Mediation of Executive Functions in the relationship between Internet Addiction and Early Maladaptive Schemas among Iranian university students: A structural equation modeling approach

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Abstract:

Internet Addiction is a global public health issue among university students that is associated with a range of negative outcomes. Although previous studies have indicated that the Early Maladaptive Schemas have important effects on Internet Addiction, the mechanisms underlying these associations are still unclear. To fill this gap in the literature, this study investigated the mediating role of Executive Functions in the association between Early Maladaptive Schemas and Internet Addiction following the Interaction of Person-Affect-Cognition-Execution model. The data were collected from 826 university students aged 18 to 30 years. Using structural equation modeling, it was found that schemas of the domains of disconnection/rejection, impaired autonomy/performance, and impaired limits had a significant relationship with Internet Addiction both directly and indirectly through executive functions. While other-directedness domain schemas were only directly associated to Internet Addiction. The study's findings provide new insight into the development of specific psychological approaches aimed at preventing and treating Internet Addiction

Keywords: internet addiction; early maladaptive schemas; executive functions

Abbreviations

IA: Internet addiction

I-PACE: Interaction of Person-Affect-Cognition-Execution

EFs: Executive Functions

EMSs: Early Maladaptive Schemas

CFA: Confirmatory Factor Analysis

SEM: Structural Equation Modeling

VIF: Variance Inflation Factor

ω: McDonald's Omega Coefficient

α: Cronbach's Alpha Coefficient

AVE: Average Variance Extracted

HTMT: Heterotrait-Monotrait Ratio

CI: Confidence Interval

CMIN/DF: Chi-square to Degrees of Freedom Ratio

GFI: Goodness of Fit Index

CFI: Comparative Fit Index

TLI: Tucker-Lewis Index

RMSEA: Root Mean Square Error of Approximation

SRMR: Standardized Root Mean Square Residual

1. Introduction

During the past two decades, with the rapid development of information technology, access to the Internet has become more widespread and has revolutionized the way individuals communicate with each other. Furthermore, it has become an integral, popular, and essential part of many individuals' daily lives [1, 2]. More than 66% of all the people on Earth now use the Internet, with the latest data putting the global user total at 5.35 billion [3]. Internet usage in developing countries has also increased from 7.7% to 45.3% between 2005 and 2018 [4]. In Iran, one of the developing countries, Internet and social media use has increased significantly in recent years [5]. So that there were 73.14 million Internet users and 48.00 million social media users in Iran at the start of 2024 when Iran's Internet penetration rate stood at 81.7% of the total population [6].

Despite the many benefits of the Internet [7], research has indicated that excessive Internet use may lead to Internet addiction (IA) [8]. Young [9] and Goldberg [10], in the late 1990s, were among the first authors to suggest that the Internet can lead to addiction. Young conceptualized IA as an individual's inability to control the impulse to use their Internet use, which eventually leads to psychological, social, educational, and occupational problems [9]. Despite the growing scientific interest in this disorder, the conceptual definition and diagnostic criteria for IA remain the subject of controversy [11]. To date, it has not been recognized as a disorder in the two main international systems for the classification of diseases and mental health problems, namely the latest edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) [12] and the eleventh edition of the International Classification of Diseases (ICD-11) [13]. However, many empirical studies have shown that IA is typically linked with a variety of psychological and behavioral problems, such as anxiety, depression, sleep disorders, poor interpersonal relationships, and even a high risk of suicide [14-18] and due to its harmful effects is becoming a major global public health problem [19], which is increasingly prevalent among young people [11] and university students [19, 20]. Studies on the prevalence of this behavior suggest that a significant number of university students, from 3.2% [21] to 11% [22] show signs of some form of IA, which is a significant factor in their mental and social well-being [23]. Therefore, to develop effective prevention and intervention strategies, it is imperative to identify risk factors and underlying mechanisms associated with university students' IA.

In recent years, the Interaction of Person-Affect-Cognition-Execution (I-PACE) model has become a prominent theoretical framework for explaining the development and maintenance of addictive behaviors [24, 25]. This model was initially developed in the context of Internet-use disorders [24]. Then, it was expanded to a broader range of addictive behaviors where it also becomes possible to distinguish between the early and later stages of the addiction process. The I-PACE model consists of four components, P-A-C-E, where the P-component refers to the individual's core characteristics, such as personality and psychopathological features. The A-component describes a person's ineffective coping when confronted with stressful situations. The C-component indicates an individual's cognitive biases in facing stressful situations. Finally, the E-component refers to one's Executive Functions (EFs), such as inhibitory control, and explains the impairment in the addict's decision-making, especially when faced with high-risk situations. This model has explained the formation and maintenance of addictive behavior from the perspective of the interaction of these four components and identifies early childhood experiences as a predisposition factor that leads to IA by influencing the individual's affective-cognitive responses and EFs [24, 25]. Early childhood experiences also lead to the formation of Early Maladaptive Schemas (EMSs) [26, 27]. Therefore, within the

framework of the I-PACE model, this study, using a sample of Iranian university students, investigated the effect of EMSs on IA and the mediating role of EFs in this relationship.

1.1. EMSs and IA

Among other influential psychological variables in an individual's life, EMSs are of great importance [28]. The theory of EMSs, created by Jeffrey E. Young, seems to comprehensively explain the mechanism and, above all, the dynamics of mental disorders arising from early childhood experiences [26, 29]. According to the assumptions of EMSs, the experiences we make in our earliest stages of development shape relatively stable functioning patterns and beliefs about ourselves, other people, and the surrounding world. These patterns are referred to as schemas [30, 31] which are defined as "extremely stable and enduring themes, comprised of memories, emotions, cognitions, and bodily sensations regarding oneself and one's relationship with others, that develop during childhood and are elaborated on throughout the individual's lifetime, and that are dysfunctional to a significant degree" [26]. Young [32] identified 18 EMSs, which are classified into five groups called schema domains including "Disconnection/ Rejection", "Impaired Autonomy/ Performance", "Impaired limits", "Other-Directedness", and "Over Vigilance/ Inhibition". The primary source of dysfunctional schemas is the inability to meet or inadequately meet one (or more) of the child's basic developmental needs (so-called core needs) [30, 31]. Failure to meet these needs causes emotions that are difficult for the child, such as anxiety, anger, shame, or guilt; to avoid experiencing them, individuals engage in a variety of behavioral and coping strategies, which -while reducing tension- also contribute to the perpetuation of certain schemas [33]. When triggered later in life by situations that are consciously or unconsciously perceived as similar to adverse childhood experiences, these EMSs are assumed to induce negative emotional states and dysfunctional coping responses [26], which in turn leads to negative emotional experiences, psychological distress, relationship problems, and mental health disorders [34-36].

Over the past few years, Young's theory of schemas has become a focal point for many studies that have attempted to explain the etiology of numerous psychiatric disorders [37]. Theoretically, Young et al. [26] showed that when individuals' EMS is triggered by a specific situation, they may engage in some addictive behaviors to cope with their negative thoughts or emotions. In other words, addictive behaviors can be considered as maladaptive coping modes. In addition, previous research has indicated that EMSs are associated with behavioral addictions, such as problematic smartphone use [38], pathological gambling [39, 40], compulsive sexual behavior [41], and food addiction [39, 42]. Therefore, it appears that EMSs can be important contributors to addictive behaviors including IA. However, few studies have directly investigated the relationship between EMSs and IA [39, 43, 44]. Thus, the relationship between EMSs and IA is still debatable. Furthermore, since EMSs are highly stable and enduring cognitive-emotional patterns that are resistant to change [26, 45], it is necessary to investigate the mediating mechanisms of EMSs that lead to IA, because it helps provide a theoretical basis for the prevention and intervention of IA.

1.2. The mediating role of EFs

Multiple definitions and theories of EFs have been outlined by researchers but no single agreed upon theory of the concept currently exists. This is due to the highly complex nature of EFs. Although no single definition has been identified, most researchers agree that EFs are comprised of high-level cognitive processes that, through their influence on lower-level processes, enable individuals to regulate their thoughts and actions during goal-directed behaviors [46- 50]. EFs include various cognitive processes

(i.e., planning, goal selection, set-shifting, working memory, self-monitoring, and inhibition of inappropriate behavioral responses) related to different regions within the frontal lobes, particularly the prefrontal cortex (PFC) [51].

It seems that EFs may play a mediating role in the association between EMSs and IA. On the one hand, EMSs may be linked to EFs. The related literature shows a relationship between EMSs and some components of EFs. For example, the literature review demonstrated that EMSs are related to working memory [52], cognitive flexibility [53, 54], and selective concentration [54]. Hokmabadi et al [55] also showed in their study that schema therapy is effective in increasing working and prospective memory. Therefore, EMSs appear to be an effective factor in EFs. On the other hand, EFs may have a predictive role in the developmental mechanism of IA. First, the I-PACE theoretical model [24, 25] emphasizes the crucial role of EFs in the occurrence, development, and maintenance of IA. Second, Studies have indicated a relationship between some components of EFs and IA. For example, research evidence has confirmed that individuals with IA present deficiencies in working memory, executive dysfunction, and impulsivity, similar to patients with alcohol dependence and pathological gambling patients [56, 57]. Also, some studies have shown that individuals with IA have specific deficits

in EFs, including cognitive flexibility [58] and decision-making [59]. The research results of Pichardo et al. [60] also showed that inhibition, flexibility, and emotional control (components of EFs) affect problematic Internet use. Therefore, EFs may be a mediating variable in the relationship between EMSs and IA. However, to our knowledge, no relevant empirical studies have examined these associations in university student populations.

1.3. The present study

This study aimed to investigate how Early Maladaptive Schemes influence IA in university students. Specifically, this study examined the mediating effects of EFs in these associations. To the best of our knowledge, this is the first empirical study incorporating EMSs and EFs and their roles in IA. Based on the I-PACE theory, the proposed conceptual model is shown in Figure 1. It is reasonable to hypothesize that EMSs act as triggers for individual IA and EFs serve as mediators between predisposing factors and IA. More specifically, we propose the following hypotheses:

(1) EMSs would have a significant relationship with IA.

(2) EFs would play a mediating role between EMSs and IA.
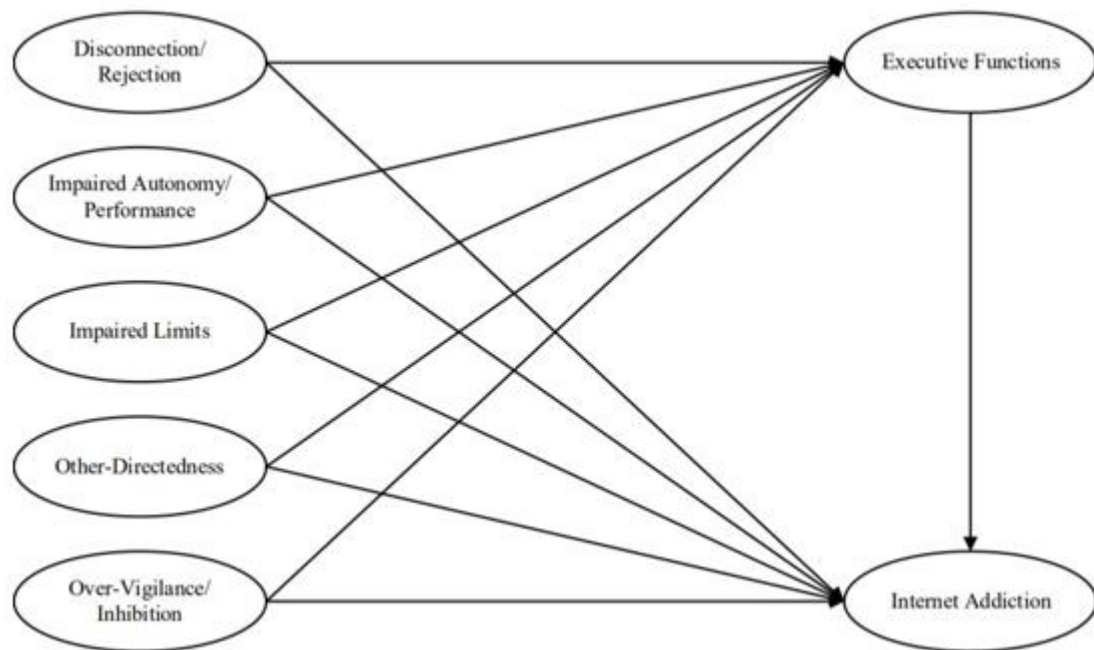
Figure 1: The conceptual model

2. Method

2.1. Data collection procedure

The data were collected as part of an unpublished master's thesis by the first author, supervised by the second author [61]. The study design was cross-sectional, and a combination of random multi-stage cluster and convenience sampling methods was used to collect the data. The data were collected between October 2023 and April 2024, using printed surveys in Persian. The study's participants were 18- to 30-year-old university students from Tehran, Iran. Data collection took place at universities under the supervision of researchers and their assistants, and on average, it took about 25 min to answer the questionnaires. Participation in the survey was voluntary and anonymous and could be canceled at any time. No personal information was collected. Informed

consent was required. First, the participants were informed of the objectives and scope of the study, and confidentiality was also guaranteed. All participants were then asked to indicate that they agreed to participate in the study and to use the data for scientific purposes. Incentives were also used to increase participation (Five 10,000,000 IRR credit gift cards were raffled among respondents, each being worth about 25 USD). The study was conducted following the principles of the Declaration of Helsinki and ethical approval was obtained from the Ethics Committee of Mashhad University of Medical Sciences, Iran (Reference IR.MUMS.MEDICAL.REC.1402.238).

2.2. Participant

The participants were recruited from the selected classes of 10 randomly selected universities using convenience sampling. These classes were

chosen through a random multi-stage cluster sampling process, and within each class, participants were recruited using convenience sampling. A total of 1100 surveys were completed by the participants. After excluding 274 surveys (208 surveys that were not fully answered, 57 surveys that showed excessively patterned responses, and 9 surveys that were identified as multivariate outliers), the final sample for data analysis consisted of 826 valid surveys, meeting the requirements for structural equation modeling [62]. Of the 826 respondents, 15.3% were males and 84.7% were females, whose age range was 18-30 years (M =22.79, SD =3.28). Regarding education level, most participants had a bachelor's degree (81.96%), 15.98% had a master's degree, and 2.06% had a doctoral degree. Regarding marital status, 24.5% of the participants were married and 75.5% were single. Finally, regarding employment status, 50.8% of the participants were employed, while 49.2% were unemployed.

2.3. Measures

2.3.1. Young Schema Questionnaire-Short Form (YSQ-SF)

The Young Schema Questionnaire-Short Form was utilized to evaluate EMSs. This questionnaire is a self-report measure with 75 items developed to assess the presence of 15 different EMSs in 5 domains, with 5 items per EMS [63]. Some examples of items are as follows: "For much of my life, I haven't felt that I am special to someone, I worry about being attacked, and I have rarely been able to stick to my resolutions". Items are scored on a 6-point Likert scale ranging from 1 (Completely untrue of me) to 6 (Describes me perfectly). Each EMS is scored by summing the responses to its corresponding items, ranging from 5 to 30, with higher scores representing a greater possibility of the presence of that EMS for that individual. In this study, we obtain the total score of each domain by summing the scores of its corresponding EMSs. The psychometric properties of the short form of this instrument also appear to be on par with those of the full (205-item) scale, demonstrating similar levels of reliability, validity, and clinical utility [64, 65]. This scale has been validated in Iran, and the findings have indicated good reliability and validity for subscales among the Iranian population [66]. The scale showed appropriate reliability in the current study ($\alpha = 0.978$; $\omega = 0.978$). Table 1 presents the reliability estimates for each domain.

2.3.2. Barkley Deficits in Executive Functioning Scale (BDEFS)

The Barkley Deficits in Executive Functioning Scale was used to assess EFs. This questionnaire, which was developed by Barkley [67], assesses one's degree of deficits in EFs on a 4-point Likert scale ranging from 1 (Never or rarely) to 4 (Very often). It comprises 89 items and is divided into five subscales measuring 5 EFs. Some examples of items are as follows: "I make decisions impulsively, I have trouble doing what I tell myself to do, and I remain emotional or upset longer than others". The total score is determined by summing all 89 items, ranging from 89 to 356, with higher scores reflecting lower EFs. This questionnaire has good validity and reliability [68, 69]. Its Persian version also shows good internal consistency and validity in Iranian individuals [70]. The questionnaire demonstrated good reliability in the present study ($\alpha = 0.988$; $\omega = 0.988$).

2.3.3. Young Internet Addiction Test (IAT)

IA was measured using the Young Internet Addiction Test developed by Kimberly Young [71]. The IAT is a self-reported measure consisting of 20 questions. Some examples of items are as follows: "How often do you find yourself saying "just a few more minutes" when online? How often do you check your email before something else that you need to do? How often do others in your life complain to you about the amount of time you spend online?". Items are rated on a 5-point Likert scale from 1 (Rarely) to 5 (Always). The total score is calculated by summing the scores of the

20 items, ranging from 20 to 100. Higher scores reflect a higher degree of IA. This scale has demonstrated good reliability and validity [72]. The Persian version of this questionnaire has been shown to have good psychometric properties among Iranian individuals [73]. The scale indicated adequate reliability in the present sample ($\alpha = 0.942$; $\omega = 0.941$).

2.4. Data analysis

We used IBM SPSS Statistics version 28 for statistical analyses and IBM AMOS version 24 for confirmatory factor analysis (CFA) and structural equation modeling (SEM).

Before testing the proposed conceptual model and hypotheses, a preliminary screening and assessment of the dataset were conducted to identify potential issues and to ensure the validity of the data, such as missing data, the presence of multivariate outliers, the normality of the variables, the linearity of the relationships, and the absence of multicollinearity. The Mahalanobis-squared distance was used to determine multivariate outliers [62]. Additionally, skewness and kurtosis values were employed to assess the normality of the variables [74]. Also, the linearity of the relationships through scatterplot analysis was assessed [75]. Furthermore, the absence of multicollinearity was checked by examining the variance inflation factor (VIF) [76]. Then, descriptive statistics and Pearson's correlation analysis were examined.

SEM with the maximum likelihood estimation method based on CFA was employed to test the proposed conceptual model and hypotheses. First, CFA was utilized to test the validity and reliability requirements of the constructs within the model. Both McDonald's omega (ω) coefficient [77] and Cronbach's alpha (α) coefficient [78] were employed to evaluate the reliability of the constructs included in the model. Convergent validity was assessed by examining the average variance extracted (AVE) values [79]. The discriminant validity of the latent variables was tested using the Fornell-Larcker criterion [80] and the heterotrait-monotrait (HTMT) ratio [81]. Second, once a valid estimation of the constructs was confirmed, the structural model was tested using SEM. Third, the mediating role of EFs in the relationship between EMSs and IA was tested using a bootstrapping process with 5000 bootstrap samples and a 95% bias-corrected confidence interval (CI). CIs excluding zero indicated significant effects [82].

Given that the chi-square to degrees of freedom ratio (CMIN/DF) is sensitive to sample size, the following indices were used based on the mentioned acceptance thresholds to evaluate the model fit to the data. [83, 84]): goodness of fit index (GFI; ≥0.90), comparative fit index (CFI; ≥0.95 for excellent, ≥0.90 for good), Tucker-Lewis index (TLI; ≥0.95 for excellent, ≥0.90 for good), root mean square error of approximation (RMSEA; <0.05 for excellent, <0.08 for good), and the standardized root mean square residual (SRMR; <0.05 for excellent, <0.08 for good).

3. Results

3.1. Preliminary and Descriptive analyses

Preliminary screening and assessment of the dataset was conducted before the Statistical Analysis. Surveys with missing data and multivariate outliers were excluded from the final dataset. In Addition, the results indicated that all variables' skewness and kurtosis values were between ±1, suggesting an approximate normal distribution [74] (see Table 1). Also, through scatterplot analysis, it was ensured that the relationships between the variables were linear. Furthermore, the results showed no VIF equal to 5 or larger, indicating a lack of multicollinearity in the variables [76]. Overall, all assumptions necessary for conducting SEM were satisfied.

The means and standard deviations of the measured variables are shown

in Table 1. On average, participants in our study reported low to moderate levels in the domains of EMSs and low levels of deficits in EFs and IA. Also, Table 1 presents the bivariate Pearson's correlations between variables included in the study. All of these correlations were statistically significant. All five domains of EMSs were positively correlated with IA and the highest correlation was observed between the Impaired Autonomy/ Performance domain and IA. Also, the results showed that IA and the domains of EMSs have a positive correlation with deficits in EFs, meaning that IA and the domains of EMSs are negatively correlated with EFs.

| Variable	M (SD)	Ske	Kur	α	ω	AVE	Correlation coefficients						
							1	2	3	4	5	6	7
1. D1	73.59 (27.67)	.378	-.434	.947	.945	.572	**.756**						
2. D2	51.20 (25.61)	.779	-.396	.967	.967	.793	.502**	**.891**					
3. D3	34.80 (10.81)	.332	-.395	.868	.867	.557	.405**	.420**	**.746**				
4. D4	31.96 (11.13)	.416	-.302	.895	.892	.645	.425**	.477**	.377**	**.803**			
5. D5	36.28 (10.97)	.081	-.513	.859	.840	.542	.288**	.258**	.300**	.279**	**.736**		
6. EFs	186.27(61.07)	.724	.059	.988	.988	.772	.469**	.529**	.468**	.395**	.236**	**.879**	
7. IA	46.17 (16.42)	.865	.365	.942	.941	.513	.429**	.478**	.402**	.375**	.206**	.581**	**.716**

Notes: D1 = Disconnection/ Rejection; D2 = Impaired Autonomy/ Performance; D3 = Impaired Limits; D4 = Other-Directedness; D5 = Over-Vigilance/ Inhibition; EFs = Deficits in EFs. M = Mean; SD = Standard deviation; Ske = Skewness; Kur = Kurtosis; α = Cronbach's alpha reliability coefficient; ω = McDonald's omega reliability coefficient; AVE = Average variance extracted. All square roots of the AVE values are shown in bold on the diagonal. **p ≤ .01.

Table 1: Descriptive statistics, reliability, AVE, and correlation coefficients (n = 82)

3.2. Confirmatory factor analysis and reliability

This study employed a CFA to assess the measurement model's fit and the reliability and validity of the research constructs. The results showed that the measurement model had an appropriate fit to the data (χ^2 (625) = 1735.683; CMIN/DF = 2.777; GFI = 0.916; CFI = 0.958; TLI = 0.953; RMSEA = 0.046; and SRMR = 0.065). These indices suggest that the model adequately represents the relationships between the observed and the latent variables.
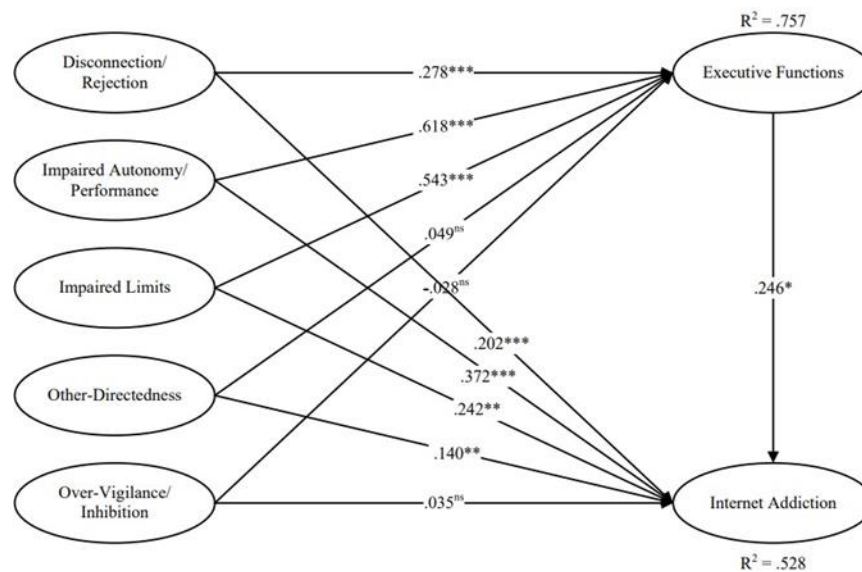
Figure 2: Final results of conceptual model. Notes: Values are standardized coefficients. ***p ≤ .001; **p ≤ .01; *p ≤ .05; ns not significant.

The CFA analysis also confirmed the validity and reliability requirements for SEM. As shown in Table 1, all values of Cronbach's α and McDonald's ω coefficients were above the suggested threshold of 0.70, indicating appropriate reliability for all constructs [85]. Also, Table 1 shows the AVE values exceeded the suggested cut-off value of 0.50, confirming acceptable convergent validity levels in the constructs [79].

All factor loadings were also statistically significant (p < 0.001) and items with factor loadings < 0.50 were removed from the CFA to guarantee adequate convergent validity levels [79]. Finally, the squared root of the AVE value for each latent variable, shown in the diagonal of Table 1, was

consistently higher than its correlations with all other variables included in the model [80]. In addition, the HTMT ratios were below the cut-off value of 0.85 [81]. These results confirm discriminant validity.

3.3. Hypothesis testing

A structural model was estimated using the maximum likelihood method to evaluate the proposed conceptual model and hypotheses. The results are shown in **Error! Reference source not found.**. According to the results, the model presented an acceptable fit to the data (χ^2 (635) = 2033.604; CMIN/DF = 3.203; GFI = 0.909; CFI

The results support both hypotheses. H1 hypothesized that EMSs (i.e. Disconnection/ Rejection, Impaired Autonomy/ Performance, Impaired Limits, Other-Directedness, and Over-Vigilance/ Inhibition domains) would predict IA. As shown in Fig. 2, the analyses determined that

Disconnection/ Rejection, Impaired Autonomy/ Performance, Impaired Limits, and Other-Directedness domains predicted IA (β = 0.202; SE = 0.008; p < 0.001 for Disconnection/ Rejection, β = 0.372; SE = 0.008; p < 0.001 for Impaired Autonomy/ Performance, β = 0.242; SE = 0.014; p = 0.003 for Impaired Limits, and β = 0.140; SE = 0.006; p = 0.010 for Other-Directedness). These associations were weak. Therefore, H1 was partially supported.

Besides the direct links, the mediating effects were also tested. To determine whether EFs mediate the relationship between EMSs and IA, H2 was tested using a bootstrapping process with 5000 bootstrap samples and a 95% bias-corrected CI. The results of bootstrap analyses indicated that Disconnection/ Rejection, Impaired Autonomy/ Performance, and Impaired Limits domains were indirectly and positively associated with IA via EFs (See Table 2). Therefore, H2 was supported, providing evidence of the mediating role of EFs in the relationship between EMSs and IA.

Path	β	SE	95 % CI	P
1. Disconnection/ Rejection → EFs → IA	.069	.031	[.011, .163]	.026
2. Impaired Autonomy/ Performance → EFs → IA	.152	.057	[.024, .336]	.008
3. Impaired Limits → EFs → IA	.134	.052	[.019, .281]	.010
4. Other-Directedness → EFs → IA	.012	.011	[-.010, .066]	.276
5. Over-Vigilance/ Inhibition → EFs → IA	-.007	.012	[-.035, .012]	.562

Notes: Bootstrap sample size = 5000; CI = Confidence interval; β = Standardized coefficient; SE = Standard error.

Table 2: Summary of mediation effect analysis (n = 826)

These results indicated that Disconnection/ Rejection, Impaired Autonomy/ Performance, and Impaired Limits domains can, directly and indirectly, predict IA. While the Other-Directedness domain can only predict IA directly and the Over-Vigilance/ Inhibition domain is neither directly nor indirectly associated with IA.

4. Discussion

The present study examined the impact mechanism of EMSs on IA through EFs among Iranian university students by applying the I-PACE model. This section is structured based on the hypotheses analyzed in this study, and the limitations and conclusions of this study are presented at the end. Three important findings can be derived from the results. First, there was a significant relationship between the four domains of EMSs and IA. Second, the mediating role of EFs in the relationship between EMSs and IA was confirmed. Finally, the results supported the I-PACE model among Iranian university students. The findings of this study extend previous studies about the effect of EMSs on IA and explore the mediation mechanisms among these variables, which help understand the mechanism of IA more accurately and provide more effective guidance for IA intervention among university students. In the first part of this section, we discuss the main findings following the hypotheses proposed in this study. Next, we explain the limitations of the study.

4.1. Associations between EMSs and IA

The results of the present study showed that there is a significant positive relationship between schemas of the domains of Impaired Autonomy/ Performance, Impaired Limits, Disconnection/ Rejection, and Other-Directedness with IA. These findings are in line with the previous studies [39, 43, 44] and are consistent with the theory of Young et al. [26] and

Ball [86] who have explained that EMSs underlie several psychopathologies. In fact, schemas are designed to help us survive in adverse environmental conditions [87], in other words, negative experiences in early childhood reinforce negative emotions and cause individuals to avoid their emotions when faced with similar situations. This avoidance in turn can lead to negative emotional states and maladaptive coping strategies [26]. Therefore, IA can be conceptualized as a maladaptive coping mode utilized for emotional regulation through which individuals cope with their negative thoughts and emotions. Furthermore, the existence of EMSs can lead to reduced cognitive flexibility [53, 54], which makes individuals unable to direct their attention to other ways away from themselves and their problems [88], which in turn may lead to an increase in Internet use, as the most accessible method, in facing problems. Previous studies have shown that the stronger the maladaptive schemas, the more likely addiction to substance use, Internet use, or obsessive behaviors [89]. Impaired Autonomy/ Performance domain schemas are associated with a low sense of personal agency which may lead to feelings of entrapment and hopelessness [26]. Therefore, Internet use becomes like a tool that a person uses to cope with their negative emotions, which are caused by a pattern of perceived personal flaws. Individuals with schemas of the Impaired Limits domain are vulnerable in regulating their emotions, managing their impulses, and engaging in goal-orientated behaviors [26]. As a result, despite the negative consequences across different contexts in their lives, they often engage in impulsive and behavioral addictions and tend to use the Internet as a quick solution to regulate their mood. Disconnection/ Rejection domain schemas, which are intrinsically associated with insecure attachment style and neglected core emotional needs such as love, support, and belonging [26], often lead to the

development of several coping mechanisms to reduce psychological distress and emotional pain, including maladaptive self-soothing strategies such as problematic Internet use. Individuals with schemas of the Other-Directedness domain, who seek to gain others' approval, are afraid of being abandoned, and their sense of self-worth depends on the response of others [26], may take any action to satisfy their needs (others' approval, continuous emotional relationships, sense of value induced by others, etc.), and naturally, the Internet is one of the most accessible and easy solutions for these people.

4.2. EFs as mediators

The results demonstrated that EFs serve as a mediator between EMSs and IA. First, EMSs of the Impaired Autonomy/Performance, Impaired Limits, and Disconnection/Rejection domains predicted deficits in EFs significantly, which is in line with previous studies [52-55]. As previously mentioned, schemas are designed to help us survive in adverse environmental conditions [87], and when faced with new challenges, different types of them may be activated to effectively deal with the difficult situation and the resulting emotions [90]. A key component of EMSs includes emotions, and differences in the expression and regulation of emotions account for a large range of individual personality differences [91]. Individuals with high levels of EMSs in mentioned domains tend to believe that they are unworthy of love and connection, incapable of achieving success, and unable to control their lives [26]. This negative self-worth can lead to strong negative emotions [26, 92, 93] that interfere with EFs. This result can be interpreted using the dual competition model [94, 95], which attempts to explain the interaction between emotion and EFs in terms of shared processing resources. The model describes EFs as capacity-limited processes engaged in evaluating the behavioral relevance of stimuli and tasks in question. The behavioral interference of emotion often observed when high-arousal items are processed can be interpreted in terms of competition for finite available resources. According to the model, task performance is typically impaired in the presence of a task-irrelevant emotional stimulus because resources needed for the primary task are utilized, at least in part, toward the processing of the emotion-laden stimulus. Second, deficits in EFs were positively linked to IA, which is consistent with previous research [56-60]. EFs are control systems that allow us to regulate our behavior in a planned, goal-oriented, flexible, and effective manner [51, 96, 97]. Poor EFs are associated with deficits in goal setting, reduced self-control capacity, difficulty in shifting attention, etc. [98]. Control processes and EFs may significantly influence one's cognition, especially coping style and expectations of Internet use. Therefore, deficits in EFs, especially in situations where a person is confronted with Internet-related cues, may lead to difficulties in developing other coping strategies than turning to the Internet to deal with negative mood [99]. As a result, the reduction of EFs leads to disadvantageous decision-making in the face of Internet-related cues. In this regard, Brand et al. [24] propose a dysfunctional interaction between poor executive control and situationally accelerated reward-seeking, which may promote disadvantageous decision-making to use certain Internet applications/sites to reduce craving and increase mood, that may increase the risk of IA in university students with deficits in EFs.

4.3. Implications for theory and practice

From a theoretical perspective, extending previous studies on the influence mechanism of EMSs on IA among university students, the present study provides empirical support for the I-PACE model of IA among university students in the context of Iranian culture as well as a reference for further research on the formation mechanism of IA. From a practical perspective, our findings may help guide the prevention and intervention of IA among university students. In general, further attention

should be given to developing IA prevention and intervention programs. First, when screening and choosing a target population for further prevention and intervention programs, the population with schemas of domains of Impaired Autonomy/Performance, Impaired Limits, and Disconnection/Rejection and with deficits in EFs should be of particular concern. Second, and even more importantly, our results could offer invaluable knowledge on how to prevent and intervene in IA among university students. Specifically, schema therapy could have the potential to decrease IA in university students. Therefore, clinicians can apply the schema model with their clinical assessment to identify the EMSs that contribute to IA and to develop case conceptualization for treatment planning. In addition, the finding that EFs mediate the associations between EMSs and IA provides important implications for practice. Since EMSs are resistant to change [26, 45], to prevent and intervene in IA in university students, training techniques should be used to improve students' EFs skills because this may be more efficient than directly altering EMSs.

4.4. Limitations and further directions

The present study had some limitations. First, as the results were obtained based on cross-sectional data, the structural relationships analyzed in this study should be interpreted with caution. Thus, future studies should use longitudinal data and clinical trials to better understand the structural relationships between Brain-Behavioral Systems, EFs, and IA. Second, all data were collected through self-report questionnaires, which may have increased bias. Future measures of peer nomination and behavioral tasks could be added, and data could be collected from multiple sources of information to make the data more realistic and reliable. Third, this study did not distinguish IA into specific subtypes. Previous research has shown that it is important to distinguish generalized IA from specific IA [100, 101]. Therefore, more information on Internet use needs to be included in future studies to verify whether the current findings are appropriate for generalized IA or specific IA. Fourth, the data were not obtained from a completely random sample, which did not lead to generalization. Finally, factors such as not considering gender differences, the study population, and temporal context might limit the generalizability and external validity of the findings of this study.

5. Conclusion

The present study extends the literature on EMSs and their impact on IA. In summary, this study explored the relationship between EMSs and IA among Iranian university students by using the I-PACE model. The results indicated that EMSs influence IA either directly or indirectly through EFs. Given that IA is not only harmful to the physical and mental health of university students but also places a large burden on their families and society, this study suggests that further attention should be given to developing IA prevention and intervention programs, especially in populations with schemas of domains of Impaired Autonomy/Performance, Impaired Limits, and Disconnection/Rejection and with deficits in EFs. Also, schema therapy and training techniques to improve EFs should be put on the agenda of clinicians and therapists.

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Declaration of competing interest

The authors report there are no competing interests to declare.

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