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The validation of Implicit Association Test measures for smartphone and Internet addiction in at-risk children and adolescents

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Background: Potential concerns are increasing that smartphone and Internet addictions may have deleterious effects on the mental health. Despite the recognition of the important role that implicit associations may have over explicit processes in addiction, such implicit associations have not been comprehensively investigated with respect to Internet addiction. Therefore, we modified the Implicit Association Test (IAT) for smartphone and Internet addictions and investigated its validity in children and adolescents. *Methods:* In this experimental study, 78 at-risk children and adolescents ranging in age from 7 to 17 years completed an IAT modified with pictures captured from the most popular Internet games among youth. Furthermore, measures of Internet and smartphone addictions, mental health and problem behaviors, impulsive tendencies, self-esteem, daily stress, and quality of life were assessed simultaneously. *Results:* Significant correlations were found between IAT D2SD scores and standardized scales for Internet ($r = .28$, $p < .05$) and smartphone ($r = .33$, $p < .01$) addictions. There were no significant correlations between IAT parameters and other scales measuring the constructs that are less relevant to the features of addiction, such as daily stress levels, impulsivity, and quality of life. Multiple regression analysis revealed that the IAT D2SD was independently and positively associated with smartphone addiction ($p = .03$) after controlling for other clinical correlates. *Conclusions:* This study demonstrated good convergent and discriminant validity of this IAT as a novel measurement relating to Internet and smartphone addictions. Further longitudinal and prospective studies are needed to evaluate its potential utility in clinical and community settings.

Keywords: implicit association, Internet addiction, smartphone addiction, adolescent

INTRODUCTION

During the past several decades, there have been substantial increases in the types and patterns of Internet use. While the Internet affords several benefits, poor control over Internet use may lead to academic problems, family discord, and depressed mood (Christakis, 2010; Kubey, Lavin, & Barrows, 2001; Park, Hong, Park, Ha, & Yoo, 2013). This phenomenon may be conceptualized as Internet addiction and classified as a behavioral addiction (Holden, 2001), although some groups have argued that the specific behavior conducted on the Internet (e.g., gaming) should be the focus of the disorder (Petry et al., 2014). Although Internet addiction has been reported in both Eastern and Western populations (Cao & Su, 2007; Durkee et al., 2016; Heo, Oh, Subramanian, Kim, & Kawachi, 2014), the prevalence of Internet addiction is particularly high in Eastern Asia including South Korea. The prevalence of Internet addiction is higher in teenagers than in other age groups and has steadily increased from 10.4% in 2011 to 12.5% in 2014 among Korean adolescents (Korean National Information Society Agency, 2015). This phenomenon may relate to South Korea having the highest rate of smartphone ownership worldwide (Lee et al., 2016), and smartphones afford convenient Internet access. Considering that the typical onset of behavioral addiction may occur in adolescence and follow a chronic course with remissions and

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exacerbations, Internet addiction is becoming a major concern in adolescents.

Behavioral addictions bear a resemblance to substance addiction in terms of natural history, phenomenology, and neurobiology (Banz, Yip, Yau, & Potenza, 2016; Hammond, Mayes, & Potenza, 2014; McGue & Iacono, 2005). Behavioral addictions are characterized by maladaptive, repetitive behaviors, and they share considerable phenomenological parallels with substance addictions (Banz et al., 2016; Potenza, 2001). A growing body of evidence supports that problematic Internet use should be conceptualized as a behavioral addiction (Chamberlain et al., 2016; Spada, 2014). For example, Internet gaming disorder, as identified in Section III of the fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5; American Psychiatric Association, 2013), is the next most likely candidate after gambling disorder to become a formally recognized behavioral addiction, in line with the proposed inclusion of gambling and gaming disorders in ICD-11 (World Health Organization, 2017) as "Disorders Due to Addictive Behaviors." Thus, poorly controlled Internet use may share mechanisms of underlying impaired control over gambling or substance use.

Dual-process models of addiction (Wiers & Stacy, 2006) suggest that two different systems may control addictive behaviors: (a) an automatic (or implicit) system component comprised memory associations that are prompted relatively spontaneously by motivational and situational circumstances; and (b) a controlled (or explicit) system comprised cognitions amenable to introspection and deliberate decision-making processes. With respect to addictive behaviors, the controlled system may be overridden by the automatic system. In the context of Internet addiction, such models could explain why individuals continue overusing Internet despite the awareness that it may cause or exacerbate negative consequences. The model suggests that implicit cognitions may also contribute to poor control over Internet use and thus should be evaluated.

It has been proposed that automatic processes contribute importantly to the development and maintenance of addictions (Robinson & Berridge, 2003; Wiers, Rinck, Kordts, Houben, & Strack, 2010). Data suggest that processes of implicit cognitions, and especially implicit associations, may reliably predict substance use (Rooke, Hine, & Thorsteinsson, 2008). Hence, it is important to understand the automatic processes that contribute to addictive behaviors. The Implicit Association Test (IAT; Greenwald, McGhee, & Schwartz, 1998) interrogates implicit cognitions and has been used to investigate substance addictions (Rooke et al., 2008). Regarding behavioral addictions, implicit associations assessed by IAT have been connected with problematic gambling (Brevers et al., 2013; Yi & Kanetkar, 2011) and cybersex addiction (Snagowski, Wegmann, Pekal, Laier, & Brand, 2015). Despite studies implicating automatic processes in addiction, questions regarding the validity of different types of IATs have been raised (De Houwer, Heider, Spruyt, Roets, & Hughes, 2015; Tibboel, De Houwer, Dirix, & Spruyt, 2017). Although one IAT study showed some relations with Internet gaming addiction (Yen et al., 2011), the validity of the IAT was limited due to the lack of associations with addiction-related variables.

This study describes the development and validation of the IAT – measures for smartphone and Internet addiction (IAT-SI) for use in teenagers. The IAT-SI was developed to measure the implicit associations between positive emotions and Internet-game-related pictures. We examined the IAT-SI's convergent and discriminant validity. Furthermore, we examined whether the positive implicit associations persisted after controlling for other addiction-related variables. Based on prior studies in the fields of substance and behavioral addictions, we hypothesized that scores on the IAT-SI would show convergent validity with Internet and smartphone addiction measures and divergent validity with psychiatric assessments [e.g., of attention-deficit/hyperactivity disorder (ADHD)] and other measures less closely linked to Internet use (e.g., self-esteem and quality of life). We also hypothesized that youth at high-risk for smartphone addiction as compared with those at low risk would show greater IAT-SI scores and would differ on multiple Internet-related, psychiatric, and other measures including self-esteem and quality of life. Finally, we hypothesized that IAT-SI scores would be related to measures of Internet or smartphone addiction after controlling for other measures.

MATERIALS AND METHODS

Participants

We screened children with Internet addiction and/or smartphone overuse who visited the Clinic I-CURE Center (Uijeonbu St. Mary's Hospital/Nowon Eulji Hospital/SMG-SNU Boramae Medical center) located in a metropolitan area of South Korea. The Clinic I-CURE Center is a hospital-based research center, which obtains data on Internet and/or smartphone overuse in children aged 7–18 years. All children were screened using self-report forms of Korean scale for Internet addiction and two different smartphone addiction-related scales and Internet Addiction Proneness Scale for children and adolescents checked by their caregivers. Participants should score higher than cut-off value at least one of these screening tools (cut-off scores are shown in Supplementary Table 1, link: www.akademiai.com/doi/suppl/10.1556/2006.7.2018.02). We screened 85 children from August 2015 to 2016 and 81 who met screening criteria enrolled in this project (80% boys). Among them, IAT data of 78 students ranging in age from 7 to 17 were available for this study.

MEASURES

IAT

In this, the IAT (Greenwald et al., 1998) was modified with Internet-game-related pictures to generate the IAT-SI. The reason why Internet-game-related pictures were used is that Internet gaming is a primary form of Internet use (aside from academic purposes) among Korean adolescents (Heo et al., 2014). The IAT-SI was administered in computerized form using Inquisit 4.0 Millisecond Software (2014). During the IAT-SI, participants were instructed to categorize picture

Table 1. Demographic and psychological characteristics of the participants ($n = 78$)

Variables	Mean (*N*)		*SD* (%)
Sex			
Male	61		78.2
Female	17		21.8
Age (years)	12.75	±	2.50
IAT-SI D_{2SD}	0.03	±	0.66
K total (Internet addiction)	75.03	±	17.18
K_D (disturbance of adaptive functions)	17.88	±	5.01
K_W (withdrawal)	11.23	±	3.69
K_T (tolerance)	11.62	±	3.37
SAS-SV total (smartphone addiction)	30.85	±	11.56
CASS-S	23.14	±	9.97
DHQ	67.95	±	18.17
K-ARS	15.83	±	10.51
RSES	27.52	±	5.79
BIS	55.98	±	9.20
AQ	63.66	±	16.42
PQL	1,809.38	±	387.67

Note. Values are the mean ± standard deviation or *n* (%). K-scale: Korean Scale for Internet Addiction for adolescents; SAS-SV: Smartphone Addiction Scale – short form version; CASS-S: Conners–Wells' Adolescent Self-Report Scale – short form; DHQ: Daily Hassles Questionnaire; K-ARS: Korean ADHD Rating Scale; RSES: Rosenberg Self-Esteem Scale; BIS-II: Barratt Impulsiveness Scale-II; PQL: Pediatric Quality of Life Inventory/ Generic Core Scale; AQ: Aggression Questionnaire.

stimuli as rapidly as possible according to target ("Internet game" vs. "furniture") and attribute ("positive" vs. "negative") concepts using two buttons on a standard keyboard. The dimensions of target and attribute concepts were then mixed in subsequent blocks, leading to compatible ("Internet game or positive" vs. "furniture or negative") and incompatible ("Internet game or negative" vs. "furniture or positive") pairings. Each of the two picture categories (i.e., Internet game and furniture) was represented by eight picture stimuli. For the target concept of "Internet game," Internet-game-related pictures were chosen from representative game screenshots from the top eight most popular Internet games in Korea for the past 5 years. For the second target concept of "furniture," eight different furniture pictures were obtained online using picture search engines and were matched to the Internet-game-related stimuli with respect to size and pixel. Two sets (positive and negative) of word stimuli were listed in Supplementary Table 2 (link: www.akademiai.com/doi/suppl/10.1556/2006.7.2018.02). Furthermore, in line with prior studies (Nosek, Greenwald, & Banaji, 2007), an IAT with seven rounds was implemented. The task order of compatible and incompatible blocks was counterbalanced to prevent order-specific effects (Greenwald et al., 1998). An overview of the whole procedure is presented in Figure 1 and schematics of the single response trial were presented in Figure 2.

Furthermore, the D_{2SD} score was used as primary outcome measurement for the IAT since this algorithm was recommended by Greenwald, Nosek, and Banaji (2003).

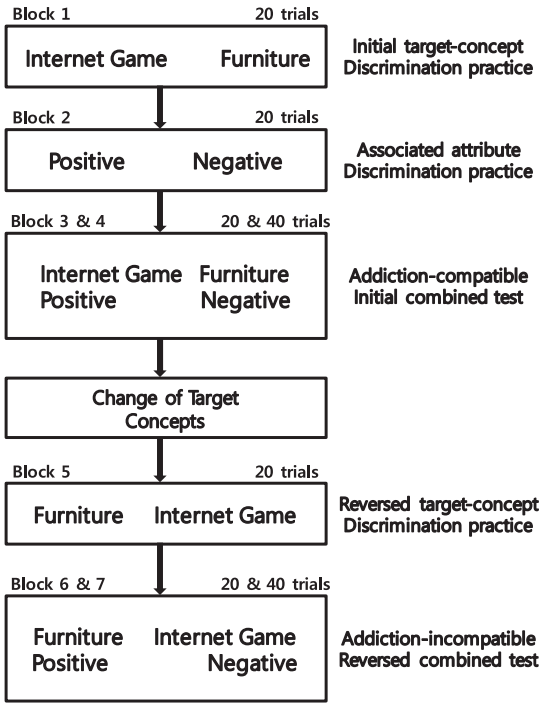

Figure 1. Sequence of blocks in the IAT-SI. Half of the participants received the blocks in the opposite order (incompatible and compatible) separated by a short break

The D_{2SD} outperformed other scoring algorithms in a representative study by Glashouwer (Glashouwer, Smulders, de Jong, Roefs, & Wiers, 2013). The D scores ranged from −2.00 to 2.00, with zero indicating no difference in average response latency between conditions. Higher D_{2SD} scores indicated stronger positive implicit associations with game-related pictures and positive values. The internal consistency of IAT-SI (calculated as in Greenwald et al., 2003) was $\alpha = 0.75$.

Internet and Smartphone Addiction Questionnaires

The Korean Scale for Internet Addiction for adolescents (K-scale; Korean National Information Society Agency, 2013) is the assessment scales for screening Internet addictive behavior. K-scale has 40 items, the responses to which are scored based on a 4-point Likert scale (ranging from 1: "not at all" to 4: "always"). It has three major factors: "disturbance of adaptive functions," "withdrawal," and "tolerance." K-scale scores are used to generate high-risk, potential-risk, and general user groups. Cronbach's α correlation coefficient for K-scale was .83. The Smartphone Addiction Scale – short form version (SAS-SV) has 10 items, the responses are scored based on a 6-point Likert scale (ranging from 1: "not at all" to 6: "it really is"). The score of each question was summed to obtain the total score of the SAS-SV, and scores higher than the cut-off value (31 for male subjects and 33 for female subjects) were considered high-risk users (Kwon, Kim, Cho, & Yang, 2013). Cronbach's α correlation coefficient for SAS-SV was .91. The Smartphone Addiction Proneness Scale (SAPS) for youth and adults is a measure of smartphone addiction. The SAPS has 15 items, the responses to which

Figure 2. Schematic examples of the single response trial of (a) addiction-incompatible block of the IAT with game-related pictures and (b) addiction-compatible the IAT with furniture pictures. All words with 2 or 3 characters in Korean

are scored based on a 4-point Likert scale (ranging from 1: "not at all" to 4: "it really is") (Korean National Information Society Agency, 2011). The Internet Addiction Proneness Scale for Children and Adolescents has 15 items, and it was administered to parents for corroborating the self-report K-scale. The proneness scale is scored based on a 4-point Likert scale (ranging from 1: "not at all" to 4: "it really is") and is used to define high-risk, potential-risk, and general user groups (Korean National Information Society Agency, 2011). The reliability test of the scale yielded a Cronbach's α of .880. In our analysis, the SAPS was excluded, because scores on the SAPS and SAS-SV overlapped in domains being assessed.

Other clinical measurements

To measure common psychiatric problems that may co-occur with Internet and smartphone addiction, we used scales measuring ADHD, impulsiveness, aggression, and stress. First, we used the Conners–Wells' Adolescent Self-Report Scale – short form (CASS-S), which is a self-report assessment tool for adolescents with ADHD in Korea (Bahn, Shin, Cho, & Hong, 2001). Cronbach's α for internal consistency was .88. We also used the parent version of the Korean ADHD Rating Scale-IV (K-ARS) (DuPaul et al., 1998) to evaluate ADHD symptoms; the K-ARS comprised 18 items reflecting the DSM-IV diagnostic criteria. The reliability (Cronbach's α values with .82–.89) and validity of the Korean version has been well-established (So, Noh, Kim, Ko, & Koh, 2002). The Barratt Impulsiveness Scale-II (BIS-II; Barratt & White, 1969) was used to assess impulsiveness and consists of 23 questions (Lee, 1992). Cronbach's α values were .81. The Aggression Questionnaire (AQ) consists of four subscales and has a total of 27 items. Two of the 29 items developed by Buss and Perry (1992) were excluded from the Korean version (Kwon & Seo, 2002). Cronbach's α for internal consistency was .86. The Daily Hassles Questionnaire (DHQ) consists of six subfactors: parent, family environment, friends, school, teacher, and school-related stress (Han & Yoo, 1995).

To measure positive psychology, we used self-esteem and quality-of-life scales. The Rosenberg Self-Esteem Scale (RSES) consists of items assessing positive self-esteem and negative self-esteem. The reliability and validity of the Korean version has been established (Lee, Nam, Lee, Lee, & Lee, 2009). Cronbach's α was .86, .88, and 0.80 for elementary-, middle-, and high-school students, respectively. The Pediatric Quality of Life Inventory (PedsQL 4.0)/ Generic Core Scale developed by Varni, Seid, and Kurtin (2001) and validated by Choi (2004) is divided into child and parental reports.

Statistical analysis

Continuous variables were analyzed parametrically using the *t*-tests. Categorical data were analyzed using the χ^2 tests. Pearson's correlation analyses between the IAT D_{2SD} scores and other clinical scales were performed to test the convergent and discriminant validity of the implicit association measurements. Step-wise multiple regression analysis was used to adjust for relevant covariates and to explore the psychometric properties associated with the IAT for smartphone and Internet addictions. All statistical analyses were conducted using SPSS version 16.0 (SPSS, Chicago, IL). A $p < .05$ was considered to indicate statistical significance.

Ethics

The study procedures were carried out in accordance with the guidelines of Declaration of Helsinki. The study was approved by the institutional review board (IRB) for human subjects of Uijeonbu St. Mary's Hospital (IRB no. UC150NMI0072) and Eulji University Eulji Hospital (IRB no. EMCS2015-05-020-001) and Seoul Metropolitan Government Seoul National University Boramae Medical Center (IRB no. 16-2016-4). All participants and their parents consented to attend the study after being informed about purpose and procedures of the study.

RESULTS

The demographic and psychological variables for 78 participants are shown in Table 1. More male participants (78%) were enrolled than the female participants. According to the total scores on the SAS-SV, 55% of participants were considered as high-risk for smartphone addiction.

Convergent validity

Significant correlations were found between scores on the IAT-SI and standardized scales for Internet or smartphone addiction. There were significant relationships between the IAT D_{2SD} score and the K-scale total score ($r = .28$, $p < .05$) and "Disturbance of Adaptive Functions" subscale score of the K-scale ($r = .25$, $p < .05$) (Table 2). In addition, IAT D_{2SD} scores were most strongly correlated with scores on the SAS-SV ($r = .33$, $p < .01$).

Discriminant validity

There were no significant correlations between scores on the IAT-SI and other psychological scales, such as the CASS-S, DHQ, ARS, RSES, BIS, AQ, and PQL, measuring constructs hypothesized to be less relevant to Internet use and smartphone addiction. In conjunction with the findings in Table 2, the correlations in Table 3 demonstrate the specificity of the IAT-SI with respect to Internet and smartphone addiction measures and not for ADHD or other less-related measures.

According to the scores of the SAS-SV total and subscales, the participants were classified into high-risk and low-risk groups for smartphone addiction. IAT D_{2SD} scores significantly differentiated between high-risk (0.214 ± 0.541) and low-risk groups (-0.137 ± 0.648) for smartphone addiction ($t = 2.340$, $p < .023$) (Figure 3). The high-risk and low-risk groups significantly differed on many but not all psychological measures (Table 4).

To explore the psychometric properties of the IAT-SI, a first univariate regression independently analyzed all the factors, and only factors (SAS-SV total, DHQ, and PQL) with a significance level <0.15 were included in a second step-wise multiple regression with D_{2SD} score as the dependent variable. This two-step multiple regression analysis revealed that only SAS-SV total was significantly associated with D_{2SD} score ($R = .31$, adjusted $R^2 = .08$, $\beta = 0.31$, $t = 0.22$, $p = .03$).

DISCUSSION

The results partially support our a priori hypotheses and provide preliminary evidence for the validity of the IAT-SI in children and adolescents at risk of smartphone and Internet addiction. In support of its convergent validity, correlations between the IAT-SI and explicit measurements of smartphone ($r = .33$) or Internet addiction ($r = .28$) were comparable in magnitude to implicit–explicit measurement correlations from the broader literature on behavioral addictions ($r = .21$–$.29$) (Snagowski et al., 2015). Correlations between scores on the IAT-SI and the disturbance subscore of Internet addiction ($r = .25$) provided additional support for the instrument's convergent validity. Preliminary evidence for its discriminant validity was provided by statistically non-significant, low correlations between scores on the IAT-SI, and explicit measurements of theoretically less-related constructs (e.g., self-esteem, impulsivity, and quality of life).

Table 2. Correlations between D_{2SD} scores on the IAT-SI and hypothesized convergent measures

Measure	IAT D_{2SD}	K_total	K_D	K_W	K_T	SAS-SV
IAT-SI D_{2SD}	1					
K_total	0.28*	1				
K_D	0.25*	0.81**	1			
K_W	0.23	0.84**	0.64**	1		
K_T	0.12	0.77**	0.67**	0.60**	1	
SAS-SV	0.33**	0.56**	0.48**	0.59**	0.45**	1

Note. K-scale: Korean Scale for Internet addiction for adolescents; D: subscale for disturbance of adaptive functions; W: subscale for withdrawal; T: subscale for tolerance; SAS-SV: Smartphone Addiction Scale – short form version.
*$p < .05$. **$p < .01$.

Table 3. Correlations between D_{2SD} scores on the IAT-SI and hypothesized divergent measures

Measure	IAT-SI D_{2SD}	CASS-S	DHQ	ARS	RSES	BIS	AQ	PQL
IAT-SI D_{2SD}	1							
CASS-S	0.12	1						
DHQ	0.25	0.61**	1					
K-ARS	−0.14	0.25	0.06	1				
RSES	−0.20	−0.61**	−0.54**	−0.20	1			
BIS-II	0.10	0.57**	0.23	0.07	−0.55**	1		
AQ	0.20	0.59**	0.61**	0.12	−0.47**	0.30*	1	
PQL	−0.28	−0.66**	−0.56**	−0.11	0.66**	−0.56**	−0.50**	1

Note. CASS-S: Conners–Wells' Adolescent Self-Report Scale – short form; DHQ: Daily Hassles Questionnaire; K-ARS: Korean ADHD Rating Scale; RSES: Rosenberg Self-Esteem Scale; BIS-II: Barratt Impulsiveness Scale-II; AQ: Aggression Questionnaire; PQL: Pediatric Quality of Life Inventory/Generic Core Scale.
*$p < .05$. **$p < 0.01$.

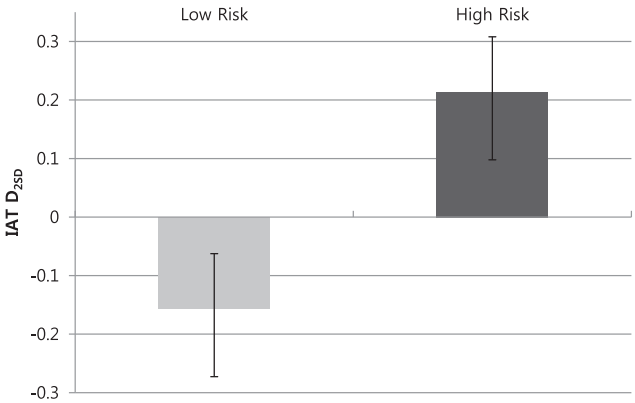

Figure 3. Comparison of mean D_{2SD} score on the IAT-SI between high-risk and low-risk groups for smartphone addiction (error bars indicate the standard error)

Furthermore, multiple regression analysis of independent associations with IAT-SI and smartphone addiction scores reflects good construct validity of this task as a measurement relating to smartphone and Internet addiction. Also as hypothesized, individuals with higher versus lower smartphone addiction scores had higher scores on the IAT-SI and showed differences on many but not all measures. Finally, higher IAT-SI scores remained associated with measures of smartphone addiction after controlling for other variables. Implications of the findings are described below.

Our preliminary results were comparable with previous findings from studies of substance-use disorders in which a positive relationship between implicit associations and addiction-related measurements was observed, and these were of a similar magnitude (Rooke et al., 2008). Picture images that were used in the IAT-SI in this study may be particularly appropriate, because unlike substance-use disorders, addictive use of the Internet or smartphones predominantly involves visual stimuli. Our findings provide evidence that problematic use of the Internet or smartphones shares common implicit characteristics with substance-use disorders.

In dual process models of addiction (De Houwer, 2006; Wiers & Stacy, 2006), addictive behaviors are viewed as the joint outcomes of two semi-independent processes: relatively rapid appetitive or impulsive processes, which include automatic appraisals of stimuli in terms of their emotional and motivational significance, and relatively slower reflective processes, which include controlled processes related to conscious deliberations, emotional regulation, and expected outcomes. In this regard, an addictive behavior, once established, may be perpetuated by strong appetitive processes, which may exert their influences outside conscious awareness and receive relatively little guidance from reflective processes. Thus, this study demonstrated that the IAT-SI might be helpful to capture implicit processes uniquely, relatively beyond respondents' intentional control, which may be relevant to the understanding of smartphone and Internet addictions.

Incentive salience may develop relatively rapidly in early adolescence (Brenhouse & Andersen, 2008), and adolescents are particularly vulnerable to developing addictions (Chambers, Taylor, & Potenza, 2003). Similarly, the observation that the prevalence of Internet addiction has increased more rapidly in teenagers than in other age groups (Korean National Information Society Agency, 2015) suggests that teenagers might be more greatly affected by Internet and smartphone overuse. Along with our findings, reports that implicit positive associations prospectively predicted binge drinking in adolescents

Table 4. Comparison of demographic and clinical characteristics of the participants according to risk for smartphone addiction measured by SAS-SV

Variables	High risk ($n = 33$)	Low risk ($n = 40$)	Statistic[a]	p value
Sex				
Male	28 (84.8)	28 (70.0)	$c = 2.232$	.135
Female	5 (15.2)	12 (30.0)		
Age (years)	12.93 ± 2.53	12.67 ± 2.35	$t = 0.448$	.655
IAT D_{2SD}	0.21 ± 0.54	−0.14 ± 0.65	$t = 2.340$	<.023
K total (Internet addiction)	81.20 ± 17.53	67.55 ± 13.59	$t = 3.414$	.001
K_D (disturbance of adaptive functions)	19.58 ± 5.43	15.82 ± 3.55	$t = 4.229$	<.001
K_W (withdrawal)	12.73 ± 3.67	9.42 ± 2.84	$t = 4.229$	<.001
K_T (tolerance)	12.53 ± 3.48	10.52 ± 2.92	$t = 2.640$	.010
SAS-SV total (smartphone addiction)	39.55 ± 5.88	20.30 ± 6.99	$t = 12.773$	<.001
CASS-S	25.76 ± 10.85	20.33 ± 8.23	$t = 0.199$	.041
DHQ	72.62 ± 16.94	62.93 ± 18.41	$t = 0.392$	.045
K-ARS	14.72 ± 10.18	16.43 ± 10.75	$t = 0.833$	.541
RSES	24.97 ± .38	30.26 ± 5.00	$t = 0.552$	<.001
BIS-II	59.55 ± 8.04	52.15 ± 8.94	$t = 0.689$	.002
AQ	68.45 ± 18.04	58.52 ± 12.91	$t = 0.024$	.022
PQL	1,556.03 ± 408.54	1,475.57 ± 427.83	$t = 0.750$	.487

Note. Values are mean ± standard deviation or n (%). K-scale: Korean Scale for Internet Addiction for adolescents; SAS-SV: Smartphone Addiction Scale – short form version; CASS-S: Conners–Wells' Adolescent Self-Report Scale – short form; DHQ: Daily Hassles Questionnaire; K-ARS: Korean ADHD Rating Scale; RSES: Rosenberg Self-Esteem Scale; BIS-II: Barratt Impulsiveness Scale-II; AQ: Aggression Questionnaire; PQL: Pediatric Quality of Life Inventory/Generic Core Scale.
[a]t: t-test; c: χ^2.

(Payne, Lee, Giletta, & Prinstein, 2016; Thush & Wiers, 2007) indicate the importance of future studies to determine whether the IAT-SI may hold promise for predicting Internet or smartphone addictions.

Implicit associations may have important implications for the prevention and treatment of Internet and smartphone addictions. Like psychosocial approaches for other addictive behaviors, many conventional psychosocial interventions are aimed at increasing control over impulses, either by increasing the motivation to refrain from use or by teaching and practicing methods to avoid or manage temptations (Kuss & Lopez-Fernandez, 2016). However, questions have been raised regarding the effectiveness of current psychosocial interventions (Cutler & Fishbain, 2005). An implicit-cognition approach raises the possibility that interventions may have effects through different processes than the reflective processes that arguably have been a major focus in the field of treatments for addictions. Several training approaches to target those automatic processes have proven helpful for regaining control over addictive impulses in alcohol addiction (Houben, Havermans, Nederkoorn, & Jansen, 2012; Wiers et al., 2010). Similarly, the automatic, implicit, and associative side of cognition may substantially advance intervention strategies for smartphone and Internet addiction.

There were several limitations to this study. First, the visual stimuli that were used in these tasks were limited to Internet-game-related pictures, and they did not encompass other categories related to problematic Internet use, such as social media use or cybersex. However, Internet gaming, in particular, has been proposed to be a particularly relevant threat to children and adolescents (Festl, Scharkow, & Quandt, 2013; Kuss & Griffiths, 2012), and criteria for Internet-gaming disorder have been included in Section III of the DSM-5 (APA, 2013) as a condition warranting more clinical research. In addition, Internet addiction is more strongly related to Internet-game-related attitudes than social interaction preferences (Lee, Ko, & Chou, 2015). Therefore, we considered that in Korean children and adolescents, Internet game pictures could play a big part in giving a cue to the Internet addiction or proxy for Internet addiction. Nonetheless, future IAT studies focusing on different types of Internet addiction are required. Second, the sample size of this study was limited but comparable with other IAT studies in addiction research (Snagowski et al., 2015; Yen et al., 2011). Third, as this study was cross-sectional, causal relationships between implicit association and Internet addiction cannot be inferred. Longitudinal studies should reveal how both explicit variables and implicit associations develop when Internet addiction is initiated. Finally, several psychological tools for divergent measures, such as DHQ, BIS-II, and AQ, were not fully validated for use with young children.

CONCLUSIONS

Much research has historically focused on explicit processes of addiction, with several more recent studies investigating implicit measurements. Potential tools to capture implicit process may be useful for understanding addictions (Cox, Fadardi, Intriligator, & Klinger, 2014). Consistently, implicit association measurements have been incorporated into interventions targeting alcohol-use disorders (Boffo, Pronk, Wiers, & Mannarini, 2015; Houben et al., 2012). The good construct validity of the IAT-SI in this study suggests that implicit processes may similarly be targeted in Internet and smartphone addictions. The IAT-SI is short, and thus should be feasible to implement in multiple settings, and has promising psychometric properties. The generalizability of our findings to other samples, such as a community sample and for other age ranges, remains to be demonstrated. Further studies are required to examine the predictive potential and clinical utility of the IAT-SI, particularly with respect to developing treatments that consider non-reflective aspects of behavior.

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