internal consistency, test–retest reliability, and convergent validity with other established measures of sleep (Buysse et al., 1989). The German version was validated by Backhaus and Riemann (1996). We used the overall score, for which a score of five or more indicates a “poor” sleeper (Buysse et al., 1989). In this data set, the PSQI sum score’s Cronbach’s α was .737.

2.2.6 | Global Physical Activity Questionnaire (GPAQ) (Armstrong & Bull, 2006)—

The German GPAQ was developed by the WHO for physical activity surveillance cross-nationally (Armstrong & Bull, 2006). It consists of 16 short-answer questions on sedentary behavior and physical activity participation in three domains: (1) activity at work, (2) travel to and from places, and (3) recreational activities. The recorded activities are categorized as moderate- or vigorous-intensity. The GPAQ has shown good test–retest reliability and demonstrated moderate-to-strong correlations with objective measures of physical activity, such as accelerometers, suggesting convergent validity (Bull et al., 2009). The main physical activity index used in this study was the Total Physical Activity MET minutes per week, referred to as GPAQ hereafter. We used the more specific moderate-intensity GPAQ and vigorous-intensity GPAQ scores as secondary indices. To accommodate comparisons between studies, participants were also asked to complete the Godin-Shephard Leisure-Time Physical Activity Questionnaire to compute the Godin Health Score (Godin, 2011; Supporting Information Material). The Godin Health Score and GPAQ were robustly correlated ($r = .536$, $p < .001$).

2.3 | Catch items and careless answers

Five catch items were embedded within the questionnaire (e.g., “Please answer ‘I agree’ to this item”). Participants were told that some items were included as tests of attention and random responding so that participants would not think these items reflected mistakes or were part of the psychological assessment battery. Participants who failed at least two catch items were excluded from analyses.

We implemented the techniques described by Meade and Craig (2012) to reduce, identify, and remove careless responses in this questionnaire battery. To optimize response rates for the questionnaire battery, anonymity was not the default setting, allowing participants to choose between using their first names or pseudonyms. Notably, these choices were optional, and participants could complete the survey without answering these specific items without any adverse effects on the questionnaire battery. Toward the end of the questionnaire battery, participants were asked to evaluate the level of care they exercised in their responses using a scale ranging from 1 (*Almost no care*) to 5 (*Full care*). In addition, participants were asked to assess if they considered the quality of their answers to be satisfactory. Participants who reported a level of care below 3 (*Moderate care*) or acknowledged providing inadequate care in their responses were excluded from the subsequent analyses.

2.4 | Statistical analyses

Statistical analyses were conducted using SPSS and AMOS version 28.0 (IBM). All variables were checked for linearity (via quantile–quantile plot and histogram of standardized residuals), skewness, and kurtosis. If these assumptions were unmet, data were corrected with the transformation yielding the most normal distribution. Accordingly, the AUDIT and GPAQ were log-transformed (GPAQ was first winsorised at ±3z). The moderate-intensity and vigorous-intensity GPAQ were square-root transformed. BMI was reciprocal transformed.

As preliminary analyses, bivariate Pearson correlations of key variables are presented. In those correlations, family-wise Bonferroni corrections were applied to adjust for the number of dependent variables per family. Thus, the significance level for the three physical activity variables (GPAQ, GPAQ moderate, GPAQ vigorous) was set to .05/3 = .0167 and for the six internalizing symptoms (SCL-27-plus$_{GSI}$, SCL-27-plus$_{Vegetative,}$ SCL-27-plus$_{Agoraphobic,}$ SCL-27-plus$_{Social\ Phobic,}$ SCL-27-plus$_{Pain,}$ SCL-27-plus$_{Depressive}$) to .05/6 = .0083. Only one variable from each family (i.e., GPAQ and SCL-27-plus$_{GSI}$) was later used to test our hypotheses.

To test hypotheses, we constructed two path models: one to examine the association of impulsivity scores with internalizing symptoms and alcohol use behavior, controlling for neuroticism, and one to examine the association of physical health variables with impulsivity scores, controlling for gender and age. For both path models, our indicators of fit were comparative fit index (CFI) (acceptable values >0.90), root mean square error of approximation (RMSEA) (acceptable values <0.06), standardized root mean square residual (SRMR) (acceptable values <0.08), and the χ^2 test (which is known to be biased by sample size and thus was not our primary fit index) (Hu & Bentler, 1999; Schermelleh-Engel et al., 2003; Xia & Yang, 2019).

3 | RESULTS

3.1 | Descriptive and correlational analyses

Means, standard deviation, skewness, and kurtosis for variables used in the path models are shown in Table 1. Our sample was relatively heterogeneous across all variables. The average GPAQ score (indexing total physical activity) was largely above the minimum to meet health recommendations (>600 MET – min/week) (Bull et al., 2009). The average AUDIT score (4.62, indexing alcohol use behavior) was in the recreational use zone (0–7) defined by the WHO. The average PSQI score was 5.69, indicating that, on average, our sample was experiencing poor sleep quality. All tested correlations had a good linear fit except for BMI with impulsivity scores (Figure 1) displaying a curvilinear form.

Figure 1 displays the correlation coefficients of impulsivity factors with other key variables. As expected, all three impulsivity factors showed positive correlations with neuroticism, which were of moderate size for Feelings Trigger Action and large for the other two impulsivity factors. Impulsivity factors also showed small negative correlations with GPAQ and age, and small to moderate positive correlations with PSQI scores. BMI showed significant small to moderate positive quadratic associations with Feeling Trigger Action (R^2 = .033, p < .010) and Lack of Follow-Through (R^2 = .019, p < .050).

As shown in Figure 1, significant positive correlations were detected between each impulsivity factor and internalizing symptom indices (i.e., SCL-27-plus$_{GSI,}$ SCL-27-plus$_{Vegetative,}$ SCL-27-plus$_{Agoraphobic,}$ SCL-27-plus$_{Social\ Phobic,}$ SCL-27-plus$_{Pain}$, SCL-27-plus$_{Depressive}$). Pervasive Influence of Feelings showed numerically larger associations than the other two impulsivity factors with each internalizing symptom index. Feelings Trigger Action and Lack of Follow-Through showed small positive correlations with the AUDIT scores, while Pervasive Influence of Feelings did not.

3.2 | Association of impulsivity with internalizing symptoms and alcohol use behavior

The path model of impulsivity scores with psychopathological symptoms, controlling for neuroticism, fits the data well after allowing covariances between impulsivity and neuroticism scales, as suggested by modification indices ($\chi^2 = 3.12$, $df = 1$, $p = .077$, CFI = 0.997, RMSEA = .078 – 90% [0–0.183], SRMR = 0.013). As expected, neuroticism covaried with all three impulsivity factors (Figure 2 for the final path model tested) and showed a positive moderate covariation with the SCL-27-plus$_{GSI}$ (indexing Global Internalizing Symptoms Severity). Both Pervasive Influence of Feelings (std. $\beta = .48$, $p < .001$) and Lack of Follow-Through (std. $\beta = .12$, $p < .001$) were positively associated with SCL-27-plus$_{GSI}$, while Feelings Trigger Action was not (std. $\beta = -.05$, $p = .210$). Only one ERI factor, Feelings Trigger Action, was positively associated with the AUDIT scores (std. $\beta = .18$, $p < .010$), consistent with our hypotheses. For comparison, the model without control for neuroticism is provided in Supporting Information: Figure S1. As shown there, most links showed similar associations. Yet, one can note that the link between Pervasive Influence of Feelings and SCL-27-plus$_{GSI}$ was numerically larger (std. $\beta = .63$, $p < .001$) when the model was not controlling for neuroticism. One can finally note that an alternative model controlling as well for age and gender was tested, yet no association was displayed between those variables and AUDIT scores or SCL-27-plus$_{GSI}$, thus resulting in a very poor model fit. Therefore, this model was disregarded.

3.3 | Association of physical health variables with impulsivity scores

We first attempted to implement the curvilinear associations of BMI with impulsivity factor to the path model, but it resulted in a very unstable model with a mediocre fit. Therefore, we decided to focus on linear associations, withdrawing BMI from the model.

The path model of physical health variables associated with the impulsivity scores fit the data well ($\chi^2 = 15.370$, $df = 5$, $p = .009$, CFI = 0.972, RMSEA = 0.077 – 90% [0.035–0.123], SRMR = 0.047) after covariances between predictors were established based on modification indices. As shown in Figure 3, age was negatively related to all three impulsivity factors. Female gender was related to higher scores on both ERI scales but not significantly related to Lack of Follow-Through scores. PSQI was positively related to all three impulsivity factors. The GPAQ was negatively related to Pervasive Influence of Feelings and Lack of Follow-Through.

For comparison, an explorative model splitting the GPAQ between moderate and vigorous intensity is provided in Supporting Information: Figure S2. As suggested in the preliminary correlational analyses, only GPAQ vigorous was negatively related to Pervasive Influence of Feelings and Lack of Follow-Through.

4 | DISCUSSION

This study aimed to test the unique and conjoint associations of ERI and non-ERI with internalizing symptoms, alcohol use behavior, and physical health parameters. We used well-validated measures and constructed multivariable models. The findings of our first path model showed robust and distinct relations between impulsivity factors and psychopathological symptoms when controlling for neuroticism. The second path model showed that global physical activity and poor sleep quality had distinct associations with the three impulsivity factors, even after controlling for age and gender. BMI showed curvilinear associations with two impulsivity factors, where very low or very high BMI were associated with increased impulsivity levels.

In assessing mental health profiles, we aimed to replicate previous work suggesting that two forms of ERI differ in their links with internalizing versus externalizing psychopathologies (Johnson et al., 2017), and to extend previous work by showing that these correlations can be observed when controlling for neuroticism levels. Consistent with hypotheses, the results of the first path model showed that increased levels of Pervasive Influence of Feelings, the form of ERI tied to poor constraint over motivation and cognition, were strongly associated with increased global internalizing symptoms severity (indexed by high SCL-27-plus$_{GSI}$ scores). A smaller but still significant association was also observed between increased levels of Lack of Follow-Through, the non-ERI factor, and increased global internalizing symptoms severity. Also consistent with hypotheses, increased levels of Feelings Trigger Action, which reflect rash and regrettable behavior and speech when responding to emotions (Carver et al., 2011), were uniquely associated with increased alcohol use behavior (indexed by high AUDIT scores), the most common externalizing symptoms (Kessler, 1997). While those findings align with our hypotheses, future research should aim to expand upon them by (1) assessing these associations within the context of a longitudinal study design that incorporates therapeutic interventions for ERI psychopathologies and (2) Employing additional measures of externalizing symptoms (e.g., aggression, rule-breaking behavior, drug use, suicide attempt). These efforts would contribute to a more comprehensive understanding of the underlying factors driving internalizing and externalizing disorders, providing a more holistic perspective on the role of ERI.

Our second model considered physical health variables, such as physical activity and poor sleep quality, that could be modulated using lifestyle and other interventions. Poor sleep quality (indexed by increased PSQI scores) was moderately related to increased impulsivity levels, consistent with previous findings (Miller & Rucas, 2012). Numerous lifestyle and environmental factors (e.g., stress, workload, blue light) contribute to poor sleep quality—as illustrated by the high levels of sleep problems endorsed in the current sample. Current findings expand the list of concerns associated with poor sleep quality (Ben Simon et al., 2020; Grandner, 2017) and add motivation to implement sleep interventions, such as reducing evening blue light exposure before going to bed (Shechter et al., 2018), ameliorating the sleeping environment (e.g., black room, proper matrix, proper position), improving diet and exercise (Gebhart et al., 2011; St-Onge et al., 2016), or providing cognitive behavioral therapy (Harvey et al., 2017, 2015). A future direction for this research will be to examine whether these interventions successfully reduce impulsivity.

Previous work has shown that increased impulsivity is tied to lower physical activity levels (Javelle, Vogel, et al., 2022; Javelle et al., 2020). Here, we extend this work by showing that ERI and non-ERI were tied to less physical activity (indexed by low GPAQ) when controlling for poor sleep quality (indexed by high PSQI). These links were also observed using secondary physical activity indices (i.e., Godin Health Score), suggesting that they were not an artifact of a given measure. Further analyses have shown that only vigorous-intensity physical activity (indexed by GPAQ vigorous), but not moderate (indexed by GPAQ moderate), was tied to lower impulsivity levels. The specificity of this relation is intriguing but might be related to biological markers of impulsivity. Indeed, high-intensity exercise demonstrates a more potent effect on impulsivity biomarkers, such as inflammation levels and the kynurenine pathway activity, than low-intensity exercise does (Joisten et al., 2021; Nunes et al., 2019; Paahoo et al., 2021).

Our findings on the relationship between low global physical activity and increased impulsivity are consistent with recent findings that high-intensity interval training was associated with reductions in impulsivity (Javelle et al., 2021). These findings, though, warrant further investigation as a non-exercise control group in that study also showed a slight decrease in ERI levels. Given the transdiagnostic relation of impulsivity and psychological disorders, future research could assess whether physical exercise intervention might help address mental health concerns tied to impulsivity.

Despite the clear and novel findings, it is important to consider the limitations of this study. First, the RMSEA values of our path models are slightly below the acceptable range, as suggested by Xia et al. (2019), and they are just within the acceptable range according to the cutoff values proposed by Browne and Cudeck (1992) and Jöreskog and Sörbom (1993) (Schermelleh-Engel et al., 2003). However, it is important to note that these values are context-dependent and should not be blindly followed (Kline, 2023). In our case, a slightly larger sample size would likely address this issue. Second, most participants denied alcohol use problems, and few endorsed more than mild levels of concern. While previous work has shown similar associations in samples with more severe alcohol problems (Stautz & Cooper, 2013; Zorrilla & Koob, 2019), future research is needed in clinical settings. Third, the survey duration (25–30 min) was a bit long, and 7.9% of participants failed to complete the survey. However, no differences in sociodemographic characteristics were detected between participants who did or did not finish the survey. Fourth, the curvilinear effects of BMI and impulsivity scores were not included in the second path model due to a lack of stability and mediocre fit. Yet, one should not discard their existence. Further research with even larger sample sizes and large intervals of BMI is necessary to answer this limitation. Fifth, the validity of self-rated concerns is always dependent on participant insight and willingness to disclose, and both physical activity and mental health symptoms tend to be subjective phenomena. We would, however, note that the mental health indices used here are highly validated. Sixth, additional variables that we did not measure, such as childhood adversity, diet, or neurocognitive deficits, may also affect impulsivity, along with mental and physical health concerns. Finally, causality cannot be established from our cross-sectional data.

5 | CONCLUSION

Our findings highlight the importance of differentiating poor constraint over motivation and thought (Pervasive Influence of Feelings), which was more relevant to increased internalizing symptoms, from poor constraint over behavior (Feelings Trigger Action), which was more relevant to increased alcohol use behavior.

They also converge with previous findings in suggesting that ERI is more potent than non-ERI for understanding psychopathology. Indeed, increased Lack of Follow-Through was only moderately associated with increased internalizing symptoms, while the ERI factors demonstrated stronger associations with both increased internalizing symptoms and alcohol use behavior. This work adds to a growing literature highlighting the key role of integrating emotion and impulsivity and considering the differentiation between poor control over behavior versus poor control over cognition and emotion in the face of high-emotion states.

In our second path model, beyond the expected links with age and gender, we observed significant associations of increased global physical activity and poor sleep quality with increased ERI and non-ERI. Thus, physical activity and sleep may hold potential as prevention or intervention targets in impulsivity-related disorders. BMI showed curvilinear associations with two out of three impulsivity factors and thus should be considered in further, more complex, and larger sample-size modeling research.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available in the Open Science Framework at https://osf.io/k9pzq.

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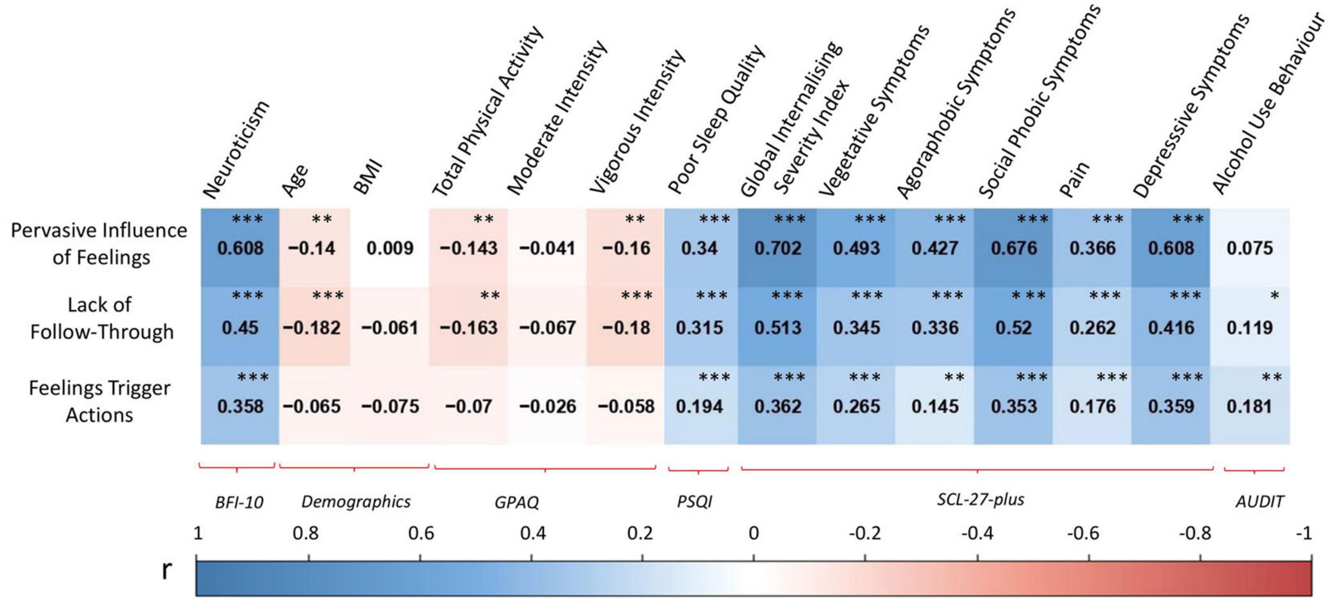

FIGURE 1.

Zero-order correlation matrix. *$p < .050$ (except for physical activity variables: family-wise $p < .013$; see Section 2.4), **$p < .010$ (except for psychopathology symptoms: family-wise $p < .008$; see Section 2.4), ***$p < .001$. AUDIT, Alcohol Use Disorders Identification Test overall score; BFI-10, Big Five Inventory-10; BMI, body mass index; GPAQ, Global Physical Activity Questionnaire; PSQI, Pittsburgh Sleep Quality Index overall score; SCL-27-plus, Symptom Checklist 27 plus.

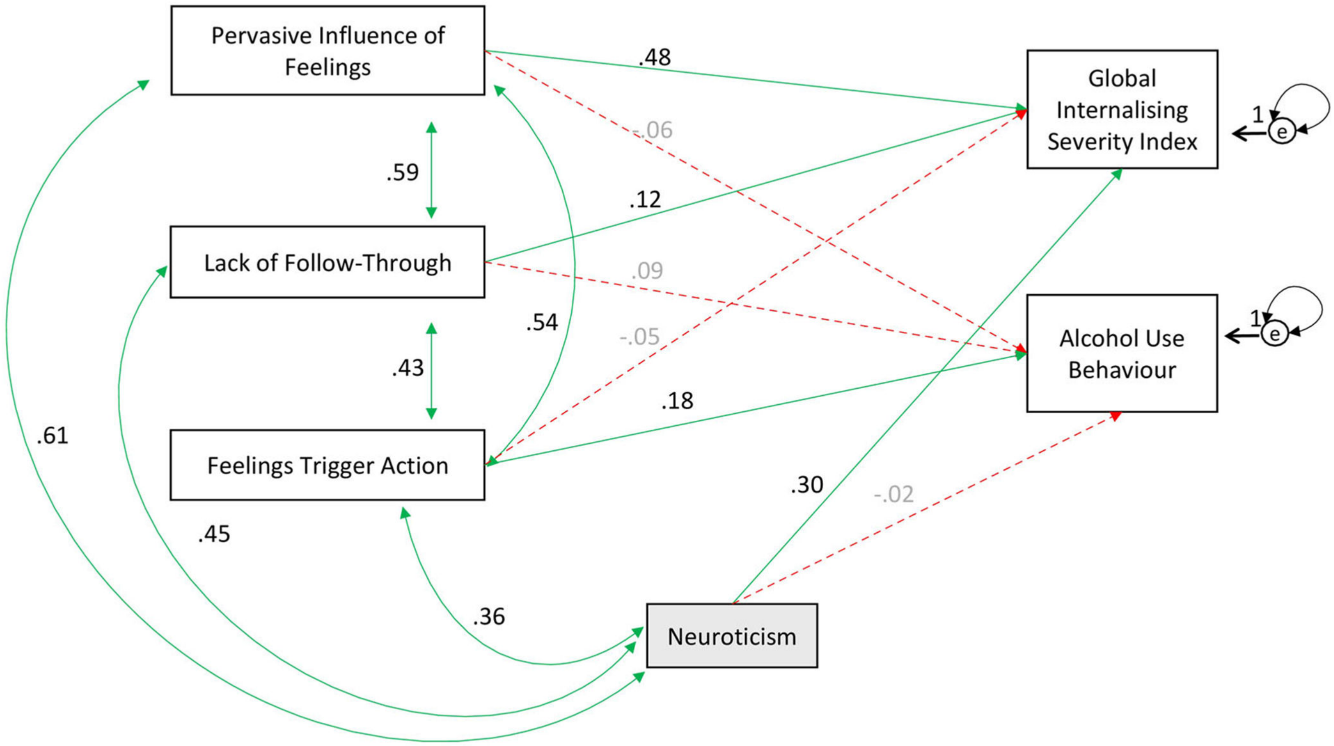

FIGURE 2.

Path model of the three impulsivity factors with psychopathology symptoms, controlling for neuroticism (*N* = 350). Significant links are presented with green arrows (with standardized regression weights in black) and non-significant links with red dashed arrows (with standardized regression weights in gray). Alcohol use behavior is indexed by the Alcohol Use Disorders Identification Test. Global Internalizing Severity Index is indexed by the Symptom Checklist 27 plus-Global Severity Index (SLC-27-plus$_{GSI}$).

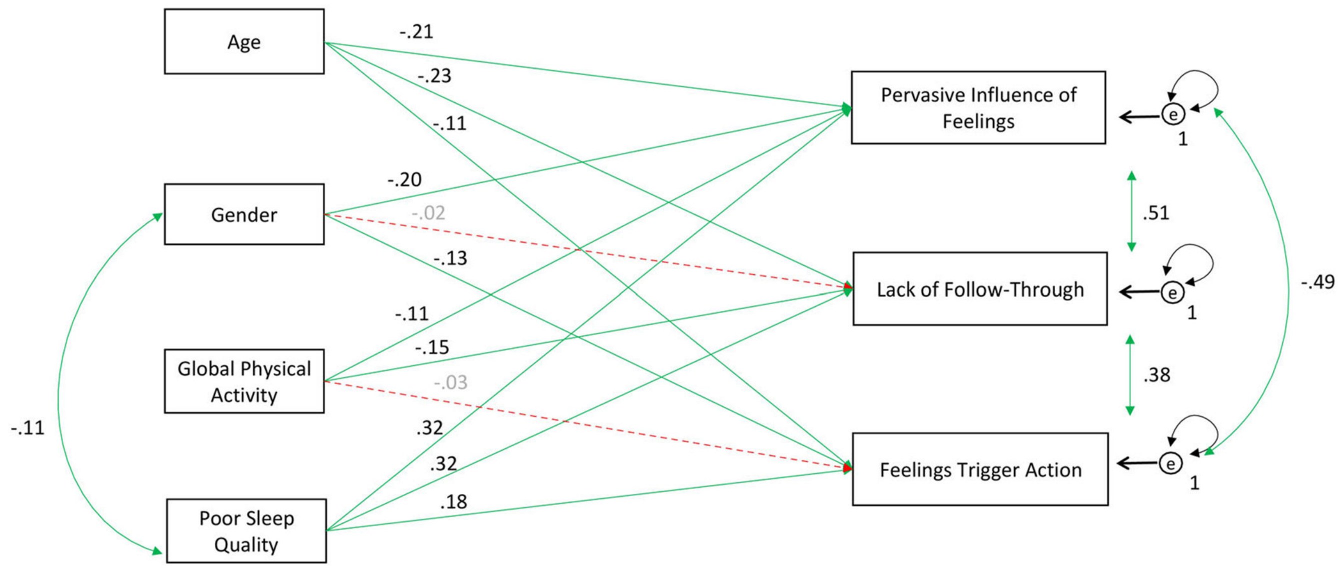

FIGURE 3.

Path model of the three impulsivity factors with physical health variables ($N = 349$). Significant links are shown with green arrows (with standardized regression weights in black) and non-significant links with red dashed arrows (with standardized regression weights in gray). Male was used as the reference for gender. Global Physical Activity is indexed by the Global Physical Activity Questionnaire overall score. Poor Sleep Quality is indexed with the Pittsburgh Sleep Quality Index overall score.

TABLE 1

Descriptive characteristics of key variables ($N = 350$).

Variables names	Groups				*n*
	Categorical variables				
Gender	Females				242 (69.1%)
	Males				107 (30.6%)
	Non-binary				1 (0.3%)
Employment status	Employed				151 (43.1%)
	Self-employed				22 (6.3%)
	Unemployed / Housewife/husband				17 (4.9%)
	Student				142 (40.6%)
	Retired				18 (5.1%)
Variables names	**Mean**	**SD**	**Range**	**Skewness**	**Kurtosis**
	Continuous variables				
Impulsivity					
Pervasive Influence of Feelings	2.87	0.86	1.00–5.00	0.19	−0.61
Lack of Follow-Through	2.49	0.67	1.00–4.47	0.33	−0.47
Feelings Trigger Action	2.54	0.59	1.19–4.44	0.32	0.00
Psychopathology symptoms					
SCL-27-plus$_{\text{General Severity Index}}$	1.14	0.59	0.00–3.48	0.94	1.13
AUDIT	4.61	4.49	0.00–25.56	1.80	4.04
AUDIT transformed$_{(\log[x+2])}$	0.74	0.27	0.30–1.44	0.16	−0.48
Physical health variables					
BMI$_{(\text{kg/m}^2)}$	24.04	4.82	16.54–47.06	2.00	5.43
BMI transformed$_{(1/x)}$	0.043	0.007	0.021–0.060	−0.61	0.58
GPAQ$_{(\text{MET – min/week})}$	4881.75	4825.65	80.00–21,755.97	1.86	3.22
GPAQ$_{\text{transformed}(\log[x+2])}$	3.49	0.45	1.91–4.34	−0.56	0.56
GPAQ$_{\text{moderate (MET – min/week)}}$	2613.61	3085.80	0.00–15,096.38	2.03	4.14
GPAQ$_{\text{moderate transformed}(\text{sqrt}[x])}$	43.70	26.53	0.00–122.87	0.90	0.48
GPAQ$_{\text{vigorous (MET – min/week)}}$	2149.41	2546.37	0.00–11,357.21	1.92	3.72
GPAQ$_{\text{vigorous transformed (sqrt[x])}}$	37.31	27.57	0.00–106.57	0.40	−0.24
PSQI	5.69	2.92	0.00–17	1.02	1.32
Covariates					
Age$_{(\text{year})}$	35.86	14.60	18–73	0.71	−0.70
BFI-10 Neuroticism	2.85	0.97	1.00–5.00	0.28	−0.74

Abbreviations. AUDIT, Alcohol Use Disorders Identification Test overall score; BFI, Big Five Inventory; BMI, body mass index; GPAQ, Global Physical Activity Questionnaire overall score; MET; metabolic equivalent of task; PSQI, Pittsburgh Sleep Quality Index overall score.