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University Students' Perceived Information overload Mediates Smartphone Immediate Response Syndrome During COVID-19 Outbreak: Taking the Perspective of Personality

La sobrecarga de información percibida por los estudiantes universitarios y su influencia en el síndrome de respuesta inmediata al smartphone durante la pandemia de la COVID-19: Tomando la perspectiva de la personalidad

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ABSTRACT

The COVID-19 pandemic has affected university students' learning and social interaction to a large level, causing different degrees of negative emotions and made them extremely sensitive to smartphone information. However, little is known about the link between personalities, perceived information overload (PIO) and smartphone immediate response syndrome (SIRS) during students' learning process in this specific emergency social context. Therefore, based on the person-environment fit model, this study investigated 482 university students from mainland China during the epidemic by a snowball sampling approach, and analyzed the relationship between their personalities, PIO and SIRS by structural equation modeling. Results indicated that individuals with extraversion and neuroticism formed SIRS from different psychological paths. PIO plays a partial mediating role between neuroticism and SIRS and a fully mediating role between extraversion and SIRS. These findings validate the association among individual personality, PIO and SIRS in the non-conventional environment and highlights the difference exist in cellphone-related psychological path between extraverted and neurotic students. Therefore, it is recommended that PIO should be controlled in a targeted manner for individuals with different personality and guide them using cellphones rationally during the epidemic.

KEYWORDS Personality; perceived information overload; smartphone immediate response syndrome; neuroticism; extraversion.

RESUMEN

La pandemia causada por la COVID-19 ha afectado en gran medida al aprendizaje y a la interacción social de los estudiantes universitarios, provocando emociones negativas de diferentes grados y haciéndoles extremadamente sensibles a la información de los smartphones. Sin embargo, se sabe poco sobre la relación entre la personalidad, la sobrecarga de información percibida (SIP) y el síndrome de respuesta inmediata al smartphone (SIRS) durante el proceso de aprendizaje de los estudiantes en este contexto social de emergencia específico. Por lo tanto, basándose en el modelo de ajuste persona-ambiente, este estudio investigó a 482 estudiantes universitarios de China continental durante la epidemia mediante un enfoque de muestreo de bola de nieve, y analizó la relación entre su personalidad, SIP y SIRS mediante un modelo de ecuaciones estructurales. Los resultados indicaron que los individuos con extraversión y neuroticismo formaron el SIRS a partir de diferentes vías psicológicas. La SIP desempeña un papel mediador parcial entre el neuroticismo y el SIRS y un papel totalmente mediador entre la extraversión y el SIRS. Estos resultados validan la asociación entre la personalidad individual, la SIP y el SIRS en el entorno no convencional y pone de manifiesto la diferencia que existe en la trayectoria psicológica relacionada con el teléfono móvil entre los estudiantes extrovertidos y los neuróticos. Por lo tanto, se recomienda controlar la SIP de forma específica para los individuos con personalidad diferente y guiarlos en el uso racional de los teléfonos móviles durante la epidemia.

PALABRAS CLAVE Personalidad; sobrecarga de información percibida; síndrome de respuesta inmediata al smartphone; neuroticismo; extraversión.

1. INTRODUCTION

The COVID-19 outbreak has disrupted individual's regular lives and also made a huge difference in teaching since late December 2019 (Cantero Téllez *et al*., 2022; Vásquez *et al*., 2023). Facing the grim situation of epidemic prevention and control, countries around the world have taken corresponding actions. Public health emergency response and strict traffic control have been implemented in all regions. Students are strictly isolated at home, so home-based online learning took place of the face-to-face schooling during the outbreak (Zhan *et al*., 2021a). The spread of COVID-19 had brought about changes in learning styles and severely damaged the education and social life of college students and negatively affected students' mental health,

social isolation, and academic performance (Cao *et al*., 2020; Elmer *et al*., 2020; Zhan *et al*., 2021b). They have to use the Internet to carry out their studies and use cell phones to meet the actual needs (e.g. study from home and work online) (Galván Orozco *et al*., 2022; Zhan *et al*., 2021c). Most students responded to the isolation and stress by adopting social media, which to some extent alleviated students' social isolation (Prowse *et al*., 2021). While people used social media to access information and stay connected with others, the misregulation of these technologies had created an information epidemic that had caused further physical and psychological damage. During the epidemic, there was an overload of information about the epidemic both online and offline, and a flood of rumors and fake news about the epidemic flooded social media, exacerbating public fears about the pandemic (Luu Duc Huynh, 2020). Influenced by the epidemic, people's attention to smartphone messages and instant messages has increased unprecedentedly.

The person-environment fit model (P-E model), proposed by French *et al*. (1982), argued that based on the state of equilibrium between an individual's resource needs (e.g., useful information) and environmental supply, when the balance was broken, negative emotions were likely to arise, leading to stress reaction to counter the adverse social environment (Ragu-Nathan *et al*., 2008). During the COVID-19 pandemic, numerous epidemic-related false news and rumors flooded social media (Shirish *et al*., 2021). The massive amount of information exceeded individuals' information processing capacity (Islam *et al*., 2020). Individuals' demand for information did not match the environmental supply. It was likely to break the equilibrium between individuals and the environment, resulting in the perception of information overload (PIO) and thus stress behaviors such as the smartphone immediate response symptoms (SIRS). What's more, studies showed that personalities are moderately correlated with individual subjective needs and cognitive load, and individuals with different personalities are also affected by cognitive load in different degrees (Gjoreski *et al*., 2020). Therefore, it is worth studying that individuals with different personalities will have varying degrees of PIO and SIRS in COVID-19 period.

The researchers have defined personalities as the characteristic patterns that influence behavior, thought, and emotion that interact with the environment. Many studies have taken personalities as the main factors affecting smartphone usage (Horwood, & Anglim, 2018; Panda, & Jain, 2018). During the COVID-19 epidemic, students need to use smartphones to study, socialize, and received external information, which undoubtedly increase the time and frequency of using smartphone. This study tried to explore the potential linkage between information overload and smartphone overuse during the epidemic, with an attempt to address the SIRS generated by different psychological mechanisms in students with different personality traits, to mitigate the negative impact caused by the unconscious overuse of smartphones by university students during the COVID-19 epidemic.

2. LITERATURE REVIEW

2.1. Personality

The five-factor model proposed by Costa and McCrae (1992), including openness, conscientiousness, extraversion, affinity, and neuroticism, is one of the most popular descriptive classification methods for personality characteristics, and is widely used to explain various human behavior and prediction of smartphone-related

activities (Roos, & Kazemi, 2018; Stachl *et al*., 2017). Among them, extraversion and neuroticism have been proved to be more predictive and regular in explaining individual differences (Eysenck, 1985; Tosun, & Lajunen, 2010).

Neuroticism refers to individuals' tendency to experience pain and the resulting differences in cognitive and behavioral styles (McCrae, & John, 1992). Individuals with higher levels of neuroticism are more likely to experience negative emotions, such as anxiety, depression, vulnerability and anger. They react poorly to stress and often view common situations as threats. Therefore, neurotic individuals are more likely to indulge in their smartphones to relieve their stress and anxiety, leading to smartphones' overuse (Roberts *et al*., 2015). Extraversion refers to a person's mental energy, interest, and attention directed to the outside, others, or external stimuli. Individuals with this personality are mainly characterized by external things rather than their thoughts and feelings (Gray, 1981). Extroverted individuals usually present as talkative, active and sociable (Komarraju *et al*., 2009). They use smartphones to receive more information and use social networks to build and improve their relationships (Kuss, & Griffiths, 2011). Some researchers have only looked at two personalities (i.e., extraversion and neuroticism) in studies involving personality, for example, Zhan *et al*. (2021c) study on cellphone addiction and Tan *et al*. (2018) study on smartphone application personality. Therefore, neuroticism and extraversion were selected in this study to investigate their relationship with SIRS and PIO in the context of COVID-19.

2.2. Perceived Information Overload

In the Omnimedia era, the subject, object, communication channel and amount of information are more integrated and complex. The accompanying information overload (IO) of users is becoming increasingly severe (Zhu, 2020). Scholars had attributed the IO effect of mobile social networks to the excessive information flow and the continuous interaction with other users online, and the sense that their responses are perpetually observed and demanded (Vorderer *et al*., 2017). IO is known as a subjective impression of receiving information too quickly to be processed efficiently. This status is conceptualized as a perception instead of an objective state (Misra, & Stokols, 2011). Studies have shown that users who experience IO are more likely to feel stressed, powerless, confused about developing things, and even experience confusion and self-doubt (Bawden, & Robinson, 2008). Therefore, in this study, we define this factor as PIO.

There are various factors lead to PIO. For example, civil servants who using online information systems may suffer from PIO due to social networking. The amount of information that individuals face when using mobile social networks can lead to overload (Schmitt *et al*., 2017). During the COVID-19 pandemic, the situation became complex and unpredictability, resulting in an increase in misinformation, and lots of unclear and inaccurate information will cause PIO (Islam *et al*., 2020), which may trigger adverse effects such as fear of missing out and anxiety (Xiao, & Mou, 2019). Therefore, it is necessary to explore the change of the PIO in the face of unknown COVID-19 development.

2.3. Smartphone Immediate Response Symptoms

According to statistics, by the end of 2019, it is estimated that more than 5 billion have mobile devices, of which more than half are smartphones, which have become an indispensable tool for people to

communicate (Hou, & Cheng, 2021). Immediate sensory responses may be necessary depending on the application and individual circumstances (Oulasvirta *et al*., 2011). Kanoh (2017) defined Immediate Response Syndrome referring to the feeling of having to check SNS sites and being is a state of psychological imbalance. Kanoh and Chou (2018) defined Immediate Response Syndrome (IRS) as a psychological tendency of Internet users obsessed with checking their social devices immediately. People's responsiveness to information is closely related to their fear of missing out, worrying about being absent from others' beneficial experiences, and a desire to be constantly connected to their experiences (Przybylski *et al*., 2013). This study defines SIRS as the behavioral tendency of Internet users obsessed with checking their social devices frequently and responding immediately, which can be regarded as a predictor of cellphone addiction.

From the above discussion, it can be inferred that personal environment and psychological tendency are related to people's SIRS. However, most of the existing studies only focus on smartphone message response and the satisfaction of cellphones for individuals' work needs (e.g., Hwang *et al*., 2020), ignoring the adverse consequences of students' frequent use and examination of cellphones during the learning process, such as decreased concentration, negative emotions, and low-performance levels, etc., as well as the changes and causes of SIRS during COVID-19-like anomalies. Therefore, during the COVID-19 outbreak, it is useful to explore the trends and influencing factors of SIRS. Appropriate intervention measures can be provided to help students get rid of unnecessary harm caused by SIRS.

3. RESEARCH FRAMEWORK AND HYPOTHESES

3.1. Personality Traits and Perceived Information Overload

From the perspective of cognitive science, IO results from the limited capacity of individual mediated information processing (Lang, 2000). From the perspective of news information, within a full media era, the media fusion would produce more complex information and disseminate a large volume of information and a more diversified main body and object, thus causing the IO in COVID-19. Chen (2003) argued that the extent of information overload is perceived by individuals and depends on personal factors such as personalities, emotions, feelings. Those with strong reservations or emotional characteristics may experience overload, mainly because they lack the skills to process content (Prasitratanaporn, 2010). Studies showed that personalities are significantly correlated with physical demands and objective cognitive load and that personalities tend to be extreme during the epidemic (Gjoreski *et al*., 2020; Zhan *et al*., 2021c). According to the P-E model, when personalities change, the physical demands and cognitive load change as well, and individuals may fail to process massive misinformation, breaking the balance with the environment that causes PIO to become more severe. Thus, we can infer a relationship between extraverts and neurotic personality and PIO. Therefore, the following hypotheses were proposed:

- H1: Neuroticism is positively related to PIO.
- H2: Extraversion is positively related to PIO.

3.2. Perceived Information Overload and Smartphone Immediate Response Syndrome

One of the typical symptoms of cellphone addiction is habitually checking for missing calls or messages (Chen *et al*., 2017; Lee *et al*., 2014). This phenomenon is more evident in instant message interactions, such as "Textiety" anxiety over receiving a message and immediately replying to it (De-Sola Gutiérrez *et al*., 2016). Smartphone users are highly vulnerable to sensory IO when dealing with the latest news's massive social demands (Lang, 2000), information is beyond an individual's ability to process, making it easy for them to miss the information they need, which produced the emotional fear of missing out. This worry drives users to pay closer attention to messages and keep in touch with others (Przybylski *et al*., 2013). Therefore, responding to smartphone messages may become a habit (Wegmann *et al*., 2017). After the outbreak of COVID-19, students' offline communication and study transferred to online. In terms of social interaction, instant messaging and different information platforms have become extremely active, and social isolation requires students to respond to messages as quickly as they can, showing the value of their social connections, even when they are studying; in terms of study, the amount of information interspersed with students' study-related messages also place certain demands on students' attention and responsiveness to information. Considering this, we proposed the hypothesis as follow:

- H3: PIO is positively related to SIRS.

3.3. Personality Traits and Smartphone Immediate Response Syndrome

Because impulsivity and trait anxiety lower the threshold of signal detection, it reduces the reaction times of high neurotic individuals so that individuals overreact to threat-related information (Crow, 2019; Mathews, 1990). Fu *et al*. (2020) suggested that the tendency to respond to information is not an external manifestation of stress in daily communication but tends to avoid external pressure and cooperate with others. Moreover, personalities were confirmed to be associated with e-mail, social networks and other Internet services (Kim *et al*., 2020; Russell, & Woods, 2020). Researchers believed that the trend of instant and immediate response to social network information would negatively affect individuals; for example, the person cannot control the desire to reply SNS messages immediately (Aoki *et al*., 2017). Therefore, the rapid response triggered by the trait is likely to trigger the SIRS phenomenon in students during cellphone use.

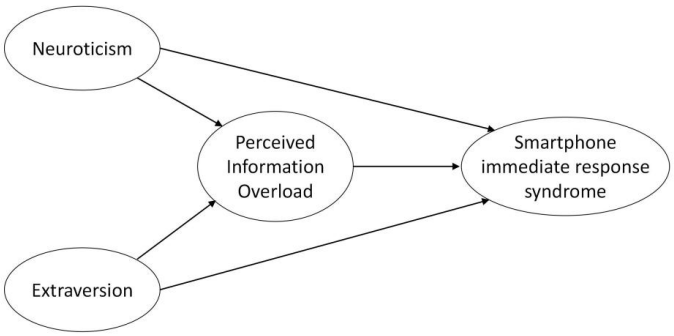
In addition, studies on text dependency suggest that extraversion may foster hyperactivity in maintaining social relationships through frequent use of text messages, while neuroticism may be sensitive to peers' reactions to their messages for fear of rejection (Igarashi *et al*., 2008). However, some researchers found no significant association between extraversion and reaction time (Crow, 2019). Although there are few academic papers on personalities and smartphone information responsiveness, considering the integration of smartphones and the P-E model, we can infer that personalities are related to SIRS (van Deursen *et al*., 2015). Therefore, we proposed the following hypotheses:

- H4: Neuroticism is positively related to SIRS.
- H5: Extraversion is positively related to SIRS.
- H6: Neuroticism is positively related to SIRS mediated by PIO.
- H7: Extraversion is positively related to SIRS mediated by PIO.

3.4. Research model

According to the P-E model, the COVID-19 outbreak leads to changes in the environment, the balance between individual needs and environmental supply is broken. Due to the need for personal safety and social interaction, students are forced to also receive a great deal of information during their studies, but this information often exceeds the threshold of what students can process, PIO occurs as a result, and SIRS may follow. Considering different degrees of epidemic effects on individuals with different personalities, this study included them into the research scope and proposed a research model, as shown in Figure 1.

FIGURE 1. This is a research model.



4. METHODOLOGY

4.1. Participants and Procedure

During the COVID-19, this study set up a questionnaire on a professional online questionnaire survey platform and distributed it, adopting the snowball distribution approach. The electronic questionnaire was sent out from WeChat groups to university and graduate students who experienced 14 days or more home isolation. Then they were invited to fill out the questionnaire and further distribute it to their classmates.

A total of 482 students returned their questionnaires to us. After eliminating 57 invalid questionnaires which chose too many single options (e.g., “uncertain”), had obvious contradictory answers, the number of valid questionnaires was finally 425, and the recovery rate of valid questionnaires was thus 88.2%. Among all participants (104 males, 321 females). In terms of the time individuals using smartphone each day, 254 participants (59.8%) used their phone for less than 3 hours, 171 (40.2%) for 4-6 hours.

4.2. Questionnaire

The questionnaire in this study was set up around four dimensions (i.e., Neurotic personality, Extraversion, PIO and SIRS), and the questionnaire items for each variable were designed according to previous researches. Participants were required to choose the most appropriate answer from five different levels, from 1 (strongly disagree) to 5 (strongly agree).

4.2.1. Neuroticism and Extraversion

For neuroticism and extraversion, the scale was adapted from the self-assessment version of the NEO Five-Factor Personality Trait Questionnaire by Costa and McCrae (1992). In this study, five items were measured extraversion, and four items were measured neuroticism (e.g., "I always ponder for a long time before making decisions" "I take the lead when communicating with people"). We believe that the higher the subject's score in the dimension, the more he conforms to the characteristics described in that dimension.

4.2.2. Perceived Information Overload

In the process of compiling a questionnaire on the PIO dimension, we referred to the questionnaire content of PIO by Hwang *et al*. (2020) Three items were used to explore the degree of participants' perceptual information process in this study (e.g., "I often get too many unwanted messages on my phone." "The volume of messages on my phone causes me to misunderstand some messages.").

4.2.3. Smartphone Immediate Response Symptoms

Kanoh (2016) developed an IRS checklist. This study investigates Smartphone Immediate Response Symptoms, we abbreviate this as SIRS. As a result, we adapted the scale according to the characteristics of using smartphones to explore the participants' SIRS. This study used five items to examine the degree of participants' SIRS (e.g., "If I read a message and don't respond right away, I feel anxious because I missed it." "If I forget to respond to an important message, I get restless.").

4.3 Data analysis

All responses were separated randomly into two sections using SPSS 26, and were subjected to exploratory factor analysis (EFA) with SPSS (N = 212) and confirmatory factor analysis (CFA) with Mplus (N = 213) to determine the questionnaire's structure, reliability, and validity. Finally, based on the hypotheses, this study used Mplus to construct the model, check the model fit, analyze the path, and check the existence of mediating effect.

5. RESULTS

5.1. Exploratory Factor Analyses of Questionnaire

This study used EFA to examine relationships between items and factors and to identify the structure of the questionnaire. The extraction method was Principal Component Analysis, and the rotation method Varimax with Kaiser Normalization, and the eigenvalues with loads less than 0.3 were excluded, after that we obtained the eigenvalues and variance explained for each factor, and the Cronbach's α value for each factor was also validated. As shown in Table 1, the questionnaire's Cronbach's α value was 0.805, verifying the adequacy of the sampling. And for all four variables, the cumulative variance explained was 66.294% means that this structure of 17 items explains 66.294% of the differences in relationship patterns among items. For each factor, the percentages of factors explained by Neuroticism (M = 3.339, SD = 0.746), Extraversion (M = 3.323, SD = 0.664), PIO (M = 3.138, SD = 0.694) and SIRS (M = 3.010, SD = 0.733) were 18.951, 15.136, 12.674 and 19.533%.

TABLE 1. EFA of the Questionnaire.

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4
FACTOR 1: Neuroticism, α = 0.859, M = 3.339, SD = 0.746				
I can't stay calm in a stressful situation	0.692			
I am easily depressed and melancholic	0.771			
I always think long and hard when faced with a decision	0.793			
Sometimes I strain my nerves and suffer from stress	0.774			
I am often distracted by trivial things	0.776			
FACTOR 2: Extraversion, α = 0.804, M = 3.323, SD = 0.664				
I will take the initiative to communicate with people		0.825		
I like to try things I haven't touched before		0.717		
I always keep an optimistic expectation before things happen		0.773		
In public, I often speak first		0.817		
FACTOR 3: Perceived Information Overload, α = 0.796, M = 3.138, SD = 0.694				
The large number of messages on my phone made me send messages with errors			0.796	
The large number of messages on my phone makes me misunderstand some messages			0.840	
A large number of messages or documents exchanged on my phone can cause me to accidentally delete them by mistake			0.817	
FACTOR 4: Smartphone Immediate Response Symptoms, α = 0.868, M = 3.010, SD = 0.733				
If I don't have my phone within easy reach, I get anxious				0.716
If I don't get a response to a message I sent after 15 minutes, I get anxious				0.743
Whenever I see (hear) a message from my cell phone, I will respond immediately, otherwise I will feel uneasy				0.848
When I am ready to go to bed and receive a message from my cell phone (such as a WeChat message), I will respond immediately or I will feel uneasy				0.802
When I put my cell phone in a place where I don't always put it, I feel uneasy				0.811

5.2. Confirmatory Factor Analyses of Questionnaire

CFA and Cronbach's α were used to assess the model's construct validity and reliability. Cronbach's α was used for reliability tests and CFA was used for composite reliability (CR) tests to test internal consistency. Table 2 showed the values of estimated factor loading (FL), average variance extraction (AVE), CR and Cronbach's α. According to Table 2, all Cronbach α values ranged from 0.859 to 0.911, exceeding the threshold value of 0.7 (Taber, 2017). All of CR exceeded 0.7, indicating a high external consistency for each dimension of the model (Peterson, & Kim, 2013).

Cooper and Emory (1995) argued that structural validity consists of convergence validity and discriminant validity. To assess convergent validity, the following criteria were validated: (1) all FL should exceed

0.6; and (2) the value of AVE associated with each explicit variable should exceed 0.5. The value of FL and AVE in Table 2 both meet the criteria, indicating acceptable convergence (Hair *et al*., 2014). What's more, the results show that both absolute value of skewness and kurtosis are less than 1, means the data in this study can be normally distributed, which is in line with the premise of structural equation model analysis (Yu, & Richardson, 2015).

TABLE 2. Descriptive statistics and CFA of the Questionnaire.

	M	SD	Skewness	Kurtosis	α	FL	CR	AVE
Suggested value					**>0.7**	**>0.5**	**>0.7**	**>0.5**
Neuroticism	3.128	0.750	-0.702	0.806	0.874	0.652~0.828	0.879	0.597
Extraversion	3.238	0.692	0.172	0.769	0.859	0.755~0.796	0.860	0.606
PIO	3.130	0.775	0.114	0.427	0.860	0.806~0.830	0.860	0.673
SIRS	2.900	0.815	-0.037	0.398	0.911	0.775~0.846	0.911	0.673

5.3. The goodness-of-fit analysis

Based on Hair *et al*. (2014), this study integrated multiple indicators to check the model's fitness. Among them, the value of x 2 /df is required to be lower than 3.0, the value of RMSEA and SRMR should be lower than 0.08, and the value of GFI, CFI and TLI are required to exceed 0.9 (Hu, & Bentler, 1999). It can be seen from Table 3 that the relevant data all meet the above five indicators. Therefore, it can be considered that the model has a high level of fit, that is, means that the model explains better the situation shown by the actual collected data.

TABLE 3. Modification indexes.

Modification index	χ2	df	χ2 / df	GFI	RMSEA	CFI	TLI	SRMR
Threshold value	-	-	<3.0	>0.9	<0.08	>0.9	>0.9	<0.08
Model indicator	172.41	113	1.526	0.919	0.050	0.970	0.964	0.043

5.4. Path analysis

Table 4 shows that neuroticism and extraversion were significantly and positively related to PIO, both of them $\beta > 0$, $p < 0.001$, so H1 and H2 hypotheses are supported. H3 is proven to be valid with the standardized regression coefficients ($\beta = 0.369$, $t = 4.822$, $p = 0.000$) of PIO to SIRS. The result of H4 is valid, it means neuroticism is significantly positively related to SIRS with the result of $\beta = 0.323$, $t = 4.519$, $p = 0.000$. However, extraversion is not significant correlated with SIRS ($\beta = -0.046$, $t = -0.611$, $p = 0.541 > 0.05$), H5 is not supported.

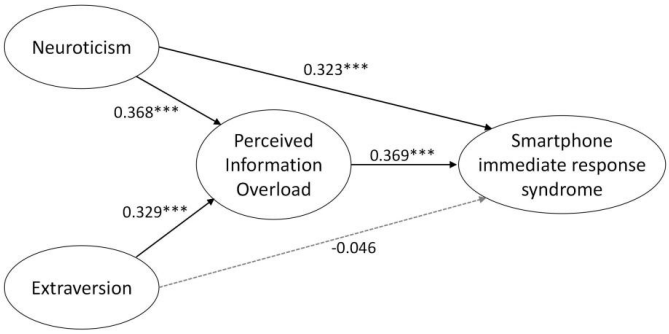
In Table 4, the dependent variable's explanatory power (R2) values indicate the strength of the independent variable's explanation of the dependent variable. According to Cohen *et al*. (2000), the value of R 2 greater than 0.15 is called medium explanatory strength. The model explained both PIO and SIRS at medium to high strength. We adjusted the original structure model and verified the research model based on the above results, as shown in Figure 2.

TABLE 4. Hypotheses test

Hypothesis	Path	t	p-value	R2	β	Hypothesis
H1	Neuroticism → PIO	5.539	0.000***	0.243	0.368	Support
H2	Extraversion→ PIO	4.804	0.000***		0.329	Support
H3	PIO → SIRS	4.822	0.000***	0.319	0.369	Support
H4	Neuroticism →SIRS	4.519	0.000***		0.323	Support
H5	Extraversion→ SIRS	-0.611	0.541		-0.046	Not Support

Note. ***P < 0.001

FIGURE 2. Verification of the research model.



5.5. Indirect Effect Analysis

From Figure 2, we could see that the relationships between variables include a direct effect and an indirect mediating effect. The indirect effects were analyzed by the bootstrap method and the results were shown in Table 5. When the interval formed by the corresponding value of the 95% confidence interval (CI) did not contain zero, indicating that the model exists a mediating effect (Lau, & Cheung, 2010). The results showed that there was a mediating effect between neuroticism and SIRS, and the mediating effect was significant (β = 0.130, p < 0.05; 95% CI, [0.040, 0.239]). In the same way, we found that PIO can mediate the relationship between extraversion and SIRS. The results showed that both H6 and H7 are supported.

TABLA 5. Indirect effects by the bootstrap method.

Point Estimate		Product of Coefficients			Bootstrap 1000 Times 95% CI			
					Percentile		Bias Corrected	
		S.E.	Est./S.E.	p-Value	Lower	Upper	Lower	Upper
Neuroticism -PIO-SIRS	0.130	0.052	2.487	0.013*	0.040		0.052	0.266
Extraversion -PIO-SIRS	0.169	0.066	2.567	0.01**	0.057		0.069	0.338

Note. *P < 0.05,**P < 0.01,***P < 0.001

6. DISCUSSION

Considering the unbalanced social situation during the COVID-19 outbreak, this study examined the relationship between neuroticism, extraversion, PIO and SIRS in students' learning process, and obtained the following findings: (1) neuroticism and extraversion can positively predict PIO; (2) PIO is positively related to SIRS; and (3) PIO plays a partial mediating role between neuroticism and SIRS, and a fully mediating role between extraversion and SIRS.

H1 and H2 are well proven, both neuroticism and extraversion could predict PIO significantly and positively. PIO was positively related to individual factors, information characteristics and other factors (Eppler, & Mengis, 2004). Individuals had higher stress levels during the COVID-19, which might contribute to individuals getting higher scores on neuroticism and extraversion (Liu *et al*., 2021). After the COVID-19 outbreak, individual's use of new media was significantly associated with more negative emotions, depression, anxiety and stress (Chao *et al*., 2020). This may because of numerous information directly displayed on smartphones, such as text, voice, video, etc. However, individuals with strong emotional traits who lack the ability to process the content are more likely to experience information overload. The test results of H1 support the judgment of individuals with neurotic personality who like to be alone but hate stress and perceive information overload. The test results of H2 confirmed that individuals with an extraverted personality are also prone to the inference of PIO when traditional social activities are blocked.

H3 is supported in this study, indicating that PIO is positively related to SIRS. During the COVID-19 outbreak, health information related to the epidemic was disseminated through various channels and flooded students' lives (Hong, & Kim, 2020), however, such numerous health information poses challenges for users to effectively locate and process the valuable information they need (Zhang *et al*., 2016). People had to pay more attention to such news because they were afraid of missing important health-related information to reduce the uncertainty and negative emotions brought by the unknown COVID-19 virus, leading to the generation of SIRS (Kanoh, & Chou, 2018). What's more, in the context of COVID-19, the existence of social media alleviated the loneliness and social distance of home learning caused by the epidemic. Social and learning needs rob students of cognitive resources, and PIO is more likely to occur (Li, & Chan, 2021). However, to prove the importance of friendship, responding to messages quickly and increasing the frequency of smartphone use became one of the response measures of students, which gave rise to SIRS (Kanoh, & Chou, 2018). When faced with smartphone information, individuals usually complete the target information's perception with only the necessary cognitive energy. Faced with massive amounts of information, people are more likely to respond immediately and abundantly than respond in a targeted and quality manner (Kleinmuntz, & Schkade, 1993). As a result, SIRS is inevitably produced when individuals focus on more content and are afraid of missing out on the information they need. In this sense, in the context of COVID-19, PIO significantly affects users' SIRS during students' learning process, which is supported by the results of H3.

H4 receives affirmative support, while H5 does not, indicating that the relationship between neuroticism and SIRS is significantly positive, whereas the relationship between extraversion and SIRS is not significant. Previous studies showed neurotic people tend to use social networks more to compensate for the difficulty of interacting with others and thus spend more time sending text messages (Bianchi, & Phillips, 2005;

Butt, & Phillips, 2008). Igarashi *et al*. (2008) found neurotic individuals were concerned about text messaging with their peers to avoid isolation and disconnection from their peers. The test results of H4 further support previous research results. For extraverts, they are more inclined to use smartphones for social activities (Horwood, & Anglim, 2018). They use social networks to establish and improve their interpersonal relationships but do not indulge in reacting to information instead of getting more information from their phones (Kuss, & Griffiths, 2011). Therefore, H5 is not valid, indicating no significant correlation between extraversion and SIRS in the specific social background of COVID-19.

Both H6 and H7 were confirmed to be valid in this study. The results show that PIO could serve as a partial mediator to influence the prediction of SIRS by neuroticism. Neuroticism can not only directly cause the immediate reaction of smartphones, but lead to SIRS by triggering PIO. This may be because during the COVID-19 epidemic, people were isolated at home (West *et al*., 2020), but social needs caused neurotic people to communicate through the Internet. They believed that it was a negative phenomenon that they did not get information quickly (Lu *et al*., 2011). To get rid of this, they will respond rapidly to smartphone messages. However, during the COVID-19, being in a state of fear or distress changes their use and perception of social media, thereby making them overloaded and fatigued (Whelan *et al*., 2020), and the desire to receive information in a short time causes them to pay more attention to the signal of their smartphone, triggering SIRS.

In addition, we also found that PIO plays a completely mediating role between extraversion and SIRS, which shows that extroverts do not directly cause SIRS, but under the action of PIO, the indirect effect of extraversion on SIRS has been significantly supported. Doucet and Stelmack (2000) believe that extraverts need extra processing time to deal with information, leading to an insignificant relationship between extraversion and SIRS. However, an abundance of misinformation appeared in the Coivd-19 outbreak, and due to the low perception and processing capacity of extraverted individuals (De Pascalis *et al*., 2018), an imbalance between individual demand for real epidemic-related information and environmental supply was highly likely to arise, and according to the P-E model, massive misinformation could not be processed in a timely manner, leading to information overload (Rathore, & Farooq, 2020), information needs to be confirmed by increasing the frequency and duration of cellphone use, resulting in the occurrence the SIRS stress behavior. Besides, it is admitted that, PIO may be a potential result of SIRS because the overuse of smartphones increases the proficiency and intensity of information that leads to PIO (Li, & Chan, 2021), but this study did not explore different perspectives on the relationship between SIRS and PIO, and the relationship between PIO and SIRS can be subsequently studied in depth in the model to complement the circular relationship between SIRS and PIO.

7. CONCLUSIONS, LIMITATIONS AND FURTHER STUDY

This study explored the relationships between Extraversion, Neuroticism, PIO and SIRS during university students' learning process in the COVID-19 epidemic based on the P-E model, and validated that PIO has a significant mediating effect between personalities and SIRS. However, neurotic and extroversive students generate SIRS from different psychological mechanisms. Comparatively, Neurotic students were more likely to suffer from PIO and SIRS. While students with an extraverted personality do not form SIRS directly,

however, they gradually develop SIRS when perceiving abundant information overload. Therefore, during COVID-19, in order to get rid of the harm caused by SIRS, different treatment options for mitigating PIO should be provided according to the personality characteristics of the students.

For extraverted students, teachers should consciously cultivate students' information literacy, improve their ability to process information (Lei *et al*., 2018), and guide students to choose more authentic and reliable official websites when searching for information, as so to reduce students' spending on reading the COVID-19 related news, and then reduces the impact of irrelevant information on students' PIO (Rathore, & Farooq, 2020). It can be clearly known that the uncontrollable use of smartphones in the learning process has a certain impact on students' learning concentration, learning atmosphere, etc. Therefore, in order to solve the sensory information overload caused by multitask and multichannel information for students, designing for personal boundaries may be a good choice for students, which can instruct them to learn to distinguish between learning and daily life messages, and treat different types of messages in different ways to reduce the experience of information overload and nomophobia. For neurotic students who were more prone to SIRS, it was necessary not only to alleviate their PIO, but also to provide positive psychological exercise to enhance the individual's ability to adapt to environmental changes and ultimately alleviate SIRS (Matz *et al*., 2020). Soucek and Moser (2010) suggested that necessary training interventions for neurotic students can contribute to the improvement of students' knowledge and media competence, and Ellwart *et al*. (2015) provided a structured online team adaptation procedure to deduce information overload. Moreover, these two interventions have been verified to have a certain effect on reducing PIO. It is expected that these interventions will ultimately reduce students' SIRS and reduce the negative impact of improper use of smartphones in students' learning process during the COVID-19 pandemic.

Future study is recommended to conduct experiments on exploring the effect of manipulating PIO to control SIRS, and obtain empirical evidence on the different psychological mechanism between Extraversion and Neuroticism on cellphone using. In addition, participants in this study were university students who survived a 14-day quarantine during COVID-19 pandemic in China, therefore, it is believed that the findings might be applicable to similar samples from countries that are still suffering from the COVID-19 or the other serious public emergency risk. According to the P-E model, this study believes that the emergence of SIRS is caused by negative emotions of PIO generated by the disruption of environmental equilibrium, using PIO as an influential factor in the creation of SIRS. However, previous research also indicated that PIO could be a result of SIRS, because the overuse of smartphone increased the proficiency and intensity of information, leading to the production of PIO (Li, & Chan, 2021). Different views on the relationship between SIRS and PIO were not explored in this study, but it provides a potential future research direction and subsequent attempts could be made to delve deeper into the relationship between PIO and SIRS in the model, complementing the circular relationship between SIRS and PIO. Moreover, as the psychological and cognitive consequences due to this environmental change are considered stable according to the P-E model. It would also be beneficial to collect another set of data after COVID-19 outbreak and compared with the results of this study, in order to investigate the generalizability of the current model and make further discussion.

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