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The Effects of Behavioral Activation System/Behavioral Inhibition System (BAS/BIS) and Peer Pressure on Smartphone Overdependence Among Korean Adolescents

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Adolescents' addictive use of smartphones has been the focus of clinical attention. Gray's neuropsychological systems, behavioral activation system (BAS) and behavioral inhibition system (BIS), consistently predict smartphone overdependence (SO) across various age groups. Additionally, peer pressure (PP)— as it relates to smartphone usage — is considered a notable factor and one which wields significant influence on adolescents. In this context, this study aimed to investigate the relative impact of intra-individual factors, BAS/BIS, and peer-related factor, PP, on adolescents' SO. Furthermore, the study sought to explore whether these two factors interact with each other in influencing adolescents' SO. We collected data from 489 Korean middle school students and analyzed the data separately by gender, considering potential gender differences in the interrelationships among variables based on prior research findings. The findings reveal a significant positive correlation among BAS/BIS, PP, and SO. Furthermore, BAS/BIS and PP were confirmed to significantly predict SO with no gender differences. However, the moderation effect was only significant in the male group. Based on these findings, we discussed preventive interventions concerning adolescents, limitations, and suggestions for further research.

Keywords: behavioral activation system (BAS), behavioral inhibition system (BIS), smartphone overdependence, smartphone addiction, peer pressure, adolescents

Introduction

The addictive use of smartphones among adolescents has long been a central topic in clinical discussions, with a notable increase in cases, particularly in South Korea. According to the 2022 survey conducted by the National Information Society Agency (NIA), 40.1% of adolescents were classified as smartphone overdependence groups, representing a 3.1% increase from the previous year. Today's adolescents have grown up in a technologically advanced environment, where smartphones are an integral part of their daily lives, evolving into indispensable tools for nearly every teenager. Haddon and Livingstone (2012) emphasize instilling online resilience in children, enabling them to effectively navigate and overcome the various issues that can arise in the digital environment, rather than pathologizing their smartphone use. From a sociocultural perspective, interventions should be culturally sensitive and accommodating to the unique adolescent culture, avoiding overly restrictive approaches that simply curtail smartphone usage. Therefore, investigating various factors influencing smartphone overdependence (SO) is crucial to effectively addressing adolescents' SO.

Prior research has classified SO as a form of behavioral addic-

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tion, akin to addiction to gaming or gambling (Goel et al., 2015; Lee & Yang, 2018). Within the domain of factors influencing behavioral addiction, the temperamental construct known as Behavioral Activation System/Behavioral Inhibition System (BAS/BIS) has consistently garnered attention as a pivotal variable explaining an individual's temperamental susceptibility to behavioral addiction (Breen & Zukerman, 1999; Kim et al., 2016; Kim & Hwang, 2019; Kim & Lee, 2011; Park et al., 2013). Furthermore, it is well-established that both BAS and BIS play pivotal roles in responding to environmental stimuli and regulating motivational aspects of behavior (Fowles, 1987, 1993). Therefore, to comprehend SO as a form of behavioral addiction, it is imperative to consider BAS and BIS within Gray's Reinforcement Sensitivity Theory (Gray, 1982). Gray identified these biological systems that influence individual behavior as the BAS and BIS. BAS is associated with reward sensitivity, a tendency to seek novelty and excitement, and an inclination toward impulsively pursuing one's desires. In contrast, BIS is linked to vigilance to cues of punishment or threat and the experience of anxiety (Carver & White, 1994). Essentially, if BAS can be likened to a psychological accelerator that promotes goal-directed behaviors, BIS can be likened to a psychological brake that inhibits responses when confronted with punitive or threatening cues (Kim & Kim, 2001).

In case of BAS, from a personality perspective, it is reported that BAS is closely associated with the dimension of impulsivity, which includes a tendency to seek stimulation and make hasty decisions (Moeller et al., 2001). This impulsivity is recognized as a risk factor for addictive behaviors (Thomsen et al., 2018). In this context, BAS is regarded as potential personality factor related to addiction (Jeong et al., 2020; Yi & Hwang, 2015). In the majority of studies assessing BAS, researchers employ a scale developed by Carver & White (1994) comprising three subdimensions: reward responsiveness, fun-seeking, and drive. According to findings from Lee et al. (2015), scores on the 'drive' and 'fun-seeking' subdimensions of BAS were significantly higher in groups of adolescents addicted to smartphones. Additionally, Kim et al. (2016) emphasized the importance of 'drive' and 'reward responsiveness' within these subdimensions for predicting the group at high risk of smartphone use. Anderson and Smith (2001) revealed that the 'reward-responsiveness' plays a role in facilitating reward-related learning. Positive expectations acquired through this learning process enhance the frequency of subsequent behaviors, ultimately leading to addiction. In summary, research outcomes vary depending on the subdimensions of BAS. However, Corr and McNaughton (2008) have suggested that for an effective measurement of the BAS, multidimensional subfactors should be comprehensively evaluated. Many previous studies have also treated these subdimensions as constituting a unified concept of BAS and consistently reported a positive correlation between a high BAS tendency and behavioral addiction (Cho & Cho, 2008; Park et al., 2013; Yang & Suh, 2017).

On the other hand, BIS is closely associated with negative emotions, and multiple studies consistently suggest an increased likelihood of experiencing anxiety or discomfort in social situations with the intensification of BIS inclination. Furthermore, there is evidence that individuals, when confronted with negative emotions, tend to engage in smartphone-mediated interactions as a means of avoidance (Jung et al., 2016; Amiel & Sargent, 2004; Kimbrel, 2008; Park et al., 2011). Additionally, there is an argument that individuals with prominent BIS characteristics may exhibit heightened sensitivity to cues of punishment compared to those with weaker BIS traits, leading to more pronounced experiences of anxiety and, consequently, an increased dependence on smartphones (Jo et al., 2017). Kruglanski and Orehek (2011) have reported that BIS exhibits increased sensitivity to social rejection. Moreover, individuals with heightened BIS sensitivity tend to be more vigilant towards negative aspects and show a propensity for a pessimistic outlook (Hirsh & Kang, 2016, as cited in McGarry & Shortland, 2023). Furthermore, based on studies showing that individuals with high levels of the fear of missing out (FOMO) tend to use social networking sites more often (Fox & Moerland, 2015; Przybylski et al., 2013), it can be inferred that individuals with pronounced BIS characteristics may turn to smartphones more frequently. Thus, it can be inferred that individuals with heightened BIS characteristics are likely to rely more on smartphones, in an effort to mitigate the fear of social exclusion.

Meanwhile, BIS represents a comprehensive concept of 'punishment sensitivity,' encompassing anxiety and fear. In line with these characteristics of BIS, Carver and White (1994) have made a questionnaire that differs from existing anxiety scales. This questionnaire does not inquire about the frequency of an individual's anxi-

ety experiences but rather whether they are likely to experience anxiety in certain situations (Jorm et al., 1998). However, McNaughton and Gray (2000) emphasize in the revised Reinforcement Sensitivity Theory that anxiety within the BIS should be clearly distinguished from the concepts of terror or fear. Thus, in order to explore the impact on SO more precisely, there is a need for research that distinguishes between the concepts of anxiety and fear within BIS and elucidates their relationship with SO. Meanwhile, Corr and McNaughton (2008) reported that fear operates when leaving a dangerous situation (active avoidance), anxiety when entering it (e.g., cautious 'risk assessment' approach behavior), or withholding entrance (passive avoidance). In light of these considerations, it can be inferred that the tendency to use smartphones more frequently out of fear of social exclusion or to rely on smartphones to alleviate anxiety experienced in social situations is closely related to the anxious facet of BIS. Therefore, this study attempts to investigate the connection between the anxiety concept within BIS and SO.

In sum, many studies report that BAS/BIS are ultimately associated with smartphone addiction. Therefore, when considering these findings collectively, it is predicted that individuals with high BAS traits may become deeply engrossed in smartphones, which provide immediate gratification because of their sensitivity to positive affect and rewards, such as the pursuit of new stimuli and pleasure, potentially leading to increased SO. On the other hand, individuals with high BIS characteristics may be expected to rely more on smartphones to alleviate negative emotions and avoid social exclusion. In simple terms, one can assume that BAS/BIS systems follow different pathways but ultimately converge on one outcome, SO. However, not all individuals with inherent vulnerabilities display maladaptive behaviors, such as behavioral addiction (Lee & Kwon, 2020). Therefore, it is important to explore the factors that may affect the relationship between these motivational systems and SO.

Adolescence is a period characterized by significant physical and emotional maturation, involving the reorganization of their self to meet emerging roles and social demands. Individuals' biological characteristics can lead to different outcomes even under similar environmental conditions (Yi, 2014). Additionally, as adolescence is the developmental period when individuals are most affected by peer relationships and peer culture, peer pressure appears to be another important factor influencing adolescents' SO. Early adolescents share more time with their peers than their parents (Palani & Mani, 2016) and tend to conform to peer values, group beliefs, and behaviors more easily than other age groups (Jeong, 2019). In typical development, from adolescence onward, it is common for children to develop greater emotional dependence and a sense of belonging through their peers than their parents (Buist et al., 2002).

Peer groups have long been a focal point of research as a substantial contributor to adolescent substance abuse and addiction (Bahr et al., 2005; Farrel & White, 1998; Steinberg et al., 1994). Oetting and Beauvais (1986) elucidated the psychological and social factors influencing adolescent substance abuse, using the Peer Cluster Theory (PCT). According to this theoretical framework, peer groups that encourage substance abuse introduce adolescents to drugs, instruct them on methods of use, and influence them to adopt beliefs and attitudes that perpetuate drug use. Likewise, during the trajectory leading to smartphone addiction, peer groups can exert a diverse range of influences. For instance, they can introduce adolescents to various smartphone features and usage methods, engage in collaborative gaming, share captivating content, and foster a sense of belonging among group members. Furthermore, Lee (2001) suggests that cultural elements are inherently embedded in the value of mobile phones as a medium. Individuals driven by motivation rooted in these cultural dimensions may be acutely aware of peer influence and are likely to conform within the group, driven by considerations related to their identity, social status, economic power, and communication style. In essence, due to the developmental characteristics of adolescents striving to establish their identity within peer groups, it is conceivable that unique cultural motivations specific to adolescent cohorts could influence smartphone usage.

Additionally, in the collectivist culture of Korean society, which tends to place more emphasis on the perceptions of other members within their groups, individuals are more likely to feel pressured into relationships based on collective values (Joo et al., 2018). Thus, it can be assumed that middle school students' smartphone use patterns will also be significantly influenced by their peer groups as their dependence on and sense of belonging to their peer

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groups increases during their development, especially in Korea. Therefore, it is crucial to investigate how adolescents experience peer norms and implicit pressures related to smartphone usage and how these factors influence their actual smartphone usage patterns. Nevertheless, prior research has overseen these aspects.

Numerous studies have revealed associations between smartphone addiction and peer-related factors such as peer pressure, peer attachment, and peer relationships (Chang et al., 2012; Jung, 2019; Kim & Kim, 2018; Kim & Byun, 2015; Park et al., 2012; Yoon, 2005). However, prior research predominantly treats peer variables and smartphone addiction as separate constructs, with a focus on understanding the influence of peer variables on smartphone (Kim et al., 2016). Additionally, while various scales related to peer pressure or conformity are available (Berndt, 1979; Brown et al., 1986; Santor et al., 2000; Cho & Chung, 2009), most of them primarily assess peer pressure or conformity concepts in general circumstances. In other words, studies exploring the peer norms or culture among adolescents that directly affect smartphone usage have been scarce thus far. Consequently, there exists a pressing need for research that delves into the distinctive traits of adolescents, particularly concerning the investigation of peer norms or culture that may directly impact smartphone usage. Hence, in this study, the term "peer pressure (PP)" refers to "peer pressure regarding smartphone use". This definition encapsulates the unique culture of adolescents and the unspoken norms related to smartphone usage. While the existing definition primarily addresses peer influence in general situations, the PP defined in this study focuses on the influence or pressure by peers that encourage smartphone use or heighten dependence on smartphones. Therefore, this study aimed to examine the more substantive peer influence related to adolescents' SO and complement the limitations of previous research, which has shown difficulties in directly explaining the relationship between variables related to peers and adolescents' SO.

Furthermore, it would be meaningful to investigate how PP, directly related to smartphone usage, interacts with the biological vulnerabilities studied as intrinsic factors (BAS/BIS) significantly associated with SO. We posited that individuals with high BAS sensitivity, as mentioned earlier, are more likely to engage in behaviors accessing positive reward cues, while those with high BIS sensitivity tend to exhibit more behaviors aimed at mitigating or avoiding negative cues. Within the same context, as peer groups hold significant importance for adolescents, it can be assumed that they may strongly sense the pressure to adhere to peer group guidelines regarding smartphone usage to maintain positive relationships and intimacy. Studies supporting our hypothesis emphasize the significance of smartphones in maintaining or enhancing smooth peer relationships as they facilitate communication with peers anytime and anywhere (Shin & Lee, 2013; Yi, 2014). Moreover, adolescents may experience anxiety about potential peer exclusion, leading to excessive smartphone use to avoid exclusion from their peers (Yoon & Kwon, 2011). In summary, it can be inferred that adolescents with a high BAS tendency are likely to exhibit higher levels of SO due to their inclination to seek positive emotions and rewards, such as joy and satisfaction, in intimate relationships. Lee and Kim (2020) confirmed that adolescents with high BAS/BIS levels also have higher levels of interaction and relationship motivation. Furthermore, adolescents with strong BIS traits may be more inclined to rely on smartphones as they may be more sensitive to cues such as exclusion from their peer groups. The findings of the study by Fox and Moerland (2015), supporting this assumption, suggest that individuals with higher anxiety about exclusion may use smartphones more frequently to maintain relationships.

In conclusion, this study aims to explore PP, which is expected to influence adolescents' SO, in conjunction with the well-established BAS/BIS factors closely related to SO. The primary objective is to investigate the impact of BAS/BIS, as well as the peer group norms directly linked to smartphone use among adolescents, on actual SO. Additionally, we examine the potential interactions among these key variables. Reflecting on similar studies, research has shown that peer conformity among adolescents has different associations with Internet addiction based on gender. For female students, higher peer conformity had a positive impact on internet addiction, while among male students, lower peer conformity was associated with higher levels of internet addiction (Ha & Jo, 2003). Moreover, in studies examining factors related to adolescent risk behaviors, it was observed that the influence of peer conformity is more prominent among female adolescents than male adolescents. These results suggest that the relationship between peer conformity

and peer pressure may vary by gender (Yoon & Nam, 2007). Furthermore, gender differences in BAS/BIS levels have also been reported (Choi & Yang, 2018; Jiang & Zhao, 2010; Oi et al., 2019). Considering these findings, we have investigated the influence of PP by gender in our research.

Methods

Participants and Procedure

The entire procedure received approval from the Institutional Review Board under Approval No. HYUIRB-202009-030-1 and adhered to the guidelines of the Declaration of Helsinki. Data was collected through a structured survey from middle school students. After providing a detailed study explanation and receiving consent, 495 student responses were collected. After excluding insincere responses, 489 responses were chosen for analysis. The average age of participants was 14.55 years (SD = 0.58), with males averaging 14.65 years (SD = 0.59) and females averaging 14.45 years (SD = 0.54). Out of the total participants (N = 489), 51.1% (n = 250) were male, and 48.9% (n = 239) were female. The average daily smartphone usage for all adolescents was 5.20 hours (SD = 1.97), with females averaging 5.86 hours (SD = 1.87) and males averaging 4.58 hours (SD = 1.87). Among the participants, 116 were classified as potential-risk groups for SO, and 14 individuals fell into the high-risk group for SO. The participant characteristics are presented in Table 1.

Table 1. *Characteristics of Participants (N = 489)*

	M (SD) or N (%)		
	Male	Female	Total
Gender	250 (51.1)	239 (48.9)	489 (100)
Age	14.55 (.587)	14.45 (.539)	14.55 (.578)
Grade			
2nd-Grade	97 (38.8)	115 (48.1)	212 (43.4)
3rd-Grade	153 (62.1)	124 (59.9)	277 (56.6)
Regions			
Seoul	43 (17.2)	45 (18.8)	88 (18.0)
Gyeonggi-do	78 (31.2)	77 (32.2)	155 (31.7)
Incheon	12 (4.8)	15 (6.3)	27 (5.5)
Daejoen	19 (7.6)	17 (7.1)	36 (7.4)
Chung-buk	18 (7.2)	17 (7.1)	35 (7.2)
Busan	18 (7.2)	7 (2.9)	25 (5.1)
Jeolla-do	26 (10.4)	24 (10.0)	50 (10.2)
Gyeongsang-do	36 (14.4)	37 (15.5)	73 (14.9)
Smartphone usage time (Average hours per day)	4.58 (1.87)	5.86 (1.87)	5.20 (1.97)
Age at first use of smartphone	10.68 (2.14)	9.98 (2.19)	10.34 (2.19)
Smartphone overdependency			
High-risk group	5 (1.0)	9 (1.8)	14 (2.9)
Potential-risk group	48 (9.8)	68 (13.9)	116 (23.7)
Non-risk group	197 (40.3)	162 (33.1)	359 (73.4)

Data Analysis

The collected data were analyzed using SPSS (v.21.0). An exploratory factor analysis was conducted to assess the reliability and validity of the PP scale. *T*-tests were carried out to investigate gender differences in key variables, and Pearson's correlational analysis was employed to examine the relationships among the primary constructs. Finally, using mean-centered data, hierarchical regression analysis was performed to examine the impact of BAS/BIS and PP on adolescents' SO, including any interaction effects.

Measure

BAS/BIS

To measure individual differences in BAS/BIS, we utilized the BAS/BIS Scales developed by Carver and White (1994) and standardized in Korean by Kim and Kim (2001). The scale was adapted for ease of comprehension by adolescents, with researchers making some modifications to the items and subjecting it to review by a clinical psychologist before use. This scale consists of 4 subfactors and 20 items: BAS-reward responsiveness (5 items), BAS-drive (4 items), BAS-fun seeking (4 items), and BIS (7 items). Cronbach's α for BAS was .88. Also, in this study, we aimed to measure the concept of 'anxiety,' which is distinct from the 'fear' aspect of BIS. Based on the study by Corr and McNaughton (2008), we measured BIS using the remaining 5 items, excluding the 2 items related to fear. The reliability coefficient for the 7 items was .70, while the reliability coefficient for the 5 items was .78.

Smartphone overdependence

The Smartphone overdependence Scale from the NIA (2017) was used. This scale consists of 3 subdimensions: Control Failure (3 items, diminished control over smartphone use), Salience (3 items, prioritizing smartphone use), and Problematic Results (4 items, continued smartphone uses despite negative consequences). Re-

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sponses are rated on a four-point Likert scale. In adolescents, a total score of 31 indicates high-risk group for SO, while 30 to 23 suggests potential-risk group for SO. Cronbach's α was .87.

Peer Pressure

In this study, we aimed to measure PP which is directly related to smartphone use. However, existing instruments capable of measuring these concepts were lacking, so the researchers created and used our own items. For example, an item measuring normal peer pressure might be "When I'm with my friends, I often feel the pressure to do things I wouldn't normally do." However, the scale developed by the researchers consists of items such as "Even when I want to take a break and relax, I have to keep going because my friends don't like it when I leave a messenger chat or a game in the middle."

Procedure for developing the measure of PP

Step 1: preliminary item construction

We conducted a literature review of previous studies on peer pressure (Oh, 1989; Yoon, 2005; Yoon & Kwon, 2011; Jo & Jung, 2009; Berndt, 1979; Palani & Mani, 2016) and found that peer pressure has both positive and negative impacts on adolescent behavior. Therefore, we designed the PP scale to encompass the positive and negative aspects of peer relationships in the context of smartphone use. On the negative aspect, we incorporated a tendency to use smartphones more to avoid feeling excluded by peers (Yoon & Kwon, 2011). To address this, we referred to the FOMO Scale (Przybylski et al., 2013) and adapted it to the Korean cultural context, following the version by Joo et al. (2018). For the positive aspect, we included a tendency to use smartphones more to maintain or enhance peer relationships. For this, we adopted the 'Measuring Online Communication Attitude (MOCA)' concept developed by Ledbetter (2009) reflecting relationship maintenance and dependency related to same-gender peers. Additionally, we acquired insights from the peer pressure vulnerability scale and peer popularity acceptance scale developed by Santor et al. (2000).

To incorporate the unique characteristics and culture aspects specific to adolescents' smartphone use behaviors, not covered in existing peer-related scales, we conducted Focus Group Interviews (FGIs). FGIs involved eight middle school students (4 boys and 4 girls), with interview lasting approximately 120 minutes. Prior to the interview, we prepared questions based on previous research that explored the relationships between adolescents, peers, and SO (Kim et al., 2016; Lee, 2015; Jo et al., 2020; Yi, 2014). Identical questions were presented to all participants, and the interview contents were recorded. After reviewing the interview contents repeatedly, we selected sentences that were consistently reported and considered to represent the thoughts, culture, and behaviors of adolescents related to smartphones. This process resulted in a total of 14 preliminary items for the scale.

Step 2: refinement of preliminary items and content validity check

To assess content validity, we employed Polit et al. (2007) method, which involved four experts rating each item on a 4-point Likert scale (1 point: not suitable at all to 4 points: highly suitable). Content validity was determined based on the proportion of experts finding each item suitable for measuring the intended concept. The experts, including a clinical psychologist, a child psychology professor, a youth counseling specialist, and a child psychology doctoral student, all with extensive experience in adolescent research and counseling, assessed the 14 preliminary items. Items with a score of 2 were revised based on expert opinions, while two items scored 1 were removed. After revisions and eliminations, a panel of three experts, including a scale development specialist, an addiction expert, and a clinical psychologist, reviewed the items. This process confirmed that all items in the final tool effectively measured the intended concept, resulting in a 12-item scale.

Step 3: reliability and validity verification

First, we collected responses from 489 participants and assessed data normality using various statistics such as mean, standard deviation, skewness, and kurtosis for each item. The validation results showed that the average scores for all 12 items ranged from 1.74 to 3.06, with standard deviations between 1.03 and 1.24. All items met the normality assumptions, as indicated by skewness (ranging from -.34 to 1.32) and kurtosis (ranging from -1.03 to 1.01) (West et al., 1995). When evaluating reliability coefficients for item removal, no item had a Cronbach's α below .85, indicating that no items needed to be eliminated. To assess the suitability of the collected data for factor analysis, we conducted the Kaiser-

Meyer-Olkin (KMO) and Bartlett's sphericity test. The KMO value of .880 confirmed the data's suitability, and Bartlett's sphericity test was significant ($\chi^2 = 2{,}172.3$, $p < .001$), validating its appropriateness for factor analysis. Due to substantial inter-factor correlations, we utilized an oblique rotation method for analysis (Seo et al., 2018). We performed common factor analysis using the maximum likelihood method (MLM) while considering the collected data as a sample rather than a population. This analysis yielded two factors with factor loadings exceeding .3 (.431-.793), demonstrating the quality of the items as good (Crocker & Algina, 1986). Eigenvalues, scree plots, and item content were assessed to determine the appropriate number of factors. The scree plot suggested that one to two factors were suitable (Hayton et al., 2004, as cited in Seo et al., 2018). However, following Gorsuch's (1983) guideline, if the eigenvalue of the first factor is at least three times the value of the second-highest eigenvalue, the scale can be considered unidimensional. In our study, the first factor had an eigenvalue of 5.00, and the second factor had an eigenvalue of 1.39, making it acceptable to merge them into a single dimension. Moreover, as this scale was designed to capture the overall characteristics of smartphone use patterns in adolescent peer groups, it was more appropriate to treat it as a unidimensional construct. Performing factor analysis with a fixed factor input of 1, the KMO value and Bartlett's sphericity remained at an acceptable level (KMO = 0.880, $\chi^2 = 2{,}172.3$, $p < .001$). The single factor had an eigenvalue of 5.003, explaining 41.69% of the total variance. Calculating the internal consistency (Cronbach's α) for the entire scale and individual subfactors, we found that item reliability generally exceeded .30. The overall scale reliability was .87, indicating good item-to-item consistency. This scale consists of 12 items, rated on a 5-point Likert scale (1 point: not at all true to 5 points: always true), with a total score of 60 points, where higher scores indicate a stronger influence of PP on smartphone use. The results of the factor analysis, including item content and factor loadings, are presented in Table 2.

Table 2. *Factor Analysis Results of the PP Scale (N = 489)*

Contents of items	Factor loadings	
9. If my friends contact me, I always keep my smartphone nearby and check immediately because I'm afraid my friends will get annoyed if I don't respond right away.	.693	
7. Even when I want to take a break and relax, I have to keep going because my friends don't like it when I leave a messenger chat or a game in the middle.	.695	
3. I feel like I have to participate in group chat rooms, even if I have to force myself, because my friends will criticize me if I'm not actively participating or if I leave.	.689	
4. I have to visit my friends' social media profiles frequently because my friends like it when I leave comments on their posts.	.684	
5. I feel that if I reduce my smartphone usage, I will have trouble communicating with my friends and our relationship will suffer.	.684	
8. To join in my friends' conversations, I must watch the contents (webtoons, videos, personal broadcasts, etc.) that my friends recommend as interesting.	.651	
6. To communicate well with my friends, I have to use my smartphone for at least 2 hours every day.	.630	
2. To communicate effectively with my friends, I have to check and respond to messenger messages as soon as they come.	.549	
1. Even if I don't like it, I have to accept invitations to group game rooms or group chat rooms when my friends invite me.	.490	
10. I think that SNS and messenger apps help maintain relationships with my friends because I can communicate with them at any time.	.474	
12. When I play games with my friends on my smartphone or watch the same video and chat, I feel a strong sense of closeness.	.459	
11. When I have something important to say, I feel that it's more natural to convey it through a messenger app rather than meeting in person and talking.	.458	
Eigenvalue	5.003	
KMO (Kaiser–Meyer–Olkin)	0.880	
Bartlett test of sphericity test	Chi-Square	2,172.300
	df (p)	*66 (.000)*

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Results

Descriptive Statistics and Correlations between the Variables

The status and correlations among the key variables in this study are presented in Table 3 below. Examination of gender-based differences in key variables revealed that females exhibited significantly higher BAS ($p < .05$) and BIS ($p < .001$) scores compared to males. Additionally, SO levels were significantly higher in females ($p < .001$), while smartphone use encouragement by peer groups showed similar levels for both genders. Correlational analysis showed that BAS had a significantly positive association with SO in both male and female groups (male $r = 0.27$, female $r = 0.27$, $p < .01$). Similarly, BIS showed a significantly positive association with SO in both male and female groups (male $r = 0.38$, female $r = 0.33$, $p < .01$). PP and SO were significantly positively correlated in both male and female groups (male $r = 0.54$, female $r = 0.51$, $p < .01$). Furthermore, after performing the Fisher transformation and z-test to examine differences in the magnitude of each correlation coefficient, it was found that the correlation between PP and SO was significantly stronger than the correlations between BAS/BIS and SO ($p < .05$) in both male and female.

Mediational Analysis

The results of hierarchical regression analysis on the influence of

Table 3. *Means, Standard Deviations, Correlations Among Variables (male n = 250, female n = 239)*

Variable	M (SD)		$t^{\dagger}$	1	2	3	4
	Male	Female					
1. BAS	31.74 (7.72)	33.25 (7.34)	-2.21*	1	0.31**	0.21**	0.27**
2. BIS	12.00 (3.58)	13.76 (3.40)	-5.56***	0.64**	1	0.32**	0.33**
3. PP	27.88 (9.10)	28.17 (8.62)	-0.36	0.32**	0.38**	1	0.51**
4. SO	17.91 (5.77)	19.91 (5.29)	-3.82***	0.27**	0.38**	0.54**	1

*Note. lower left triangle = male; upper right triangle = female; BAS = Behavioral Activation System; BIS = Behavioral Inhibition System; PP = Peer Pressure; SO = Smartphone Overdependence, **p < .01 (all two-tailed).*
*†t-test result; *p < .05, ***p < .001 (all two-tailed).*

Table 4. *Regressions Summary for BAS (male n = 250, female n = 239)*

Predictor		Male					Female				
		B (β)	*t*	R^2	ΔR^2	*F*	*B* (β)	*t*	R^2	ΔR^2	*F*
Step 1:	BAS	0.20 (0.27)	4.42***	0.07	0.07	19.57***	0.22 (0.27)	4.27***	0.07	0.07	18.22***
Step 2:	BAS (A)	0.08 (0.11)	1.93	0.31	0.23	82.92***	0.13 (0.17)	2.99**	0.29	0.22	71.56***
	PP (B)	0.32 (0.51)	9.11**				0.32 (0.48)	8.46***			
Step 3:	BAS (A)	0.12 (0.16)	2.11**	0.33	0.02	7.49**	0.13 (0.16)	2.86**	0.29	0.00	0.13
	PP (B)	0.32 (0.50)	9.11***				0.32 (0.48)	8.29***			
	A × B	0.01 (0.15)	2.74**				0.00 (-0.02)	-0.36			

Note. BAS = Behavioral Activation System; PP = Peer Pressure.
***p < .01, ***p < .001 (all two-tailed).*

Table 5. *Regressions Summary for BAS (male n = 250, female n = 239)*

Predictor		Male					Female				
		B (β)	*t*	R^2	ΔR^2	*F*	*B* (β)	*t*	R^2	ΔR^2	*F*
Step 1:	BIS	0.61 (0.38)	6.47***	0.14	0.14	41.83***	0.56 (0.33)	5.32***	0.11	0.10	28.28***
Step 2:	BIS (A)	0.33 (0.20)	3.63***	0.33	0.19	69.05***	0.31 (0.18)	3.10**	0.29	0.18	60.70***
	PP (B)	0.30 (0.47)	8.31***				0.30 (0.45)	7.80***			
Step 3:	BIS (A)	0.38 (0.24)	4.16***	0.35	0.02	5.94*	0.31 (0.18)	3.10**	0.29	0.00	0.42
	PP (B)	0.31 (0.49)	8.65***				0.30 (0.44)	7.30***			
	A × B	0.02 (0.13)	2.44*				0.01 (0.04)	0.65			

Note. BIS = Behavioral Inhibitiob System; PP = Peer Pressure.
**p < .05, **p < .01, ***p < .001 (all two-tailed)*

PP on the relationship between BAS and SO are presented in Table 4. First, in the male group, BAS explains 7% of the variance in SO in the first step. When examining the main effects, the BAS significantly predicted SO levels ($B = 0.20$, $\beta = 0.27$, $p < .001$). In the second step, with the introduction of PP, the main effect of BAS did not reach statistical significance. However, the PP accounted for 31% of the variance in SO and significantly predicted SO levels ($B = 0.32$, $\beta = 0.51$, $p < .01$). In the third step when the interaction term for BAS and PP is introduced, the explanatory power increases by 2%, and the interaction effect is significant. In the female group, the main effects were significant. BAS statically predicts SO levels ($B = 0.22$, $\beta = 0.27$, $p < .001$), while PP is also confirmed as a significant factor influencing SO ($B = 0.32$, $\beta = 0.48$, $p < .001$). However, the moderating effect was not significant.

The results of hierarchical regression analysis on the influence of PP on the relationship between BIS and SO are presented in Table 5. First, in the male group, BIS explains 14% of the variance in SO in the first step. When examining the main effects, the BIS significantly predicted SO levels ($B = 0.61$, $\beta = 0.38$, $p < .001$). In the second step, with the introduction of PP, the main effect of BIS and PP accounted for 33% of the variance in SO and significantly predicted SO levels (BIS: $B = 0.33$, $\beta = 0.20$, $p < .001$, PP: $B = 0.30$, $\beta = 0.47$, $p < .001$). In the third step when the interaction term for BIS and PP is introduced, the explanatory power increases by 2%, and the interaction effect is significant. In the female group, the main effects are significant. BIS statically predicts SO levels ($B = 0.56$, $\beta = .33$, $p < .001$), while PP is also confirmed as a significant factor influencing SO ($B = 0.30$, $\beta = 0.45$, $p < .001$). However, the moderating effect was not significant.

The interaction patterns in the male group were expressed as a regression line based on specific values of PP:1 *SD* above the mean, mean, 1 *SD* below the mean (Aiken & West, 1991). The results are shown in Figure 1. In the simple slope analysis, when PP was 'low (-1 *SD*),' the influence of BAS/BIS on SO was not significant (BAS: $B = 0.03$, $t = 0.55$, $p > .05$, BIS: $B = 0.19$, $t = 1.80$, $p > .05$). On the other hand, when PP levels were 'mid (M)' (BAS: $B = 0.12$, $t = 2.69$, $p < .01$, BIS: $B = 0.38$, $t = 4.14$, $p < .001$) and when PP levels were 'high (+1 *SD*),' the impact of BAS/BIS on SO was statistically significant (BAS: $B = 0.21$, $t = 3.34$, $p < .01$, BIS: $B = 0.57$, $t = 4.26$, $p < .01$). In other words, in the group less influenced by PP, the influence of BAS/BIS on SO is not substantial. However, in the group where PP has a moderate to high influence, an increase in BAS/BIS levels corresponds to a greater increase in SO levels.

Discussion

This study aimed to investigate peer group norms directly associated with smartphone usage and explore the influence of this environmental factor on SO. Simultaneously, it sought to examine the relationship of intrinsic individual factors closely linked to SO, such as BAS/BIS, and to determine whether these intrinsic and extrinsic variables functioned as predictive factors for adolescents' SO. The research findings are as follows: Firstly, the scale used in this study to measure PP related to smartphone usage exhibited

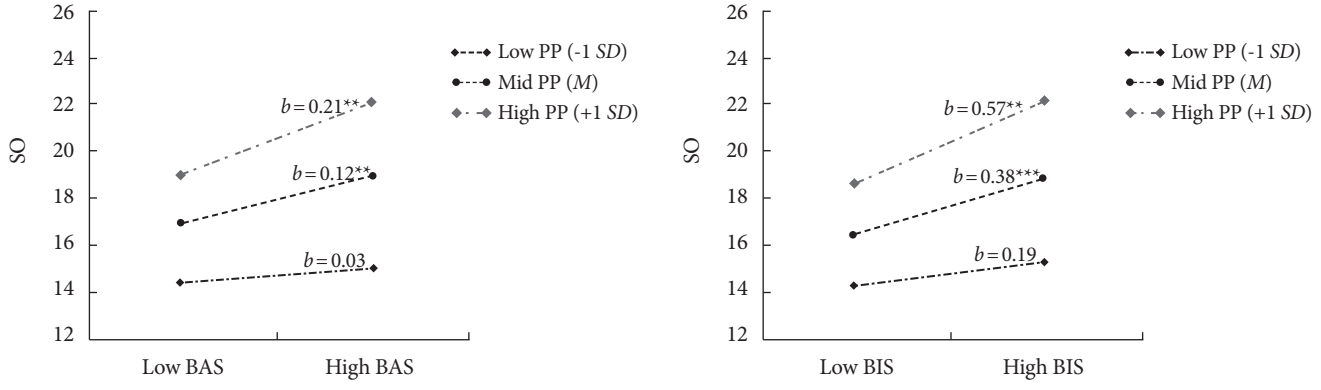

Figure 1. *Moderating effects of PP on the relationship between BAS/BIS and SO in the male group.*
*Note. SO = Smartphone Overdependence; BAS = Behavioral Activation System; BIS = Behavioral Inhibition System; PP = Peer Pressure; b = B (Unstandardized Coefficient). **p < .01, ***p < .001.*

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appropriate levels of reliability and validity. Consequently, this scale is considered useful for measuring the tendency of adolescents to use smartphones more to avoid isolation from or maintain close relationships with their peers. Kim et al. (2016) also emphasized the importance of recognizing the dependency on smartphones for maintaining peer relationships as a crucial factor for effective interventions related to SO. In the same context, it is anticipated that this scale can be utilized as a tool in clinical interventions to help adolescents recognize that PP related to smartphone usage can increase their risk of SO.

Secondly, an analysis of gender differences in key variables showed significant disparities in BAS/BIS and SO levels. Specifically, in terms of BAS/BIS levels, females exhibited significantly higher scores compared to males. This is consistent with previous research findings, which reported similar results indicating that BAS/BIS scores for females were higher than those for males (Choi & Yang, 2018; Jiang & Zhao, 2017; Oi et al., 2019). However, this presents a different pattern compared to research results indicating no significant differences in BAS/BIS levels between male and female adolescents (Lee & Kim, 2020). This highlights the potential for diverse patterns based on the age and gender of the study participants. Consequently, there is a need for additional research across various age groups to further explore gender differences in BAS/BIS levels. The level of SO was found to be higher in female students compared to male students, a result consistent with prior research findings and survey results (Kim, 2013; Jeon & Jang, 2014; NIA, 2020, 2021, 2022). However, the finding that female students have higher levels of SO compared to male students can be interpreted in various ways. Relevant studies report that female adolescents tend to actively engage in social networking services (SNS) due to their immersion in social relationships, and this is suggested to contribute to their higher levels of SO (Kim et al., 2016; Kim & Shin, 2015). Alternatively, some studies suggest that the mental health factor such as depression, may be more relevant to SO levels than peer relationships in female students (Kyoung & Kim, 2019). Furthermore, the portability and immediacy of smartphones are optimized for effective communication. This has led to reports suggesting that female students who use smartphones for communication and relationship-building purposes tend to have higher SO levels (Lee & Kim, 2020). In addition, many studies propose that female students may be more vulnerable to SO than male students and are influenced by a complex array of factors. Conversely, there were no significant gender differences observed in PP levels. This aligns with the findings of Kim and Lim (2019), who reported no significant gender differences in peer variables related to smartphone dependence, such as peer pressur susceptibility and peer popularity seeking tendencies. In other words, the norms and pressures related to smartphone use among peers may be concepts experienced similarly by adolescent groups regardless of gender. However, the PP measured in this study pertains to PP in specific situations directly related to smartphone use, and since there is a lack of previous research measuring a concept identical to this, further validation with adolescents is needed for a more accurate understanding of these results.

Thirdly, upon examining the correlations among the key variables, it was observed that BAS/BIS exhibited a significant positive association with SO, indicating that higher levels of BAS/BIS correspond to higher levels of SO. Furthermore, PP displayed significant positive correlations with SO within both male and female groups. Importantly, when comparing the correlation coefficients for statistical significance, it was confirmed that in both male and female adolescents, PP exhibited significantly stronger associations with SO compared to BAS/BIS. In other words, PP is strongly linked to adolescents' SO, possibly due to their strong desire for connection and relationships with their peers. A previous study reported that adolescents have conformity dispositions, and they are willing to accede to PP (Brown et al., 1986). Another study noted that adolescents high in the need for belonging will use the smartphone more than adolescents low in the need for belonging, putting them at a higher risk of smartphone addiction (Wang et al., 2017). This supports our finding that the PP inciting smartphone usage has a strong association with SO.

Fourthly, the results of examining the influence of BAS/BIS on SO depending on the level of PP are as follows. To begin with, regarding the main effects, BAS/BIS was identified as a statistically significant predictor of SO levels in both male and female groups, consistent with previous research findings. Similarly, PP also statistically influenced SO in both male and female groups. These findings align with Lee's (2016) research, which proposed that adolescents increase smartphone usage to build trust, facilitate effec-

tive communication, and alleviate feelings of social exclusion in their peer groups. Furthermore, the results of interaction tests revealed a significant moderating effect in the male adolescent group. Specifically, when PP levels were mid (*M*) or high (+1 *SD*), a positive relationship between BAS/BIS and SO was observed in the male adolescent group, indicating that higher levels of PP could enhance the impact of BAS/BIS characteristics on SO. The male group more influenced by PP showed SO levels approaching the range of potential-risk group for SO as their BAS/BIS levels increased. In other words, as our study targeted general adolescents rather than clinical groups experiencing smartphone addiction, the current average SO scores of the study participants may not reach potential or high-risk levels. Nevertheless, our findings indicate that, especially in the male adolescent group, through the interaction between BAS/BIS and PP, adolescents who are more influenced by peer norms are more likely to approach the potential-risk group level (23 points). This underscores the importance of preventive interventions, particularly for reducing peer influence in male adolescent groups. On the other hand, the male group less influenced by PP showed almost no difference in SO levels based on BAS/BIS levels. This suggests that the male group less affected by PP may potentially represent individuals with high self-regulation capabilities. In other words, despite BAS/BIS traits, individuals in this group seem capable of controlling their intrinsic tendencies. Therefore, it is expected that both PP and smartphone usage habits can be effectively regulated, it can be presumed that the level of SO is lower in this group. However, a precise understanding of these aspects would necessitate further exploration through relevant studies.

In the case of females, there were significant main effects of BAS/BIS and PP on SO, but the moderating effect of PP in the relationship between BAS/BIS and SO was not significant. The gender difference in this interaction effect may be attributed to the vulnerability of female adolescents to SO. Referring to the presented data, females exhibit significantly higher scores on the BAS/BIS scale, particularly on BIS related to anxiety about social exclusion. Additionally, the SO level of females was significantly higher, and the age at the first use of smartphones was earlier. Furthermore, Korean females prioritize relationships and a sense of belonging more than males and experience higher levels of FOMO (Joo et al., 2018). In other words, regulating anxiety related to social exclusion or controlling BAS/BIS tendency may be more challenging for females. Therefore, in the case of the female group, although the interaction effect was not significant in this study, there is a possibility that diverse interactions may exist among the vulnerabilities related to smartphone usage mentioned above.

Lastly, the most crucial finding of this study is the significant role of peer norms and pressures in predicting adolescents' SO level. Our results demonstrate that the explanatory power for SO significantly improves when considering both personal intrinsic factors, BAS/BIS, and external environmental factor, PP, in both male and female adolescent groups. Therefore, this study emphasizes the critical importance of peer norms and pressure, particularly in the context of smartphone use, as vital contributors to SO among adolescents. Furthermore, this research suggests that interventions focusing on promoting a peer culture that actively encourages wise smartphone use may be more effective than interventions solely emphasizing limitations on smartphone use. In other words, while individual therapy is crucial for adolescents with severe smartphone addiction, our results emphasize the need for preventive interventions aimed at fostering a culture where adolescents collectively engage with smartphones in a healthier manner. Previous studies on interventions for adolescents with smartphone addiction have often emphasized the significance of enhancing self-regulation skills. However, some studies have reported that this approach is effective in reducing resistance to addiction but does not significantly alleviate daily life impairment or withdrawal symptoms (Kim et al., 2015; Kim et al., 2013; Kim et al., 2020, as cited in Kim et al., 2020). Moreover, research investigating preventive programs for general users highlighted the effectiveness of activities that help individuals recognize negative emotions stemming from excessive smartphone use and explore alternative behaviors (Lee & Kim, 2019). Applying these insights to our findings, it appears beneficial to structure preventive intervention programs for adolescents by addressing peer pressure-related stress and exploring alternative activities to reduce involvement with such pressures. Additionally, a study by Shin and Jeong (2018) found that peer group discussions among friends about the potential risks associated with internet and smartphone content effectively reduced smartphone addiction levels, while parental interventions had minimal

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impact. Many studies have emphasized the importance of improving each other's smartphone usage habits and enhancing peer support to increase the effectiveness of adolescent smartphone addiction treatment programs (Avci et al., 2023; Jeon & Jeon, 2017). These findings support the proposal in our study that peer group interventions are crucial for establishing healthy media usage habits among adolescents. Therefore, expanding intervention programs in schools that enable adolescents to monitor each other and take on support roles within their peer groups can be a useful method for preventing SO among adolescents.

This study has several limitations. Firstly, our research sample consisted solely of second- and third-grade middle school students, necessitating further research that includes a broader age range to produce results more universally applicable to the entire adolescent population. Secondly, the measurement tool developed by the reseachers underwent validation and reliability analysis based solely on data collected within this study, without a preliminary investigation. Consequently, a supplementary phase involving extensive verification and confirmation of reliability and validity through follow-up studies is imperative. Thirdly, in our study, SO encompassed all smartphone content; however, it is crucial to recognize that issues related to smartphone use go beyond just overuse. Different usage patterns or intentions can lead to various other problems, independent of excessive use, as smartphones can enable activities such as online gambling, pornography consumption, social media engagement, gaming, etc. (Panova & Carbonell, 2018). Hence, future research should categorize usage based on patterns or intentions. Despite these limitations, the present study provides insight into and understanding of the strong effect of PP on smartphone use among adolescents. We expect that the results of this study can be applied as useful data for more effective prevention and educational intervention for adolescents in schools and clinical settings.

Author contributions statement

CJA, a graduate of Hanyang University and current clinical psychology intern at Gyeonggi Provincial Medical Center Uijeongbu Hospital, Department of Clinical Psychology, conceptualized and designed the research, collected and analyzed the data, and wrote the original draft of the manuscript. HSK, a professor at Hanyang University, supervised the research process, and reviewed the manuscript. All authors provided critical feedback, participated in the revision of the manuscript, and approved the final submission.

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