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Full length article

Cellphone addiction during the Covid-19 outbreak: How online social anxiety and cyber danger belief mediate the influence of personality

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ARTICLE INFO

Keywords:

Covid-19

Personality

Cellphone addiction

Online social anxiety

Cyber danger belief

ABSTRACT

The highly contagious Covid-19 virus is spreading around the world, and quarantining at home has become one of the main preventative behaviors, but it has also led to news blackouts, affecting people's normal life and interactions. In order to determine a predictor of cellphone addiction (CPA), the present study, based on the Risk of Information Seeking and Processing (RISP) model, investigated the relationship between personality (Neuroticism and Extraversion) and CPA during the epidemic, mediated by online social anxiety (OSA) and cyber danger belief (CDB). A total of 683 questionnaires were collected through snowball sampling and analyzed by Mplus. Results indicated that neurotic and extroverted individuals developed CPA through different mediating factors. Neuroticism affected CPA through OSA while Extraversion affected CPA through CDB. These findings highlight the importance of different mechanisms of individuals with different personalities. Corresponding cognitive treatments on the perception of social anxiety and cyber danger are recommended on neurotic and extroverted individuals, respectively, in order to reduce their degree of CPA.

1. Introduction

Since late 2019, the Covid-19 virus has fully spread throughout the world, gradually developing into a major public health emergency, not only posing a huge threat to life, but also leading to psychological and behavioral problems including anxiety, depression, and insomnia (Chen et al., 2020; Kang et al., 2020). In response to the harm to human health caused by the Covid-19 pandemic, the Chinese government has issued relevant regulations and emergency policies to strictly prevent the spreading of Covid-19 virus, including checking and tracking the suspected cases, and strictly controlling individuals' outdoor activities and reduce public gatherings (National Health Commission of the People's Republic of China, 2020). Although home quarantine has become an important preventative measure against the epidemic, it might cause social isolation and other side effects (West et al., 2020). Access to epidemic-related information has greatly increased the frequency of using smartphones, and the demands of study and work (e.g., learning and working online at home) also increased the number of hours spent on using cellphones (Kiraly et al., 2020; Statista, 2020), while compulsive use and habitual checking of information are typical symptoms of smartphone dependence (Chen et al., 2017; van Deursen et al., 2015).

The above evidence shows that social isolation imposed by the pandemic affected the use of cellphones, which might potentially lead to more severe cellphone addiction.

With the gradual extension of home quarantine period, negative information such as internet rumors and a shortage of epidemic prevention supplies have emerged one after another, creating a certain amount of anxiety (Kiraly et al., 2020). McKenna and Bargh (2000) speculated that online social interaction is particularly attractive to people with social anxiety because individuals who have social anxiety can communicate anonymously online, and the various communication obstacles encountered in daily communication are greatly reduced. This implies that socially anxious individuals do not lack the ability to communicate openly, but their behaviors depended on their assessment of risk when performing within a social situation (Cuming & Rapee, 2010). This perception is defined as Cyber Danger Belief (CDB) in this study, indicating an individual's attitude towards the degree of risk existing on the Internet, which is an important issue that might need special attention during the Covid-19 outbreak.

The Risk Information Seeking and Processing (RISP) model proposed by Griffin et al. (1995) suggests that individuals in a risk situation proactively gather information about risk events and build their

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defensive beliefs and behaviors to safeguard their health in response to uncertainty. Kahn (1990) highlights that people perceive sources of interpersonal danger more easily when they consider the world as dangerous, suggesting that lack of confidence in one's surroundings may contribute to network danger beliefs (Zhang et al., 2010). In this process, the individual's risk experience, information sufficiency, and personality would influence his/her behavior and attitudes, as well as cause emotional reactions that trigger the individual's concerns associated with anxiety (Griffin et al., 1999). Recently, RISP has been used in some studies related to major disasters such as earthquakes (Wu et al., 2020) and nuclear crises (Ho et al., 2020). The current study takes a microscopic approach to investigate the phenomenon of Cellphone Addiction (CPA) under the risk of the Covid-19 epidemic, which is caused by a series of behavioral and psychological changes among people.

There are increasing evidences showing that social anxiety and CDB play a crucial role in social network use (Liu & Ma, 2020), and it is suggested that social anxiety be regarded as a mediator to regulate the association between shyness and CPA (Hong et al., 2015). All of these proposals have reported that there are significant associations between personality traits and social network use (Partala, 2011). However, most studies have focused on the analysis of the phenomenon and the influences of CPA under normal circumstances, while few have explored its mediating effect. Therefore, this study tried to examine the effects of CDB and online social anxiety (OSA) as mediators in the relationship between personality traits and CPA, specifically, during the Covid-19 period.

2. Literature review

2.1. Cellphone addiction

CPA has not been uniformly defined, but it can be considered a form of technology addiction (Lin et al., 2014), which is similar to behavioral addiction defined in the fifth version of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), such as compulsive behavior, functional impairment, withdrawal, and tolerance (Kocsis, 2013). In the current study, CPA is defined as the addictive behavior of escaping reality or creating pleasure from using a smartphone (Mok et al., 2014).

Previous researchers have identified problematic patterns and behaviors of smartphone use (Kim, 2019; Samaha & Hawi, 2016), and there has been in-depth research on the variety of harms caused by CPA, such as family conflict (Turel et al., 2008), decrease in sleep quality, and academic performance (Lisewski et al., 2020; Zhang & Wu, 2020). Generally speaking, smartphones' accessibility and diverse internet-based functions make it even more addictive than other technology addictions (Lin et al., 2016), and its properties during Covid-19 would be unique since it can help people escape reality and obtain pleasure. However, when the addictive individuals were disturbed or stopped using smartphone, the interfered withdrawal symptoms (e.g., feeling anxious, depressed, irritable) would probably appear on them. After a sustained period of time, interpersonal relationship problems will occur, and the individual's addictive experience might counterintuitively relapse (Mok et al., 2014). As can be seen, the impact of CPA is severe, but there is little research conducted on whether the degree of CPA and its risk has changed during the Covid-19 outbreak, which is one of the focus in the current study.

2.2. Personality

Costa and McCrae (1992) have established a five-factor model (FFM) model for personality evaluation, which is regarded as the most widely used model with common consensus in personality research (Horwood & Anglim, 2018). Before that, Gray (1970; 1981) proposed another personality evaluation model from the biological perspective, including a Behavioral Inhibition System (BIS) and a Behavioral Approach System (BAS). Some researchers believed that Neuroticism and Extraversion

could be used to examine BIS and BAS (Ide et al., 2020; Rogers & Revelle, 1998) since extraverted individuals and neurotic individuals have different sensitivities to reward and punishment signals. Some researchers claimed that Neuroticism is positively associated with BIS and unpleasant emotional processing, whereas Extraversion is positively associated with BAS and pleasant emotional processing (Gomez & Gomez, 2002; Spark & O'Connor, 2020).

Compared with the other personality factors in FFM, Extraversion and Neuroticism have a closer and more consistent relationship with emotions (Wright et al., 2006). A neurotic individual is anxious, overly emotional, and over-reactive to all types of stimuli, and tends toward negative affect, whereas an extroverted individual often seeks companionship, desire excitement, take risks, and tend toward positive emotions (Costa Jr. & McCrae, 1992; Eysenck, 1990).

2.3. Cyber danger belief

There is limited literature defining CDB because of the paucity of research at this time. This study derives a description of CDB from the RISP model proposed by Griffin et al. (1999), which incorporates "relevant channel beliefs" into the assessment of an individual's ability to know more about risks, expecting that critical analysis of risk information will result in attitudes and even behaviors that are more resistant to risk. This risk perception process is influenced to some extent by emotional reactions to risk (e.g., worry, anger) and certain personal attributes (e.g., social status, previous risk experiences, etc.; Griffin et al., 1999). In addition, Hong et al. (2015) mentioned belief in dangerous virtual communities as an extension of dangerous world beliefs to the online environment, which is essentially the same as the concept of CDB. Consequently, this study, based on Griffin et al. (1999) and Hong et al. (2015), considers CDB as a collection of beliefs that individuals create concerning the dangers or risks that exist on the Internet that influence individuals' online behaviors, which is essentially an attitude about the degree of risk.

2.4. Online social anxiety

According to the definition in the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (American Psychiatric Association, 2013), social anxiety is an excessive fear of potentially embarrassing or humiliating situations. Weidman and Levinson (2015) recognized highly socially anxious individuals through three dimensions (i.e., social inactivity, close relationship quality, and self-disclosure). People with OSA would be afraid of others negatively evaluating them in conversation (Mansell & Clark, 1999), and avoid drawing attention and disclose themselves during social interaction (Wallace & Alden, 1997; Baker & Edelmann, 2011). Furthermore, many studies have explored social anxious patients in online social media such as Facebook (Sindermann et al., 2020) and Instagram (Jiang & Ngien, 2020) without differentiating OSA and social anxiety. Although OSA is specific to social anxiety in online domains, social anxiety appears to be similar in online and offline environments (Weidman & Levinson, 2015). Individuals with high levels of social anxiety remain vulnerable to OSA (Yen et al., 2007), and individuals who experience high degrees of social anxiety tend to develop OSA when participating in online social networks (Hong et al., 2015). Thus, the current study adopts Weidman's definition of OSA.

2.5. Personality and cyber danger belief

Studies have shown that people with high Neuroticism tendencies often worry about their health when faced with infectious diseases (van Deursen et al., 2015). Mortensen et al. (2010) found that individuals with lower Extraversion tendencies were more likely to avoid infectious diseases. During the current epidemic, however, the uncertainty and low predictability associated with Covid-19 poses a threat to individuals'

physical health and influences their mood and cognition. To protect themselves, people are likely to generate negative emotions and negative cognitive appraisals (Mortensen et al., 2010; Schaller & Murray, 2008), which can result in increased sensitivity to cognitive dissonance and social risk (Li et al., 2020). While both neurotic and extroverted individuals' attention to epidemic information increased substantially, the negative cognitive assessment and social risk sensitivity associated with the epidemic are making individuals doubt about the information reliability. As a result, they are more likely to judge themselves as unsafe when gathering epidemic-related information, which probably exacerbating neurotic and extroverted individuals' CDB. Therefore, the following hypotheses were proposed.

H1. Greater levels of Neuroticism will significantly predict higher levels of CDB.

H2. Greater levels of Extraversion will significantly predict higher levels of CDB.

2.6. Personality and online social anxiety

Gray (1970; 1981) argued that BIS is related to trait anxiety while BAS is related to trait impulsivity. Norton et al. (1997) claimed that neuroticism could effectively predict an individual's social anxiety. For them, communicating via smartphones helps to seek comfort and relieve social anxiety (Li & Lin, 2019). However, other researchers did not agree with this conclusion and claimed no relationship between Extraversion and smartphone using behavior (Herrero et al., 2019). Therefore, it is worth examining and exploring whether the OSA profile of neurotic and extroverted individuals and the relationship between these two personalities and OSA have changed during the epidemic. Thus, the hypotheses are proposed as follows.

H3. Greater levels of Neuroticism will significantly predict higher levels of OSA.

H4. Greater levels of Extraversion will significantly predict higher levels of OSA.

2.7. Cyber danger belief and cellphone addiction

Hong et al. (2015) proposed that beliefs about dangerous virtual communities are negatively correlated to user persistency in Facebook. A dangerous social environment indicating a great deal of disinformation on the Internet, and cyber fraud is prevalent, which can easily make individuals lack of confidence and trust in their surroundings (Zhang et al., 2010). During the Covid-19 pandemic, the Internet was flooded with false information (Shimizu, 2020). Internet users might feel uncertain about the accuracy of the information they get and show a tendency to double check and confirm the information they need (van Deursen et al., 2015), leading to an increase in cellphone use. Therefore, the next research hypothesis is proposed as follows.

H5. Greater levels of CDB will significantly predict higher levels of CPA.

2.8. Online social anxiety and cellphone addiction

Existing research indicates that social anxiety is associated with Internet addiction (Yen et al., 2007). In contrast to real-life interactions, the Internet does not require an immediate response, which helps individuals get rid of anxiety-provoking social cues (e.g., threatening facial expressions). Therefore, it could reduce the stress of people with OSA (Yen et al., 2012). During the Covid-19 pandemic, people's negative cognition (e.g., social anxiety) would increase along with their distrust on the environment, as well as their social uncertainty regarding epidemics and transmission pathways. Subsequently, they need to communicate through smartphones to relieve social anxiety, thus

become overly dependent on their smartphones (Horwood & Anglim, 2018; Li & Lin, 2019). Therefore, the following hypothesis is proposed.

H6. Greater levels of OSA will significantly predict higher levels of CPA.

2.9. Research Model

According to the RISP model, individuals with different personalities might have different levels of fear when faced with the unknown epidemic state, which will lead to the use of smartphones to collect epidemic-related information, causing CDB and OSA, and further leading to CPA. Research has shown that CDB and OSA have different effects on different personality traits (Mortensen et al., 2010; Norton et al., 1997), and that personality trait, CDB and OSA have been shown to be associated with CPA (Hong et al., 2015; Yen et al., 2007). Based on the evidence, this study, during the Covid-19 pandemic, investigated the mediating effect of CDB and OSA on the path of personalities predicting CPA, as shown in Fig. 1.

3. Method

3.1. Participants

A total of 683 questionnaires were collected in this study. Then, we excluded those that were completed in less than 150 s, selected too many single options, or showed obvious inconsistent answers, resulting in 621 remaining valid questionnaires. The participants' location covered all of the provinces in mainland China except Tibet. Their ages ranged from 14 to 53 years old ($M = 23.24$, $SD = 5.661$). In terms of gender, 153 (24.6%) of the respondents were male and 468 (75.4%) were female. In terms of education level, 430 (69.2%) of the respondents were undergraduates and 122 (19.6%) were postgraduates, while 69 (11.1%) were outside of higher education (e.g., high school students, doctors, etc.). Regarding mobile phone use, 89 (14.3%) used their mobile phones for less than 3 h a day, 279 (44.9%) used them for 4–6 h a day, 184 (29.6%) used them for 7–9 h a day, and 69 (11.1%) used them for more than 10 h a day.

3.2. Procedure

The questionnaire was designed and developed around five variables (in the order of Neuroticism, Extraversion, CDB, OSA, CPA) during the Covid-19 pandemic. A snowball sampling method was used when distributing questionnaires. In this way, the eligible participants, who were socially isolated by Covid-19 for at least three weeks, were invited to complete the questionnaire, then they also helped to invite more eligible participants to complete the survey. The informed consent was provided in the survey so all the participants knew they were participating in an evaluation study and the data they provided was anonymous. For those who were under 18 years old, their guardians were responsible for giving consents. We have ensured all procedures performed in studies involving human participants were in accordance with the ethical standards of American Psychological Association. Then, the collected data were randomly divided into two parts for exploratory factor analysis (EFA) ($n = 280$) and confirmatory factor analysis (CFA) ($n = 341$) respectively to test the reliability and validity of the questionnaire and explore the possible relationships among the variables in question.

3.3. Questionnaire

The questionnaire was designed using a 5-point Likert scale, from 1 = "totally disagree" to 5 = "totally agree", on five dimensions (i.e., Neuroticism, Extraversion, CDB, OSA, CPA). The participants chose the most suitable option for themselves. Three experts from the fields of

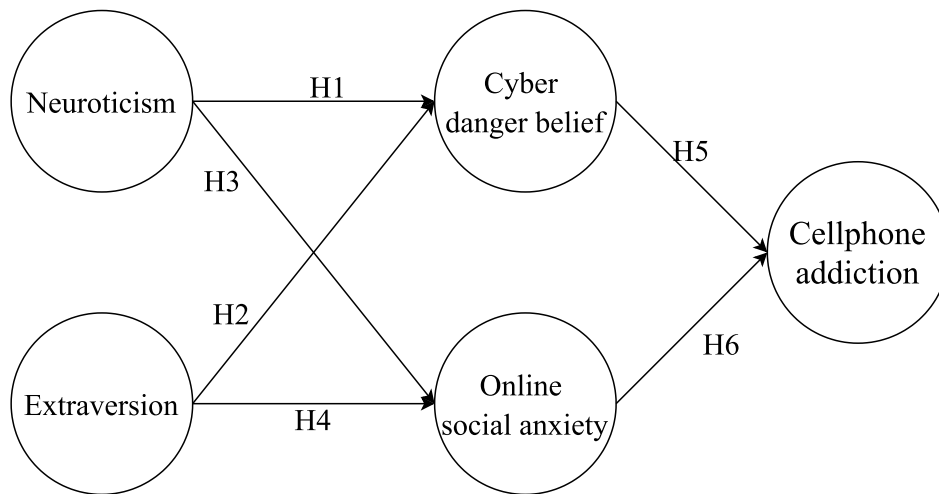


Fig. 1. Research model.

Psychology and Educational Technology were invited to evaluate the face validity of the questionnaire (Holden, 2010) and ensure every item was clearly stated and the entire questionnaire captured the expected structure. Afterwards, the internal testing of the questionnaire was widely distributed.

3.3.1. Personality measurement

The Eysenck Personality Questionnaire Scale (Eysenck et al., 1990) was used to evaluate personalities (i.e., Neuroticism and Extraversion) in this study. Five questions were retained for each dimension (e.g., I'm often distracted by trivial things; I always maintain optimistic expectations before things happen). The higher the score within the dimension, the more pronounced the personalities represented by that dimension in the subject.

3.3.2. Cyber danger belief measurement

The "Belief in a Dangerous World Scale", developed by Hong et al. (2015), was adapted for use in this study to measure the participants' attitudes about Internet dangerous and risk, such as their views on the safety of social networks (e.g., I feel that even if I am careful to protect my privacy on the Internet, things I don't want to go public will still get out there) and interpersonal dangers (e.g., I think the Internet is often full of people attacking others for no reason).

3.3.3. Online social anxiety measurement

The OSA Measurement Scale was based on Mattick and Clarke's (1998) Social Interaction Anxiety scale and Hong et al.'s (2015) two social anxiety scales, which measured levels of social anxiety in online situations (e.g., I would fear being attacked when I actively share a message with others on the Internet; I worry about the negative response to the information I share).

3.3.4. Cellphone addiction measurement

This study adopted the mobile phone addition index (Leung & Louis, 2008), which measured the level of CPA (e.g., I will still use my cellphone even when a teacher is at the lectern; I will still use my cellphone when I am doing something important before continuing with my work). However, the present study did not define a standard type of "CPA" that would classify individuals above a certain score as cellphone addicts, but rather considered higher scores as higher levels of CPA.

3.3.5. Statistical analyses

All data in this study were analyzed using SPSS 26 and Mplus 8.3 to conduct descriptive statistics, EFA and CFA. According to the Pearson correlation analysis, there were no correlations between gender/age and

the psychological variables in question (i.e., Neuroticism, Extraversion, CDB, OSA and CPA), therefore, the influence from gender and age could be excluded in the current study. Finally, we conducted path analysis for all variables to explore the relationship between the variables.

4. Results

4.1. Exploratory factor analyses of questionnaire

EFA was used to find out the number of items that affected the variable and the degree of correlation between each item and the variable. Table 1 shows the results of EFA. Participants' responses were divided into five orthogonal factors: Neuroticism (Cronbach's $\alpha = 0.838$, $M = 3.238$, $SD = 0.805$), Extraversion (Cronbach's $\alpha = 0.795$, $M =$

Table 1
EFA of the questionnaire.

| | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 |
|---|----------|----------|----------|----------|----------|
| Factor 1: Neuroticism, Cronbach's $\alpha = 0.838$, $M = 3.238$, $SD = 0.805$ | | | | | |
| NP1 | 0.775 | | | | |
| NP2 | 0.744 | | | | |
| NP3 | 0.728 | | | | |
| NP4 | 0.703 | | | | |
| NP5 | 0.578 | | | | |
| Factor 2: Extraversion, Cronbach's $\alpha = 0.795$, $M = 3.326$, $SD = 0.657$ | | | | | |
| EP1 | | 0.796 | | | |
| EP2 | | 0.740 | | | |
| EP3 | | 0.729 | | | |
| EP4 | | 0.693 | | | |
| EP5 | | 0.614 | | | |
| Factor 3: Cyber Danger Belief, Cronbach's $\alpha = 0.771$, $M = 3.541$, $SD = 0.617$ | | | | | |
| CDB1 | | | 0.785 | | |
| CDB2 | | | 0.749 | | |
| CDB3 | | | 0.738 | | |
| CDB4 | | | 0.698 | | |
| CDB5 | | | 0.512 | | |
| Factor 4: Online Social Anxiety, Cronbach's $\alpha = 0.801$, $M = 3.215$, $SD = 0.716$ | | | | | |
| OSA1 | | | | 0.830 | |
| OSA2 | | | | 0.721 | |
| OSA3 | | | | 0.692 | |
| OSA4 | | | | 0.658 | |
| OSA5 | | | | 0.640 | |
| Factor 5: Cellphone Addiction, Cronbach's $\alpha = 0.767$, $M = 3.314$, $SD = 0.703$ | | | | | |
| CPA1 | | | | | 0.771 |
| CPA2 | | | | | 0.728 |
| CPA3 | | | | | 0.670 |
| CPA4 | | | | | 0.668 |
| CPA5 | | | | | 0.625 |

Note. Overall Cronbach's $\alpha = 0.828$; and the total variance explained: 57.15%.

3.326, $SD = 0.657$), CDB (Cronbach's $\alpha = 0.771$, $M = 3.541$, $SD = 0.617$), OSA (Cronbach's $\alpha = 0.801$, $M = 3.215$, $SD = 0.716$) and CPA (Cronbach's $\alpha = 0.767$, $M = 3.314$, $SD = 0.703$) through using principal component analysis as the extraction method and the Kaiser normalized maximum variance rotation method. The cumulative variance explained by the five factors was 57.15%, and the overall Cronbach's α of the questionnaire was 0.828. Therefore, the division of the questionnaire into five variables for analysis in this study was consistent with the expectations of the proposed constructs.

4.2. Confirmatory factor analyses of questionnaire

CFA has the ability to fit actual data to pre-defined factor models. In order to detect whether the number of items and factor loading of the variables are consistent with the pre-established theoretical expectations, this study used CFA to further validate the constructs, and item OSA2 was removed according to the CFA's modification index (MI) to reduce the measurement error of the variables and optimize the factor loading of the constructs. After all the variables were tested by CFA, 24 items were ultimately left, as shown in the Appendix.

Variable consistency can be determined by checking the composition reliability (CR) of the structure (Fornell & Larcker, 1981). All of the CR values in this study are ranged from 0.848 to 0.868, which exceeded the recommended threshold of 0.7 (Hair et al., 2014). To assess internal consistency, Cronbach's α was used to assess the reliability of the questionnaire. Hancock and Mueller (2006) state that a Cronbach's α value above 0.6 indicates an acceptable level of reliability. The Cronbach's α values, ranged from 0.847 to 0.866, are listed in Table 2. All values were greater than 0.6, indicating that the questionnaire was reliable.

The core of CR is that the constructed test scores should be highly correlated (Chin & Yao, 2014). One way to test CR is to assess the correlation of scores between items of the questionnaire so that these items are considered to measure the same variable (Gregory, 2004). At the same time, convergent validity also focus on how separate variables or concepts are related to each other through correlated scores. The convergent effectiveness of this study was assessed by verifying the following conditions: (1) the average variance extracted (AVE) value extracted was higher than 0.5 (Fornell & Larcker, 1981); (2) the factor loadings of all items were significant and higher than 0.5 (Hair et al., 2014). All of the required conditions were met, indicating acceptable convergent validity in this study. By comparing the diagonal and lower triangle values of the discriminant validity in Table 3, it can be seen that the root sign value of AVE was greater than the other relevant constructs, indicating that the measurement model had some degree of discriminant validity.

4.3. Model goodness of fit test

Before using ML analysis for hypothesis testing, we first checked the data to ensure the data reliability. Since the survey was conducted online, we set up the rule that it can only be submitted when all items are completely answered, so there were no missing data in the collected questionnaire. We used all the data collected from the survey without excluding the outliers because previous research suggested that the

Table 2 Mean, standard deviation, reliability and validity of constructs.

| Suggested value | M | SD | Cronbach's α | CR | FL | AVE |
|-----------------|-------|-------|---------------------|-------|-------|-------|
| | | | >0.6 | >0.7 | >0.5 | >0.5 |
| Neuroticism | 3.279 | 0.711 | 0.864 | 0.865 | 0.767 | 0.564 |
| Extraversion | 3.323 | 0.634 | 0.866 | 0.868 | 0.752 | 0.569 |
| CDB | 3.499 | 0.628 | 0.847 | 0.848 | 0.725 | 0.529 |
| OSA | 3.193 | 0.676 | 0.858 | 0.858 | 0.776 | 0.602 |
| CPA | 3.276 | 0.685 | 0.858 | 0.858 | 0.739 | 0.548 |

Table 3 Construct discriminative validity.

| | Neuroticism | Extraversion | CDB | OSA | CPA |
|--------------|--------------|--------------|--------------|--------------|--------------|
| Neuroticism | 0.751 | | | | |
| Extraversion | 0.233 | 0.754 | | | |
| CDB | 0.333 | 0.263 | 0.727 | | |
| OSA | 0.468 | 0.016 | 0.498 | 0.776 | |
| CPA | 0.491 | 0.004 | 0.374 | 0.565 | 0.740 |

retention of outliers can represent the state of the entire population (Orr et al., 1991). Regarding the normality of the data, the skewness and kurtosis also conformed to the thresholds of ML analysis 2 and 7 (Ryu, 2011).

After preprocessing the data, this study used CFA to test the goodness-of-fit of the model. Based on Hair et al. (2014) suggestion, as shown in Table 4, the model assumed $\chi^2 = 459.832$ and $df = 247$; $\chi^2/df = 1.862$, where $\chi^2/df < 2$ indicated a very good model fit. Sarstedt et al. (2016) suggest that the focus should not just be on cardinal values, but that other fit indices should also be considered to obtain more objective conclusions so as to avoid power issues when using the cassette test in large samples. $p = 0.000$, $CFI = 0.945$. $TLI = 0.938$; $RMSEA = 0.05$, $SRMR = 0.078$, all of which are consistent with Kline's (2011) interpretation of the fit indices. Overall, the theoretical model fitted the overall pattern of the data in terms of the composite indices.

4.4. Path analysis

Table 5 shows the results of the path relationships between the hypotheses. As can be seen, Neuroticism and Extraversion affected participants' CDB with SRC of $\beta = 0.425$, $t = 6.41$, $p = 0.000$ and $\beta = 0.347$, $t = 5.20$, $p = 0.000$, respectively, thus H1 and H2 were supported. Neuroticism significantly affected participants' OSA with SRC of $\beta = 0.530$, $t = 7.86$, $p = 0.000$, thus H3 was supported. Whereas Extraversion had no significant effect on participants' OSA ($\beta = 0.135$, $t = 1.72$, $p = 0.086 > 0.05$), determining that H4 was not supported. H5 (CDB \rightarrow CPA) and H6 (OSA \rightarrow CPA) were supported with standardized regression coefficients (SRC) of $\beta = 0.160$, $t = 2.01$, $p = 0.045$ and $\beta = 0.525$, $t = 7.78$, $p = 0.000$.

Therefore, the model was reconstructed in Fig. 2, with valid ($p < 0.05$) paths indicated by solid lines and non-valid paths indicated by dashed lines, and shows a compilation of standardized path coefficients between the constructs, test results, and explanatory variables (R^2). The R^2 value is the change in percentage of the exogenous variables explaining the endogenous variables, representing the model's predictive power. The path coefficients and R^2 values indicate how well the structural model fits the empirical data based on multiple correlation coefficients (Byrne, 2001), with Neuroticism and Extraversion explaining 30.1% and 29.9% of the variance of CDB and OSA, respectively, CDB and OSA explained 34.7% of the variance in CPA. These values exceeded the 10% threshold proposed by Falk and Miller (1992). All of the variables in this study, therefore, have good predictive power (Hair et al., 2014).

4.5. Indirect effect analysis

This study further explored the mediation effects between the variables in Mplus. The results presented in Table 6 show that the confidence intervals of the three indirect effects did not contain zero, indicating that personalities had indirect effects on CPA through CDB and OSA. The results showed that the confidence intervals of the three indirect effects did not include zero, indicating that personality traits had indirect effects on CPA through CDB and OSA (Lau & Cheung, 2012). However, the mediating effect (AC1) of CDB on the relationship between Neuroticism and CPA was not significant ($p = 0.089 > 0.05$). Therefore, we concluded that there were two indirect effects exist in the model: OSA

Table 4
Modification indexes.

| Modification index | χ^2 | df | χ^2/df | RMSEA | CFI | TLI | SRMR |
|--------------------|----------|-----|-------------|-------|-------|-------|-------|
| Suggested value | – | – | <3.0 | <0.08 | >0.9 | >0.9 | <0.08 |
| Model indicator | 459.832 | 247 | 1.862 | 0.050 | 0.945 | 0.938 | 0.078 |

Table 5
Test of hypotheses.

| Hypothesis | Path | β | t-value | Support |
|------------|--------------------|---------|---------|----------|
| H1 | Neuroticism → CDB | .425 | 6.41*** | Positive |
| H2 | Extraversion → CDB | .347 | 5.20*** | Positive |
| H3 | Neuroticism → OSA | .530 | 7.86*** | Positive |
| H4 | Extraversion → OSA | .135 | 1.72 | Negative |
| H5 | CDB → CPA | .160 | 2.01* | Positive |
| H6 | OSA → CPA | .525 | 7.78*** | Positive |

Note. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

acted as a mediator which influenced the impact of Neuroticism on CPA (AC2), while CDB acted as a mediator influencing the impact of Extraversion on CPA (BC1).

5. Discussion

In the present study, we demonstrate that during the Covid-19 epidemic (1) CDB can serve as a mediating variable affecting the relationship between Extraversion and CPA, and (2) OSA can serve as a mediating variable affecting the relationship between Neuroticism and CPA.

The proposed model represented people’s psychological status during the Covid-19 pandemic. In Table 2, the mean value of Neuroticism and Extraversion indicated that the personalities of individuals became more tendentious and developed towards the extremes. This finding is consistent with the Traits as Situational Sensitivities Model (TASS; Marshall & Brown, 2006), indicating that certain personality traits (e.g., Neuroticism and Extraversion) would be stimulated to be more sensitive by special situation such as the home isolation caused by the Covid-19 epidemic. The mean value of CDB and OSA were higher than the critical value of 3, arguing for an increase in general anxiety and negativity in society triggered by the increasing social distance during the epidemic, which is consistent with previous research (Li et al., 2020; Qiu et al., 2020). It also confirmed that individuals were more sensitive to online cognition during the epidemic, and the widespread dissemination of false information led to the growth of individual online risk beliefs. In addition, the mean value of CPA showed that the epidemic increased people’s reliance on smartphones (Elhai et al., 2020). According to the RISP model (Griffin et al., 1995), individual personality tendencies became more pronounced during the epidemic, the dangerous social environment created more severe OSA and CDB, individuals needed to increase the duration and frequency of smartphone use for confirmation of an accurate picture of their surroundings, and cellphone addiction

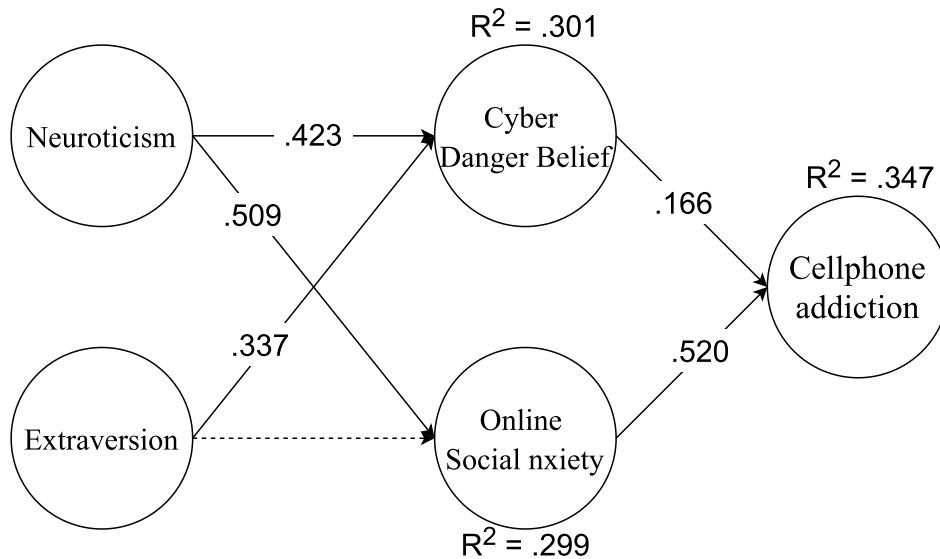


Fig. 2. Verification of the research model.

Table 6
Indirect effects analysis.

| Effect | Point estimate | Product of coefficients | | p - value | Bootstrap 1000 Times 95% CI | | | |
|-----------------|----------------|-------------------------|-----------|-----------|-----------------------------|-------|------------|-------|
| | | S.E. | Est./S.E. | | Bias corrected | | Percentile | |
| | | | | | Lower | Upper | Lower | Upper |
| Indirect effect | | | | | | | | |
| AC1 | 0.073 | 0.043 | 1.703 | .089 | 0.004 | 0.170 | 0.005 | 0.173 |
| AC2 | 0.274 | 0.064 | 4.303 | .000*** | 0.162 | 0.406 | 0.160 | 0.403 |
| BC1 | 0.056 | 0.027 | 2.047 | .041* | 0.005 | 0.113 | 0.004 | 0.112 |

Note. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

was more likely to occur.

H1 and H2 were both supported in this study, suggesting that Neuroticism and Extraversion significantly and positively predicted CDB. During the Covid-19 pandemic, there is an abundance of information about the epidemic, and it is difficult for people to have the mental stamina to deal with things as they normally would (Valika et al., 2020). Individuals with different personality traits elicit different levels of emotional responses when perceiving danger, aiming to reduce threatening behaviors (Neuberg & Cottrell, 2008). In an epidemic, Neuroticism is associated with greater perceptions of adversity and negative emotions, while individuals with high Extraversion scores may be less likely to adhere to social distance containment measures (Carvalho et al., 2020; Zajenkowski et al., 2020). As predicted by Prospect Theory (Kahneman & Tversky, 2013), people generally have the need of social interaction, however, during the Covid-19 pandemic, they would be more intended to interact through Internet in order to avoid the risk of exposure to the virus, although they would face the risk of obtaining false news and cyber fraud. To avoid the latter risks, more attention will be paid to the false news, causing individuals to face increased sensitivity to epidemic-related information, resulting in a higher level of danger and preparedness for the outside world, leading to higher CDB.

H3 was supported while H4 was not supported in this study, suggesting that Neuroticism was significantly associated with OSA, while Extraversion was not. Isolation in the context of Covid-19 triggers various psychosocial problems, such as anxiety and depression, and real-world social anxiety may be extended within social networks online (Jiang & Ngien, 2020). Individuals with high Neuroticism are inclined to experience negative emotions (Jerominus et al., 2014), so they have stronger anxiety about socializing. The findings suggest that extroverts and OSA do not show a significant relationship, possibly because extroverted people exhibit friendly, proactive, and positive emotions, so they are more likely to reduce anxiety by excessive use of devices such as smartphones to communicate with others (Darcin et al., 2015).

H5 was supported in this study, suggesting that CDB can significantly and positively predict CPA. As Ahmed (2020) and Pennycook et al. (2020) stated, people's perception of the existence of inaccurate or false information about Covid-19 would influence their decision-making process. Also, cyber criminals exploit the uncertainty and difficulties during this epidemic produced public emotional vulnerability (Naidoo, 2020), which would significantly reduce individual trust in the Internet and increase CDB. Individuals will use their cellphones more frequently to access information in order to eliminate this uncertainty and unreliability (Chen et al., 2020), which leads to CPA.

H6 was supported in this study, suggesting that OSA can significantly and positively predict CPA. Previous research indicated that patients with high social anxiety may use the Internet as a compensatory social medium (Valkenburg & Peter, 2009), so OSA may increase the frequency with which individuals use corresponding social media (Calancie et al., 2017), with the concomitant increased risk of CPA. According to previous findings on OSA and cellphone addictive behaviors, individuals' CPA is due to their fear of social behaviors (Lee et al., 2014), which is consistent with the finding of this study.

With regard to the indirect effect, this study verified that the relationship between Extraversion and CPA was influenced by the mediating variable of CDB, and the relationship between Neuroticism and CPA was influenced by the OSA mediator. Extroverted individuals use mobile phones more frequently because they are social, talkative, and are inevitably exposed to online threats and information security issues (Jang et al., 2014), causing dangerous beliefs that result in CPA. Neurotic individuals are more likely to be impulsive and irritable than extroverted individuals due to the fact that they are prone to interpersonal problems. They tend to use their smartphones to communicate with others or surf the Internet to avoid face-to-face conflicts. In the long run, this causes neurotic individuals to be more susceptible to CPA due to OSA.

6. Conclusion

Based on the RISP model, this study explored the mediating effects of CDB and OSA on the relationship between personality traits and CPA during the Covid-19 pandemic. It was found that CDB acts as a mediator that influences the relationship between Extraversion and CPA, and OSA acts as a mediator influencing the relationship between Neuroticism and CPA. For individuals with different personality traits during the Covid-19 pandemic, CDB and OSA can be strategically controlled in a targeted manner. For neurotic individuals, in order to reduce their degree of CPA, cognitive behavioral therapy and virtual reality exposure therapy could be used to relieve their social anxiety state (Boettcher et al., 2020; Walkom, 2016). Correspondingly, for Extroverted individuals, the false news identification system proposed by Chen et al., 2020 could help to suppress the spread of false news and increase the trust atmosphere and ease their CDB. The personality-based treatment might help to reduce individuals' CPA and the subsequent harm that it causes in a more effective way.

6.1. Implications and future research

The current study collected valuable first-hand data during the Covid-19 epidemic period, the findings enriched the theoretical framework of the relationships between personality traits and CPA, validated the mediating effect of OSA on the relationships between personality traits and CPA during the epidemic, and provided a novel perspective to explore the interconnections between personality traits and CPA using CDB as a mediator to enrich the relevant theoretical model. The good fit of the model supports the feasibility of the RISP theory at the micro level of CPA. It also provides a theoretical basis for the future application of the RISP model in public hazards related to the epidemic.

With respect to external validity and generalizability of this study, the age of the participants almost covered the majority group of mobile phone users and also covered almost all regions of China. Thus, it can be regarded as having a good universal coverage rate and reasonable sampling framework, results in valuable generalization potential in the whole China. Moreover, the findings could be extended to other countries where Covid-19 is still prevalent or when the other major emergent risky diseases take place in the future.

However, this study mainly examined how social isolation caused by the Covid-19 pandemic affected the use of cellphones, but the different characteristics (e.g., gender, age, race, etc.) of the participants and the environment in which they are located have not been considered much, which might need further investigation. In addition, future research could also consider conducting cognitive therapy intervention on the two mediators in order to verify the model with experimental data. Moreover, it might also be interesting to investigate the psychological status after the Covid-19 lockdown when people's life return to normal, to compare with the findings with the current study, to know more about the effect of the epidemic on the present model.

Credit author statement

Zehui Zhan: Conceptualization, Methodology, Investigation, Writing- Original draft preparation, Project administration, Funding acquisition. Qing Wei: Writing- Original draft preparation, Methodology, Software; Data curation. Jon-Chao Hong: Conceptualization, Methodology, Writing- Reviewing and Editing, Funding acquisition, Supervision.

Acknowledgements

This study was financially supported by the Major basic research and applied research projects of Guangdong Education Department (#2017WZDXM004), Science and Technology Planning Project in Guangdong Province (#2020A1414050056); National Social Science

Foundation of China (#18BGL053), Guangdong Philosophy and Social Sciences “13th Five-Year Plan” 2018 Disciplinary Co-construction Project (GD18XJY30); “Institute for Research Excellence in Learning Sciences” of National Taiwan Normal University (NTNU) from The Featured Areas Research Center, Program within the framework of the

Higher Education Sprout Project by the Ministry of Education (MOE) in Taiwan. We want to take this opportunity to thank the editor and reviewers for their valuable suggestions and thank all the participants for their supports.

Appendix

Variables and Question Items in the final Questionnaire.

| Variables | Question items |
|--------------|---|
| Neuroticism | <ol style="list-style-type: none"> 1. I am easily depressed. 2. I can't stay calm when I'm nervous. 3. I always think long and hard when I am facing a choice. 4. I sometimes strain my nerves to suffer from tension. 5. I am often distracted by trivial things. |
| Extraversion | <ol style="list-style-type: none"> 1. I am optimistic and cheerful. 2. I will take the initiative to communicate with people. 3. I am willing to take the initiative to help strangers. 4. I always maintain optimistic expectations before things happen. 5. I often start the conversation in public. |
| CDB | <ol style="list-style-type: none"> 1. I think there are more and more people who have no sense of morality on social networks. 2. I feel that even if I am careful to protect my privacy on the Internet, things that I don't want to go public will still get out there. 3. I think the Internet is full of people attacking others for no reason. 4. I think the social network has exposed me to more online scams. 5. I feel that the content that appears on social networks is becoming less and less trustworthy. |
| OSA | <ol style="list-style-type: none"> 1. I would feel nervous if someone corrects me on social networks. 2. I would fear being attacked when I actively share a message with others on the Internet. 3. I feel uncomfortable when people don't respond to my postings on social networks. 4. I worry about the negative response to the information I share. |
| CAP | <ol style="list-style-type: none"> 1. I use cellphone during class, even when a teacher is on the lectern. 2. I will definitely play with my phone before going to bed. 3. I will stop what I am doing immediately to use the phone because of the sudden alert of the phone. 4. I keep using my cell phone even during walking or talking. 5. When I am doing something important, I will check my cellphone before continuing with my work. |

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