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The impact of depression, anxiety, neuroticism, and severity of Internet addiction symptoms on the relationship between probable ADHD and severity of insomnia among young adults

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ABSTRACT

The aim of the present study was to evaluate the impact of depression, anxiety, neuroticism, and severity of Internet addiction symptoms (IAS) on the relationship between probable attention deficit/hyperactivity disorder (ADHD) and severity of insomnia among young adults. The study was conducted with online survey among 1010 volunteered university students in Ankara, people who are in the e-mail database of a company located in Istanbul that organizes e-sports tournaments and Turkish gamers from gaming forums. Scale scores were higher among the group with high probability of insomnia (n = 200, 19.8%). Also risk of high probability of insomnia was 2.7 times higher among those with probable ADHD. In linear regression analysis, both inattentiveness and hyperactivity/impulsivity dimensions of ADHD were related with the severity of insomnia, together with severities of anxiety, depression, neuroticism and IAS. Similarly, presence of probable ADHD was related with the severity of insomnia in ANCOVA, together with severities of anxiety, depression, neuroticism and IAS. These findings suggest that the presence of probable ADHD and the severity of ADHD symptoms are related with the severity of insomnia, even after controlling the depression, anxiety, neuroticism and IAS, which are all related with the severity of insomnia, among young adults.

1. Introduction

Attention deficit hyperactivity disorder (ADHD) is a childhood-onset pervasive condition that continues with some robustness into adulthood in up to 60% of patients and characterized by inattention (IN) and/or hyperactivity/impulsivity (HI) (Faraone et al., 2006; Kessler et al., 2007; Mannuzza et al., 1993). Over the past few decades, there has been increasing research and clinical interest in sleep problems associated with ADHD (Cortese et al., 2013). Although sleep disorders have been reported to affect more than half of adults with ADHD, the association between sleep and ADHD is poorly understood (Yoon et al., 2013). Nonetheless, the assessment and treatment of sleep problems in this population are crucial, as sleep disturbances may aggravate ADHD symptoms and contribute to the functional impairment of young adults and their families (Corkum et al., 2011). In addition, sleep disturbances may mimic in individuals referred for ADHD like symptoms or may exacerbate ADHD symptoms (Corkum et al., 2011).

While the use of Internet is wide and increasing, the psychological problems related to maladaptive Internet use has been frequently reported in the literature, especially among young people (Mazhari, 2012). Although it is still a controversial term and it was not included in the Diagnostic and Statistical Manual of Mental Disorders: Fifth Edition (DSM-5) (American Psychiatric Association, 2013), this phenomenon has been frequently called as Internet addiction (IA), which can be defined as excessive, uncontrolled and harmful use of the Internet (Dalbudak et al., 2013). The previous studies indicated that the rates of IA among adolescents and young people ranged from 2.4% to 37.9% in Asia, ranged between 3.1% to 18.3% in Europe (Durkee et al., 2012) and ranged between 7.2% (Dalbudak et al., 2013) and 12.26% (Kayri and Gunuc, 2009) among Turkish university students. Yoo et al. (2004) suggested that the children with ADHD had higher IA scores compared with the non-ADHD group. In a systematic review,

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Carli et al. (2012) have reported that symptoms of ADHD appeared to have the most significant and consistent correlation with IA. In the previous studies conducted among the Turkish university students, the severity of ADHD symptoms has predicted the severity of IA symptoms (IAS) even after controlling the effect of personality traits, depression and anxiety symptoms (Dalbudak and Evren, 2014) or sensation seeking (Dalbudak et al., 2015). Reviews suggested that there is a relationship between IA and ADHD, depression, anxiety (Carli et al., 2012; Ko et al., 2012) and last but not least insomnia (An et al., 2014; Kim et al., 2010). Insomnia is a highly prevalent condition, with about one third of the adult population reporting difficulties initiating or maintaining sleep and 10% also reporting significant daytime impairments (Ancoli-Israel and Roth, 1999; Morin et al., 2006; Ohayon, 2002). Significant correlations were found between potential IA and insomnia in university students (Younes et al., 2016). Also a systematic review suggested that IA was associated with sleep problems like subjective insomnia (Lam, 2014). Finally, a recent study conducted among Japanese young adults suggested that having poor sleep quality, ADHD tendencies, depression, and anxiety tendencies increased the risk of IA (Kitazawa et al., 2018).

Students who spend greater time in internet are more likely to develop depressive symptoms (Ko et al., 2014). On the other hand, students with IA have higher chance of experiencing insomnia (Chen and Gau, 2016) and these students with insomnia are more likely to develop depressive symptoms (Roane and Taylor, 2008). Consistent with this, studies conducted among Hong Kong Chinese adolescents (Cheung and Wong, 2011) and undergraduate students in Nepal (Bhandari et al., 2017) suggested that the IA and insomnia both mediated a significant proportion of the indirect effect on depressive symptoms. Finally, personality trait of neuroticism predicted IA (Dalbudak et al., 2013; Dong et al., 2013; Yan et al., 2014) among university students, even after controlling the negative affect such as depression and anxiety symptoms (Dalbudak et al., 2013). Also, results of the previous research, both that used clinical samples (Gray and Watson, 2002; Mastin et al., 2005) and non-clinical samples (Duggan et al., 2014), showed that high neuroticism was associated with severity of insomnia. Thus it is important to evaluate IAS, neuroticism and negative affect such as depression and anxiety, while examining the relationship between probable ADHD and severity of insomnia.

Although there are some studies that evaluated the relationship between ADHD and severity of insomnia, this is the first study to control other variables that are related with insomnia such as IAS, neuroticism, depression and anxiety while evaluating this relationship. We hypothesized that the presence of probable ADHD may still be related with severity of insomnia even after controlling these variables.

2. Method

2.1. Participants and procedure

An online survey using a cross-sectional design was conducted with Turkish university students in Ankara, people who were in the e-mail database of a company located in Istanbul that organizes e-sports tournaments (ESL Turkey Amateur e-sport players), and Turkish gamers from gaming forums.

The study protocol was approval by the Ethical Committee of the Cankaya University. After reading the Plain Language Information Statement, informed consent was obtained from all participants. All participants filled out an online survey that was anonymous and confidential. Furthermore, participants were not penalized for discontinuation or not participation. Overall, the data collection stage spanned from December 2017 to January 2018.

A total of 1507 potential participants initiated the online survey and they all gave informed consent (Evren et al., 2018). Among these, 257 participants did not fill any of the scales, thus a total of 1250 participants were included in the previous study since they filled the scales that were necessary for the previous study (Evren et al., 2018). This previous study was the psychometric validation study of the Turkish nine-item Internet Gaming Disorder Scale–Short Form (IGDS9-SF) (Evren et al., 2018) and did not include the results of the present study. Among these 1250 participants included in the previous study, 240 participants did not complete the rest of the survey, which were essential for the present study, thus they were removed from the study and total of 1010 participants were included.

2.2. Measures

2.2.1. Insomnia severity index (ISI)

This 7-item, validated, self-report questionnaire evaluates individual insomnia symptoms and the associated impairment or distress caused by the insomnia symptoms (Bastien et al., 2001). The Turkish version of the scale was reliable and valid (Boysan et al., 2010). These items include the following: 1) Difficulty Falling Asleep (DFA), 2) Difficulty Staying Asleep (DSA), 3) Early Morning Awakening (EMA), 4) Satisfaction/dissatisfaction with current sleep pattern (Satisfaction), 5) How noticeable to others do you think your sleep problem is in terms of impairing the quality of your life (Noticeable), 6) How worried/distressed are you about your current sleep problem (Distressed), 7) To what extent do you consider your sleep problem to interfere with your daily functioning (e.g., daytime fatigue, mood, ability to function at work/daily chores, concentration, memory, mood, etc.) currently (Interferes)? Each item was evaluated on a Likert scale with a range from 0–4, from “none” to “very severe” (for items 1–3), from “very satisfied” to “very dissatisfied” for item 4, and “not at all” to “very much” (for items 5–7). The ISI yields a total score of 0–28. The total score was interpreted as follows: absence of insomnia (0–7); sub-clinical or mild insomnia (8–14); moderate insomnia (15–21); and severe insomnia (22–28). Furthermore, clinically significant insomnia was detected when the total score was >14 (Gagnon et al., 2013). Cronbach's alpha for the ISI in this sample was 0.82.

2.2.2. Young's Internet Addiction Test - Short Form (YIAT-SF)

The YIAT-SF (Pawlikowski et al., 2013), which includes a total of 12 items measured on a five-point scale (1) *never* to (5) *very frequent,* was used to investigate the symptoms of Internet addiction. Confirmatory factor analysis revealed that the Turkish YIAT-SF resulted in an acceptable model fit (χ^2 = 173.58, sd = 53, CFI = 0.95, SRMR = 0.064 and RMSEA = 0.079). The internal consistency reliability coefficient of the scale was 0.85. The Turkish version of the YIAT-SF has been shown to be reliable and valid for both university students and adolescents (Kutlu et al., 2015). In the present study, the Cronbach's alpha of the YIAT-SF was 0.88.

2.2.3. Adult ADHD self-report scales (ASRS-v1.1)

ADHD symptoms were measured with the ASRS (Kessler et al., 2005a, 2005b), an 18-item scale based on the DSM-IV-TR criteria (American Psychiatric Association, 2000). As a self-report scale ASRS was found to be reliable and valid scale for evaluating ADHD for adults and shows a high Cronbach's α coefficient and high concurrent validity with the rater-administered measure (Adler et al., 2006). It should be noted that for the purposes of their study, Kessler et al. (2005a) administered the measure to a general population and not specifically to individuals who reported having symptoms of ADHD.

Developed under the auspices of the World Health Organization, ASRS is also a short six-item screening instrument, the questions in which were extracted, using stepwise logistic regression, from a larger survey of 18 questions comprising the Adult Self-Report Survey that taps the 18 specific “Criterion A” symptoms defining the disorder in DSM-IV. The ASRS 6-item screen was developed for community based studies and exhibits strong concordance with clinician diagnoses as well as sound psychometric properties (Kessler et al., 2006). The 5-point Likert-type scale ranges from “0” (never) to “4” (very often). Thus, the

Table 1
Comparing age, gender and scale scores according to the presence of probable insomnia, which was detected when the total score of the Insomnia Severity Index was >14.

	Probable insomnia Absent n = 810, 80.2% Mean	S.D.	Present n = 200, 19.8% Mean	S.D.	t	p
Age	21.93	3.50	21.51	2.88	1.594	0.111
Gender (n, %)					$\chi 2$ = 2.104	0.147
▓Females	477	58.9	129	64.5		
▓Males	333	41.1	71	35.5		
Anxiety	11.65	10.38	21.47	13.23	−9.776	<0.001
Depression	33.89	9.63	42.91	11.39	−10.339	<0.001
Neuroticism	3.10	1.78	4.18	1.59	−7.847	<0.001
Internet addiction severity	26.48	8.23	31.71	9.38	−7.817	<0.001
Probable ADHD*	124	15.3	66	33.0	$\chi 2$ = 32.869	<0.001
ASRS	27.20	9.76	34.56	10.30	−9.449	<0.001
▓**Inattentiveness**	13.82	5.71	17.62	6.28	−8.248	<0.001
▓**Hyperactivity/impulsivity**	13.38	5.37	16.95	5.48	−8.382	<0.001

*Odds Ratio (95% Confidence interval) = 2.725 (1.918–3.872); ADHD: attention deficit/hyperactivity disorder; ASRS: the Adult ADHD self-report scale.

possible range of scores on the ASRS screening six-item version is 0–24, with higher scores indicating more ADHD symptomology. Each response of sometimes or greater (2 or more) on screening items 1–3 equated to 1 point; each response often or greater (3 or more) on screening items 4–6 resulted in a point. A total score of 4 or more indicated probable ADHD. We therefore used this recommended definition to identify highly likely ADHD cases in our sample and named as "probable ADHD". Previous data suggest that this approach is widely used and the 6-item screening version has been shown to outperform the full 18-item version in sensitivity (68.7% v. 56.3%) and specificity (99.5% v. 98.3%) in American general population (Chamberlain et al., 2017; Kessler et al., 2005b, 2006). Containing six diagnostic symptoms, it takes only a few minutes to complete ASRS and therefore is ideal for screening procedures. Nevertheless, the result of the test does not replace a clinical diagnosis and the clinician must take false positives into consideration by evaluating the ASRS positives with gold standard scales. The ASRS was validated in Turkish in a sample of university students previously (Dogan et al., 2009). Cronbach's α coefficients were found to be 0.83 for 'inattention', 0.77 for 'hyperactivity/impulsivity' and 0.87 for ASRS in the present study. In the present study for evaluation of ADHD symptom severity 18 item version and for evaluation of probable ADHD six-item version of the scale were used.

2.2.4. Eysenck personality questionnaire revised abbreviated form (EPQRA)

The EPQR-A includes 24 items in four personality traits: "neuroticism/stability" trait was used to assess the stability of emotion; "extraversion/introversion" trait was used to assess the tendency of extraversion and introversion; "psychoticism/socialization" trait was used to assess the subjects' psychiatric characteristics and "lie" trait was used as the validity scale (Francis et al., 1992). The reliability and validity of the questionnaire were supported in a Turkish university student sample (Karancı et al., 2007). In the present study only neuroticism trait were used, according to the purpose of the study. Kuder–Richardson alpha coefficient for the neuroticism trait was 0.65, and the test–retest reliability of the trait was 0.82, for Turkish version (Karancı et al., 2007). Cronbach's α coefficient was found to be 0.67 for the neuroticism trait in the present study.

2.2.5. Beck depression inventory (BDI)–Beck anxiety inventory (BAI)

Symptoms and severity of depression were evaluated by using the Beck depression inventory (BDI) (Beck et al., 1961), Turkish version (Hisli, 1989), and symptoms and severity of anxiety were evaluated by the Beck anxiety inventory (BAI) (Beck et al., 1988), Turkish version (Ulusoy et al., 1998). Both scales have been validated on Turkish populations. Cronbach's alphas were 0.90 for BDI and 0.93 for BAI in the present study.

2.3. Data analysis

The statistical package SPSS 17.0 for Windows (SPSS, 278 Chicago, IL) was used for all the analyses. Student t test was used to compare groups according to the current age and scale scores. Categorical sociodemographic variable of gender and clinical variable of probable ADHD were compared by means of the $\chi 2$ statistics. Using the severity of insomnia as dependent variable and severities of depression, anxiety, neuroticism, IA symptoms and ADHD as independent variables, the hierarchical multiple linear regression model was performed. Also taking severity of insomnia as dependent variable, probable ADHD as a fixed factor and severities of depression, anxiety, neuroticism and the IA symptoms as covariates ANCOVA analysis was conducted. For all statistical analysis, p values were two-tailed, and differences were considered significant at $p < 0.05$.

3. Results

Age and gender did not differ between the group with probable insomnia (n = 200, 19.8%) and the group without probable insomnia (n = 810, 80.2%). Anxiety, depression, neuroticism, IAS and ADHD scores were higher among the group with probable insomnia. The risk of probable ADHD was 2.73 times higher among those with probable insomnia (Table 1). In linear regression analysis, the severity of insomnia was related with the severity of both IN and HI dimensions of ADHD, severities of anxiety, depression, neuroticism and IAS (Table 2). Similarly, the severity of insomnia was related with the presence of probable ADHD, severities of anxiety, depression, neuroticism and IAS (Table 3).

4. Discussion

The main findings of the present study are that the presence of probable ADHD (also severity of both IN and HI symptom dimensions of ADHD) is still related with the severity of insomnia, even after controlling severities of IA symptoms, neuroticism and negative affect such as depression and anxiety. Insomnia which is common among children with ADHD (Cortese et al., 2009) is also estimated among more than 70–80% of adults diagnosed with ADHD (Weibel et al., 2017; Yoon et al., 2013). Adult ADHD patients have trouble falling asleep (Baird et al., 2012; Boonstra et al., 2007; Schredl et al., 2007) and a disrupted sleep maintenance (Bijlenga et al., 2013; Schredl et al., 2007; Sobanski et al., 2008; Surman et al., 2009), and find it hard to wake up in the mornings (Boonstra et al., 2007; Surman et al., 2009). Comorbidities

Table 2
Stepwise linear regression analyses with severity of insomnia as a dependent variable and severities of depression, anxiety, neuroticism, Internet addiction symptoms and attention deficit hyperactivity disorder (ADHD) symptoms as independent variables.

		Unstandardized coefficients		Standardized coefficients	*t*	*p*
		B	Std. error	*Beta*		
Step 1	**Anxiety**	0.092	0.017	0.195	5.403	<0.001
	Depression	0.130	0.020	0.250	6.523	<0.001
	Neuroticism	0.417	0.102	0.135	4.110	<0.001
Step 2	**Anxiety**	0.088	0.017	0.185	5.203	<0.001
	Depression	0.113	0.020	0.217	5.687	<0.001
	Neuroticism	0.343	0.101	0.111	3.395	0.001
	Internet addiction	0.102	0.018	0.160	5.542	<0.001
Step 3a	**Anxiety**	0.071	0.017	0.151	4.234	<0.001
	Depression	0.104	0.020	0.200	5.312	<0.001
	Neuroticism	0.272	0.100	0.088	2.717	0.007
	Internet addiction	0.068	0.019	0.107	3.553	<0.001
	ASRS total score	0.096	0.017	0.179	5.681	<0.001
Step 3b	**Anxiety**	0.072	0.017	0.151	4.228	<0.001
	Depression	0.104	0.020	0.200	5.300	<0.001
	Neuroticism	0.272	0.100	0.088	2.715	0.007
	Internet addiction	0.068	0.019	0.107	3.551	<0.001
	Inattentiveness	0.097	0.031	0.106	3.098	0.002
	Hyperactivity/impulsivity	0.095	0.034	0.095	2.811	0.005

ASRS: Adult ADHD self-report scale. Variables entered in the first step: depression, anxiety and neuroticism. Step 1: $F = 105.603$, df = 3, 1006, $p < 0.001$, Adjusted $R^2 = 0.237$; Variables entered in the Step 2: depression, anxiety, neuroticism and Internet addiction symptoms. Step 2: $F = 89.218$, df = 4, 1005, $p < 0.001$, Adjusted $R^2 = 0.259$, R^2 Change = 0.023; Variables entered in the Step 3a: depression, anxiety, neuroticism, Internet addiction symptoms and attention deficit hyperactivity disorder (ADHD) symptoms. Step 3a: $F = 80.049$, df = 5, 1004, $p < 0.001$, Adjusted $R^2 = 0.281$, R^2 Change = 0.023; Variables entered in the Step 3b: depression, anxiety, neuroticism, Internet addiction symptoms and dimensions of ADHD (inattentiveness and hyperactivity/impulsivity) instead of total ASRS score. Step 3b: $F = 66.642$, df = 6, 1003, $p < 0.001$, Adjusted $R^2 = 0.281$, R^2 Change = 0.023.

Table 3
ANCOVA analysis with severity of insomnia as dependent variable, probable attention deficit hyperactivity disorder (ADHD) as a fixed factor and severity of depression, anxiety, neuroticism and Internet addiction as covariates.

Source	Type III Sum of squares	df	Mean square	*F*	*p*
Covariates					
Anxiety	602.062	1	602.062	26.664	<0.001
Depression	657.523	1	657.523	29.120	<0.001
Neuroticism	252.445	1	252.445	11.180	0.001
Internet addiction	563.401	1	563.401	24.952	<0.001
Fixed factor					
Probable ADHD	148.756	1	148.756	6.588	0.01

a. $R^2 = 0.267$ (Adjusted $R^2 = 0.263$).

are particularly frequent in adult ADHD, since they affect more than 80% of sufferers, and are associated with increased depression and anxiety (Bernardi et al., 2012; Cumyn et al., 2009; Kessler et al., 2006). Consistent with this, it has also been suggested that among those with adult ADHD, insomnia also, in part, the consequence of psychological disturbances, such as anxiety, depression (Weibel et al., 2017) and neuroticism personality trait score (Duggan et al., 2014; Gray and Watson, 2002; Mastin et al., 2005). In a previous study even when controlling for depression, ADHD sufferers showed higher sleep latency, and authors suggested that sleep-related symptoms associated with ADHD were partly explained by non-specific factors, especially depression and anxiety symptoms (Weibel et al., 2017).

Negative affect such as anxiety and depression may cause insomnia (Weibel et al., 2017). On the other hand, neurotic people, who have low activation thresholds, can become easily nervous or upset and cannot control themselves during stress, which may result as insomnia (Duggan et al., 2014; Gray and Watson, 2002; Mastin et al., 2005). Well known association of ADHD with insomnia (Baird et al., 2012; Bijlenga et al., 2013; Boonstra et al., 2007; Schredl et al., 2007; Sobanski et al., 2008; Surman et al., 2009; Yoon et al., 2013) may be indirectly through common comorbidity of negative affect (Bernardi et al., 2012; Cumyn et al., 2009; Kessler et al., 2006; Weibel et al., 2017). Internet use may be a way of coping with these negative feelings. Consistent with these, Internet is characterized by rapid response, immediate reward and multiple windows with different activities, which may reduce the feelings of boredom or aversion to delayed reward in students with symptoms of ADHD. Internet can also provide an unreal life for these students, in which they can go into artificial lives or live out their fantasies without inhibition, which may be relief for those with high neuroticism, depression or anxiety. Lack of self-control may make it difficult for these students to control their Internet use, making them vulnerable to IA (Dalbudak and Evren, 2014; Dalbudak et al., 2015). Indeed, consistent with this, previous studies suggested that the severity of depressive and anxiety symptoms (Carli et al., 2012; Dalbudak and Evren, 2014; Ko et al., 2012), neuroticism personality trait score (Dalbudak et al., 2013; Dalbudak and Evren, 2014; Dong et al., 2013; Yan et al., 2014), and both the severity of ADHD symptoms (Dalbudak et al., 2015; Yen et al., 2009; Yoo et al., 2004) and the presence of ADHD diagnosis (Dalbudak and Evren, 2014; Ha et al., 2006; Bernardi and Pallanti, 2009) were related with the severity of IA. Finally, previous studies also suggested that those with high risk of IA have higher chance of experiencing insomnia (An et al., 2014; Chen and Gau, 2016; Kim et al., 2010; Lam, 2014; Younes et al., 2016). Thus, IA, which may be way of coping for variables related with insomnia may also cause insomnia itself. Findings of the present study are consistent with these previous findings. One of the reasons for this may be that young adults mostly use the internet in bed and this may negatively impacts their sleeping (Yoshimura et al., 2016). In addition, based on recent studies on melatonin, the blue light emitted from a display such as a laptop or smartphone may play some role in sleep disturbance by altering melatonin (Chang et al., 2015). Nevertheless, those spending greater time in the Internet are more likely to develop depressive symptoms (Cheung and Wong, 2011; Bhandari et al., 2017; Kitazawa et al., 2018) or students with insomnia are more likely to develop depressive symptoms (Bhandari et al., 2017; Cheung and Wong, 2011; Roane and Taylor, 2008). Thus, cross-sectional design of the present study makes it impossible to say anything about the direction of the causal relationship between variables of interest.

There are several limitations that should be noted. First of all, university students who participated were non-clinical samples. Secondly, although all the scales used in the present study were

validated in Turkish, since they are self-rating screening scales, they may only indicate the individuals with a high probability of ADHD or insomnia, rather than the diagnosis. Thus, actually we evaluated the probable ADHD rather than the diagnosis of ADHD, and we did not evaluate if the participants actually diagnosed with ADHD previously or using pharmacotherapy for ADHD, which may also be related with the insomnia. Thirdly, ADHD may also be related with sleep disturbances other than insomnia, which we did not evaluate. Fourthly, since this study is cross-sectional the findings of this study cannot address the causal relationships among the primary constructs of interest. Nevertheless, this is the first study to evaluate the relationship between severity of insomnia with probable ADHD, while controlling other variables such as IA symptoms, neuroticism personality trait, depression and anxiety.

To conclude, the present study showed that the presence of probable ADHD (and the severity of ADHD symptoms) has predicted the severity of insomnia even after controlling the effect of the severity of IA symptoms, neuroticism personality trait, depression and anxiety symptoms among Turkish young adults. Thus, these variables must be taken as potential risk factors for insomnia in this group. The present study may suggest that to better understand the problem of insomnia among university students, additional to probable ADHD, which is an important factor, clinicians must also carefully evaluate symptoms of IA, anxiety, depression and neuroticism personality trait. Finally, the generalizability of the findings of the present study to the homogeneous populations of patients with ADHD requires further study.

Conflict of interest

None to declare.

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