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Original Article

Developing an Emotional Regulation Training Model and its Effectiveness on Students' Internet Addiction: Exploring the Moderating Role of Brain-Behavior Systems

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Abstract

Background: Dysregulated emotional responses may promote addictive behaviors as a means of coping with high levels of stress. The aim of this study was to examine the effects of emotion regulation training on Internet addiction, focusing on the moderating role of brain-behavior systems.

Method: This semi-experimental study used a pretest-posttest design with a control group and a follow-up phase. The study population included all Internet-using second secondary school students in Islamshahr, Iran in the second half of 2021. A total of 100 students were selected by purposive sampling and divided into three experimental groups (activation system (n=15), inhibition system (n=15), and fight-flight-freeze system (n=18)) and three control groups (activation system (n=16), inhibition system (n=17), and fight-flight-freeze system (n=19)). Over seven weeks, seven 90-minute emotion regulation training sessions were conducted, while the control group received no training. Research instruments included a revised questionnaire based on Jackson's (2009) Reinforcement Sensitivity Theory and Young's (2007) Internet Addiction Test. Normality of data distribution was tested using the Shapiro-Wilk index of Internet addiction for all three groups in three levels, the statistical index of Box's M test, and the assumption of homogeneity of the covariance matrices of the dependent variable. Analysis of covariance was performed using SPSS version 26.

Results: Findings suggested that emotion regulation skill training could reduce Internet addiction in individuals with the behavioral inhibition system (BIS) compared with other brain-behavior system groups (P<0.001). In addition, the Bonferroni test showed that the difference in the mean scores of Internet addiction was significant between the BIS and behavioral activation system (BAS) (P=0.432) groups as well as between BIS and fight-flight-freeze system (FFFS) groups (P=0.002) was significant. However, no significant difference was found in the mean score of Internet addiction between the BAS and FFFS groups (P=0.006).

Conclusion: The results of the study suggested that emotion regulation training for students with different neurological and behavioral systems can help reduce their tendency to excessive Internet use. Acquiring emotion regulation skills can significantly affect the tendency to use the Internet excessively.

Keywords: Emotion regulation, Internet addiction, Behavioral systems

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1. Introduction

Internet addiction is defined by an excessive preoccupation, a lack of control, a perceived need, or behaviors related to Internet use, all of which are associated with significant distress (1). This form of addiction is an impulse control disorder characterized by excessive Internet use associated with significant functional impairment, anxiety, depression, and other psychological symptoms (2). The prevalence of Internet addiction ranges from 5% to 25% among students in various countries such as the United States, China, Korea, England, Australia, Taiwan, Japan, and both Eastern and Western Europe (3). Recent study has found that the prevalence of this disorder among Iranian students ranges from 8% to 25%. Despite the varying rates of Internet addiction reported in these studies, the societal impact of this addiction should not be underestimated. Due to its widespread and profound harm, it is comparable to drug addiction in terms of social concern, especially in the coming years. It is considered one of the most important social problems of our time (4). Some studies have

suggested that Internet addiction may serve as a maladaptive coping mechanism to escape stressors and avoid confronting the challenges of everyday life (3-5). Previous research has demonstrated both the direct and indirect influence of emotion regulation strategies on the propensity to engage in addictive behaviors, including Internet gaming addiction (5).

Individuals struggling with Internet addiction often have difficulty paying attention to emotional information, recognizing and differentiating emotions, and dealing with emotional dynamics in interpersonal relationships. These difficulties cause individuals to resort to maladaptive strategies when faced with stressful life situations. It can therefore be argued that difficulties in emotion regulation and the use of maladaptive strategies may contribute to a person's tendency to excessive Internet use (6).

Emotion regulation is a process of self-regulation that allows individuals to consciously or unconsciously control their emotions in response to their environment. This regulation can include any coping strategy (adaptive or maladaptive) that an individual uses in the face of stressful circumstances (5).

Emotional dysregulation is characterized by the perception, understanding, and acceptance of emotions, a lack of access to appropriate adaptive strategies when confronted with different emotions, or an inability to control behavior in the face of strong emotional arousal (1).

Excessive Internet use can be a means of escaping reality and distracting oneself from negative emotions and stress. People who find it difficult to regulate their emotions are more inclined to resort to the Internet to respond to their negative emotions, which can lead to Internet addiction (7).

Emotion regulation can alter the process of emotion generation through the use of cognitive reappraisal strategies. This occurs in specific brain structures that serve as the starting point for emotion regulation processes, including the lateral prefrontal cortex, medial prefrontal cortex, and dorsal anterior cingulate cortex. Moreover, the lateral preorbital cortex is known to modulate emotional arousal in various brain regions such as the amygdala, insula, striatum, and medial preorbital cortex. Based on these observations, difficulties in emotion regulation could be associated with a decrease or an increase in activity (8).

A previous study has highlighted the role of the brain-behavior systems in difficulties with emotion regulation, which often manifest as behavioral problems and difficulties. Numerous psychological factors, particularly various addictive behaviors, are involved. For example, the sensitivity of each brain-behavior system in terms of reward sensitivity, punishment sensitivity, and threat sensitivity can significantly influence the development of Internet addiction (9). The mechanism that potentially modulates the sensitivities of these brain-behavior systems and arousal regulation is emotion regulation, according to the available evidence (4).

The educational approach to emotion regulation aims to create a therapeutic environment in which an individual can perceive his or her emotions and use adaptive strategies when faced with emotionally stimulating situations. The emotion regulation training model combines approaches such as the Gross Emotional Regulation Training Model, Lee Hay's Emotional Therapy Schema, and Matthew Mackey's Emotional Regulation Effectiveness. The primary goals of emotion regulation training include identifying emotionally stimulating situations, raising awareness and acceptance of emotions, implementing emotion regulation strategies that lead to adjustments in the sensitivity of brain-behavior systems, reducing emotional difficulties, and reducing Internet use tendencies.

Given the role that difficulties in emotion regulation play in Internet addiction, the central research question of this study is: can emotion regulation training effectively alleviate Internet addiction with the modulating influence of the brain-behavior system? Therefore, emotion regulation includes both the perception and evaluation of a person's emotional state and processes that play a role in understanding and managing their emotions (10). Proper use of these strategies means that individuals can prevent negative or undesirable experiences and better control their emotions. This is true even when they are confronted with intense stimuli; they can control them so that they do not fall into problematic Internet use (5). Thus, the present study was conducted to investigate the relationship between the effectiveness of emotion regulation

training on Internet addiction and the moderating role of brain-behavior systems.

2. Methods

The current study was semi-experimental in practical purpose; the experimental design of the study, as shown in Table 1, consisted of a pretest, a posttest, and a three-month follow-up with a control group.

The target population for this study consisted of all secondary school students in Islamshahr, Iran, who used the Internet in the second half of 2021. This group consisted of girls aged 15-18 years old. The sample was purposively selected from volunteers who wished to participate in the study. In the absence of information on the mean and variance of the population, G*Power software was used to estimate the required total sample size. The parameters for this estimation were set as follows: an effect size of 0.25, a type I error rate of 0.05, test power of 0.95, and six groups. The resulting estimate indicated that a sample size of 72 participants would be sufficient. However, to increase the validity of the results, the sample size was increased to 103 participants, which was eventually reduced to 100 due to the withdrawal of three individuals.

Sample selection instruments included the Internet Addiction Questionnaire (IAQ), Jackson's Revised Reinforcement Sensitivity Questionnaire (r-RSQ), and Goldberg and Hiller's General Health Questionnaire (GHQ), which were distributed to 630 female second secondary school students at Shahid Maraf Art School and Shahid Natiq Nouri High School in Islamshahr, Iran.

Once the data were collected, participants whose scores on the IAQ were one standard deviation above the mean were considered for the first sample. This group included 302 individuals. Next, the r-RST scores of the remaining 302 participants were assessed. Participants whose scores on the behavioral activation system (BAS), behavioral inhibition system (BIS), and fight-flight-freeze system (FFFS) factors of the r-RST were one standard deviation above the mean were selected. This reduced the number of eligible participants to 186. In the final phase, the GHQ scores of the remaining participants were analyzed. The participants who scored above 40 were selected as the final sample. Thus, 81 participants (whose score was <40 on the GHQ) were eliminated from the study, leaving the final number of participants at 105.

It is worth mentioning that at the end of the selection process, the BIS, BAS, and FFFS groups consisted of 34, 33, and 38 students, respectively.

According to the field of study and level of education, 17 participants from the BIS group and 17 others were placed in the first and second groups, respectively. Similarly, 16 participants from the BAS group were assigned into the first group, while 15 were allocated to the second group. Of the FFFS participants, 19 were in the first group and 19 were in the second group. The first group was subsequently designated as the control group, while the second group was designated as the experimental group.

Before the independent variable was introduced, two participants from the BIS group and one from the FFFS group in the experimental group expressed their disinterest in participating in the study. Thus, the experimental group consisted of 15 BIS participants, 15 BAS participants, and 18 FFFS participants. In contrast, the control group consisted of 17 BIS participants, 16 BAS participants, and 19 FFFS participants. The training of the emotion regulation protocol was conducted in this constellation (Table 2).

Table 1: Experimental design of the research

Groups	Moderator variable (Brain-Behavior Systems)	Pretest	Variable Independent	Posttest	Follow-up
Experimental	(BAS)	O1	X	O2	O3
	(BIS)	O1	X	O2	O3
	(FFFS)	O1	X	O2	O3
Control	(BAS)	O1	-	O2	O3
	(BIS)	O1	-	O2	O3
	(FFFS)	O1	-	O2	O3

BIS: Behavioral Inhibition System; BAS: Behavioral Activation System; FFFS: Freeze-Fight-Flight System

Table 2: Emotional regulation training protocol

Session 1: Understanding the goals of the sessions	Purpose: Introducing themselves to the group members and establishing a mutual relationship between the group leader (psychologist) and the members. Tasks: Identifying, naming and labeling emotions, distinguishing between different emotions.
Session 2: Choosing the position	Purpose: Recognizing emotions in physical and psychological states. Tasks: Identifying emotionally provoking situations.
Session 3: Adjustment of position	Purpose: Understanding primary and secondary emotions Tasks: Identifying the emotions experienced by the group members in everyday relationships.
Session 4: Allocation of attention	Purpose: Drawing their attention to threatening cues or avoiding them. Tasks: Clarifying thoughts and painful experiences, identifying and recording disturbed emotions that cause rumination.
Session 5: Cognitive reappraisal	Purpose: Changing cognitive appraisals; the underlying assumption in this phase is that situations do not directly affect emotions and cognitive processes mediate the path between situations and emotions. Cognitive reappraisal is considered a strategy that focuses on antecedents. Tasks: Identify negative appraisals that affect emotions and positive reappraisals for emotional self-regulation.
Session 6: Adjustment of responses	Purpose: Changing the physiological-behavioral and experiential consequences of emotions after the emotions have been triggered. Tasks: Habituating to emotionally arousing stimuli and emotional change through cognitive reappraisal.
Session 7: Reappraisal and troubleshooting	Evaluating and applying the goal: reappraising and removing of obstacles, applying the learned skills in natural environments outside the session.

The exclusion criteria of the study included non-participation of the members of the experimental group and non-completion of the IAQ by the participants of both groups at the posttest and follow-up.

It is noteworthy that the samples were selected from two different schools, which meant that the emotion regulation protocol training was conducted in groups at both schools.

The training program took place over seven weeks, with each session lasting 90 minutes. The experimental group from Shahid Marafet Art School participated on days with odd numbers, while the experimental group from Shahid Natiq Nouri High School participated on days with even numbers.

Groups were classified based on the results of the Internet Addiction Test (IAT) and Jackson's r-RSQ. Participants' scores in this classification phase served as pretest results. After completion of the training course in the seventh session, the IAT and Jackson's questionnaire were administered to the participants promptly and again three months later. At the same time, the control group also completed the same questionnaire.

In this study, in addition to using descriptive statistics (central and dispersion indices), a complex mixed-design method was applied to test the research hypotheses. The reason for this approach is that in addition to the independent variable of emotion regulation protocol training, the brain-behavior systems variable was introduced as a moderating or secondary independent variable.

The data obtained from the study were first described using descriptive statistical indicators such as mean and standard deviation. Then, they were analyzed using inferential statistical tests of univariate analysis of covariance to examine the differences between the experimental and control groups in the posttest and follow-up phases. Furthermore, Mauchly's sphericity test and Bonferroni's post hoc tests were performed using SPSS version 26.

2.1. Instruments

Revised Reinforcement Sensitivity Theory (r-RST) Questionnaire: The r-RST questionnaire developed by Jackson is based on the revised version of Gray's Reinforcement Sensitivity Theory and includes 30 items (11). This instrument explores three brain-behavior systems, including the r-BAS, r-BIS, and r-FFFS. In total, the questionnaire includes five subscales, each containing six items. Responses are rated on a five-point Likert scale, with 1 indicating complete agreement and 5 indicating complete disagreement. The reliability of the questionnaire was calculated by Jackson using Cronbach's alpha for each system and yielded values of 0.89 for the r-BAS, 0.71 for the r-BIS, and 0.74 for the r-FFFS. Additionally, the Iranian version of this

scale was tested for validity using factor analysis, correlations between subscales, and criterion validity methods. The Persian version of Jackson's five-factor questionnaire showed good reliability, as evidenced by Cronbach's alphas ranging from 0.72 to 0.88, test-retest coefficients ranging from 0.64 to 0.78, and test-retest correlations ranging from 0.28 to 0.68 (12).

Internet Addiction Test (IAT): Young's IAT is a 20-item scale developed to measure Internet addiction and its impact on various aspects of users' lives (13). In this study, the Persian translation of Young's IAT developed by Alavi and colleagues (14) was used. Responses are scored on a selected 5-point Likert scale (5=always, 4=usually, 3=most of the time, 2=sometimes, and 1=seldom). The possible scores range from 20 to 100, and Internet users were divided into three groups based on their scores: typical users with scores between 20 and 49, at-risk users with scores between 50 and 79, and Internet users with scores between 80 and 100 who are addicted. Higher scores represent greater dependence on the Internet, potentially leading to addictive behavior. Furthermore, the validity of the questionnaire was confirmed by three experts using the Content Validity Index (0.84), and reliability was tested by a t-test (0.88). Cronbach's alpha showed a satisfactory value (0.87) in a sample of twenty medical students during a two-week data collection period.

2.2. Data Analysis

The present study applied several statistical tests to check the normality of the data distribution. The Box's M test was not statistically significant for the dependent variable (Box's M=23.14, P=0.053, f=1.74); thus, it did not confirm the assumption of homogeneity of the covariance matrices of the dependent variable. Additionally, the results of Mauchly's sphericity test revealed a nonsignificant chi-square value for Internet addiction (Mauchly's sphericity test=0.986, χ^2=0.63, P=0.729, f=1.74). Fisher's exact test, ANOVA, and repeated measures analysis were also utilized.

3. Results

The group consisted of 100 female students who possessed three different brain systems with specific behaviors: behavioral activation, behavioral inhibition, and the fight-flight-freeze system (FFFS). The mean age of the female students was 15.18±1.31 years in both the experimental and control groups. According to Table 3, there were 4 students in 10th grade, 5 in 11th grade, and 6 in 12th grade in the experimental group with the BAS. The control group included 6 students in 10th grade, 3 in 11th grade, and 7 in 12th grade, all with the BAS. In the FFFS experimental group, there were 6 participants in 10th grade, 5 in 11th grade, and 7 in 12th grade. The FFFS control group consisted of 6 participants in 10th grade, 8 in 11th grade, and 5 in 12th grade. According to Pearson's chi-square, there was no significant difference between the groups in terms of educational level.

Table 4 reveals that in all three groups, the mean scores for Internet addiction decrease more in the posttest and follow-up phases compared to the pretest phase. The mean and standard deviation of Internet addiction for emotion regulation training in the posttest phase were BIS (31.53±7.42), BAS (41.53±8.99), and FFFS (43.44±8.08), respectively. The results also indicated that the implementation of the cognitive emotion regulation training in all three groups (BIS, BAS, and FFFS) resulted in a decrease in the mean scores for Internet addiction during the posttest and follow-up phases compared with the pretest. However, the mean comparison

Table 3: Demographic characteristics of two experimental and control groups

	Demographic information	BIS		BAS		FFFS	
		Experimental	Control	Experimental	Control	Experimental	Control
Age	15 years old	5 (33.3%)	9 (52.9%)	3 (18.7%)	5 (31.2)	9 (50%)	6 (31.5%)
	16 years old	6 (40%)	6 (35.2%)	6 (37.5%)	7 (43.7%)	2 (11.11%)	5 (26.3%)
	17 years old	3 (20%)	2 (11.7%)	5 (31.2)	3 (18.7%)	4 (22.2%)	6 (31.5%)
	18 years old	1 (0.066%)	0 (0%)	2 (1.2%)	1 (6.25%)	3 (16.6%)	2 (10.5%)
		Fisher E=2.28; P=0.521		Fisher E=3.20; P=0.391		Fisher E=2.46; P=0.540	
Grade	Tenth	4 (26.66%)	8 (47%)	4 (26.66%)	6 (37.5%)	6 (33.3%)	6 (31.5%)
	Eleventh	8 (47%)	6 (35.2%)	5 (33.3%)	3 (18.7%)	5 (27.7%)	8 (42.1%)
	Twelfth	3 (20%)	3 (17.6%)	6 (40%)	7 (43.7%)	7 (38.8%)	5 (26.3%)
		Fisher E=1.55; P=0.476		Fisher E=0.99; P=0.735		Fisher E=1.04; P=0.653	

BIS: Behavioral Inhibition System; BAS: Behavioral Activation System; FFFS: Fight-Flight- Freeze System

Table 4: Mean and standard deviation (SD) of Internet addiction in the three groups

Variables	Phases	BIS	BAS	FFFS	P (between group)
		Mean±SD	Mean±SD	Mean±SD	
Internet Addiction	Pretest	75.27±9.52	71.07±8/81	72.78±8.28	0.432
	Posttest	31.53±7.42	41.53±8.99	43.44±8.08	0.002
	Follow-up	32.20±5.97	42.80±5.89	46.83±8.94	0.006
P (within group)		0.001	0.001	0.234	-

BIS: Behavioral Inhibition System; BAS: Behavioral Activation System; FFFS: Freeze-Fight-Flight System

between participants in the three behavior-brain system groups, including BIS (32.20±5.97), BAS (42.80±5.89), and FFFS (46.83±8.94) in the experimental group, demonstrated that the implementation of emotion regulation training resulted in a decrease in Internet addiction in all three behavior-brain system groups. Nevertheless, implementation of the independent variable resulted in a greater decrease in the mean score of Internet addiction in the BIS group compared to the other two brain-behavioral system groups.

4. Discussion

The aim of this study was to investigate the relationship between the effectiveness of emotion regulation training on Internet addiction and the moderating role of brain-behavior systems. Results of the current study indicated that emotion regulation training had a positive effect on reducing Internet addiction, a process that was modulated by brain-behavior systems. These findings are consistent with those of Eynypour and colleagues (15), Quaglieri and colleagues (16), Yan and co-workers (6), and Günaydın and colleagues (17), who have collectively demonstrated the effects of emotion regulation and brain-behavior systems on Internet addiction and related dependence.

In the study by Eynypour and colleagues, multivariate regression analysis revealed that brain-behavior systems were responsible for 66.7% of Internet addiction in students (15). Active avoidance and approach, as well as elements of the BAS were found to negatively predict Internet addiction. Conversely, passive avoidance and extinction, components of the behavioral inhibition system, and fight and flight from the fight/flight system were found to positively predict Internet addiction (15).

Similarly, Quaglieri and colleagues found significant correlations between Internet addiction (IA) and Brain-Behavior Systems (16). Finally, Günaydın and colleagues (17) discovered that difficulties in emotion regulation among adolescents and family attitudes toward Internet use were associated with problematic Internet use (17). The findings of the present study suggested that the mean scores of the activation system group and the inhibition system group had no significant differences, indicating that both are equally effective in reducing Internet addiction. Therefore, it can be inferred that both the activation system and the behavioral inhibition system may have a similar impact on reducing Internet addiction through the efficacy of emotion regulation training (6).

Emotion regulation training addresses the role of emotion and its importance in daily life. It also emphasizes the importance of emotional awareness. This understanding helps individuals struggling with Internet addiction gain more insight into their emotions and recognize their crucial role in emotion regulation in life. Consequently, this training leads to changes in the emotion regulation of students who are prone to Internet addiction. They gradually rely less on strategies such as suppression and blaming, which leads them to engage less in addictive behaviors such as Internet addiction.

It is plausible to argue that emotion regulation training, supported by the moderating role of behavioral activation and inhibition systems, can effectively reduce students' Internet addiction (10).

The results of univariate analysis of covariance on Internet addiction in the behavioral activation group and the control group revealed that emotion regulation training led to a decrease in Internet addiction. This finding is consistent with the results of Eynypour and colleagues (15), Quaglieri and colleagues (16), Yan and co-workers (6), and Günaydın and colleagues (17), who demonstrated the influence of emotion regulation and brain-behavior systems on Internet addiction and dependence.

It is important to note that BAS is associated with positive responses in humans (18). This system responds to conditioned reward stimuli and the absence of punishment. The increased activity and sensitivity of this system can produce positive emotions, a predisposition to certain behaviors, and active avoidance. This system is also known as the arousal system and plays a critical role in resolving goal conflict (19).

Since using the Internet and engaging with virtual spaces can be a positive motivational state, it can stimulate the behavioral activation system. Thus, the BAS may be related to Internet addiction and influenced by a person's emotions. Specifically, emotion regulation strategies may reduce sensitivity to conditioned reward cues (20). By teaching people about their positive and negative emotions and teaching them to accept and deal with these emotions effectively, emotion regulation training can improve their mental health. Emotion regulation training can therefore help students discard ineffective thoughts and strategies that lead to interpretations and judgments based on emotions and promote the identification and adoption of more adaptive beliefs and strategies in response to their emotions (21, 22).

Implementing these changes can increase psychological flexibility and facilitate acceptance of negative emotions. When students can recognize and adapt to these negative emotions, they are less likely to engage in addictive behaviors such as Internet addiction. Previous research has suggested that difficulties with emotion regulation are associated with high levels of Internet addiction. Difficulty with emotion regulation may positively impact ineffective coping strategies; ineffective coping may in turn increase levels of Internet addiction. Emotion regulation training has been shown to help reduce these difficulties in emotion regulation (1). Therefore, it is plausible that emotion regulation training helps to reduce Internet addiction by modulating the brain activation system.

4.1. Limitations

Certain limitations were noted in this study. The study focused on high school students from Islamshahr, Iran; therefore, the findings should be generalized only with caution. Future studies may provide more accurate results if this limitation is addressed. Factors such as fatigue, inattention, dishonesty, and haste may have affected control over test responses.

5. Conclusions

Implementing emotion regulation training in students improves awareness of emotional understanding and acceptance, identifies anxiety-provoking situations, adjusts emotional responses, and decreases the propensity for Internet addiction. Emotion regulation training raises awareness of how emotions influence arousal, avoidance of emotionally charged situations, and excessive Internet use. By understanding the role of emotions in the sensitivity of brain-behavior systems to rewards, punishments, and anxiety, students can learn emotional regulation strategies (including reappraisal, attention allocation, exposure, etc.). These strategies should help reduce the propensity for Internet addiction by adjusting emotional responses and regulating brain-behavior system arousal. Consequently, it seems plausible that emotion regulation training could have a lasting impact on reducing Internet addiction, facilitated by the modulatory role of the brain-behavior systems.

Ethical Approval

This article was approved by the Ethics Committee of Karaj University with the code IR.IAU.K.REC.1401.093. To comply with the ethical principles of the research, subjects were provided with the necessary information about the research. Subjects were assured that all their information would be kept confidential. Informed consent was obtained from all subjects. Finally, intensive interventions were conducted for the control group.

Authors' Contribution

FKh: Significant contributions to the design of the paper; acquisition, analysis, and interpretation of data for the work, drafting of the paper and critical review for important intellectual content. MBH: Significant contributions to the design of the paper; acquisition, analysis, and interpretation of data for the work, drafting of the paper and critical review for important intellectual content. FMSh: Substantial contributions to the conception of the work, drafting of the paper and critical

review for important intellectual content. ZR: Substantial contributions to the conception of the work, drafting of the paper and critical review for important intellectual content. MA: Substantial contributions to the conception of the work, drafting of the paper and critical review for important intellectual content. All authors have read and approved the final manuscript and agree to be accountable for all aspects of the work, such that the questions related to the accuracy or integrity of any part of the work.

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