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Smartphones and psychological well-being in China: Examining direct and indirect relationships through social support and relationship satisfaction

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ABSTRACT

Drawing insights from media richness theory and the Internet-enhanced self-disclosure hypothesis, this study examined the direct and indirect relationships between multiple uses of the smartphone and psychological well-being. A national online survey of smartphone users in China (N = 908) was conducted. Findings based on structural equation modelling showed that face-to-face and mobile voice communication directly predicted well-being whereas the relationship was indirect for mobile email, Weibo and WeChat through social support and relationship satisfaction. The results demonstrated the importance of examining smartphone use more holistically and using theory-based perspectives to explain the contingent mechanisms linking smartphone use and well-being.

1. Introduction

The mobile phone is the fastest diffusing communication technology in history. In 2005 global mobile subscription penetration was 33.9% and surpassed 100% in 2016 (ITU, 2019). Equally impressive has been the rapid diffusion of the smartphone (Taylor and Silver, 2019), a multi-purpose mobile device that integrates the capabilities of earlier generations of the mobile phone (e.g. voice calls and texting) with advanced computing power, fast internet connectivity, and a myriad of software applications that provide functions and services that fulfill peoples' personal and practical needs. The increasing ubiquity of the smartphone has been accompanied by much debate, commentary, and research on its positive and negative implications for people's general well-being (e.g. PEW (2018)). This is because of the well-established linkages between well-being and societal outcomes in such domains as health (e.g. longevity), social (e.g. relationship quality), and employment (e.g. productivity) (Maccagnan et al., 2018). Research on the communicative uses of the smartphone is thus important because it is embedded in the everyday routines of individuals, gives the feeling that others are always available when needed (i.e. perpetual contact), and facilitates the cultivation and maintenance of social ties, which can engender well-being (Chan, 2018; Ling, 2008).

The body of research examining the mobile communication and well-being relationship has provided inconsistent and inconclusive results, however. A mobile phone offers many ways in which individuals can communicate with others, but the extant research tended to examine very specific functions, such as voice calls (Jin and Park, 2013), texting (Park et al., 2016), and social media apps (Chen and Li, 2017); or specific platforms such as WhatsApp (Bano et al., 2019) and WeChat (Pang, 2018). While insightful, these studies did not consider communicative uses of the mobile in a more holistic manner. Nor did they statistically

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control for other communicative uses especially face-to-face communications that may also explain the findings. As the authors of a recent *meta*-analysis of the digital communications and well-being research have noted, the "literature focusing on the relationships of different online media and well-being is still rare" (Liu et al., 2019, p. 259). A few studies have examined the relationship between different communication channels and well-being, such as face-to-face, voice calls, e-mail, instant messaging and social network sites (Chan, 2018; Goodman-Deane et al., 2016), but the analyses were not framed under any explicit theory or theoretical framework. Indeed, reviews of the mobile communication literature showed that over half of mobile communication studies do not incorporate any theory (Kim et al., 2017; Zheng et al., 2016).

This study contributes to the literature in three ways. First, it examines the relationship between multiple uses of the smartphone and well-being in the context of friendship ties. Second, it aims to explicate and test the *conditions* in which the relationships occur. Drawing from insights from media richness theory (Daft and Lengel, 1986) and the Internet-enhanced self-disclosure hypothesis (Valkenburg and Peter, 2009b), we propose and test a theoretical model that explains the direct and indirect mechanisms from different smartphone uses to psychological well-being through social support and relationship satisfaction. Third, the study is based on a national survey of smartphone users in China, which is home to over 840 million mobile internet users (CNNIC, 2019). Previous research on mobile use and well-being have been based on student and young adult samples (e.g. Wen et al. (2016)) so implications of the technology for wider society in the country is unknown. China is at the forefront of smartphone technology and diffusion. It has been the world's largest smartphone market since 2012 (Wong, 2020) and is home to five of the top seven smartphone manufacturers after Samsung and Apple (Counterpoint, 2020). Therefore, it provides a suitable context to examine the proposed relationships in this study.

2. Literature review

2.1. Face-to-face, mediated communication, and psychological well-being

Humans are by nature social beings and we are inherently motivated to establish and maintain interpersonal relationships because social bonds engender positive emotions and well-being (Baumeister and Leary, 1995). It is so vital that individuals without social relationships have greater mortality risks than those who smoke, are obese, or are physically inactive (Holt-Lunstad et al., 2010). Its importance is reflected in its study at both the academic (Diener, 2013) and policymaking levels (e.g. OECD (2013)). Two "traditions" of well-being pervade the literature (Ryan and Deci, 2001). The hedonic view conceives well-being (i.e. subjective well-being) as the attainment of pleasure and happiness whereas the eudaimonic view (i.e. psychological well-being) emphasizes well-being as the realization of one's potential, of which happiness is one aspect. This study adopts this holistic conception of well-being.

For most of human history face-to-face communications have been the primary way in which relationships are established and maintained, which engenders well-being across the life span (e.g. Lee, et al. (2010), Teo et al. (2015)). Therefore, the earliest research on the consequences of online communication focused on its implications for psychological well-being (Huang, 2010; Kraut et al., 1998). Two competing research paradigms examined whether online communications *displaced* or *augmented* face-to-face communications. The displacement perspective viewed online communications as taking away time from face-to-face interactions, which negatively affects relationships and well-being because they are 'inferior' due to the lack of important sensory cues (i.e. visual, auditory etc.) that facilitate meaningful communication. The augmentation perspective viewed online communications as supplementing face-to-face interactions with existing social ties, hence providing more opportunities for sustaining relationships and maintaining social bonds, which is ultimately beneficial for well-being. These questions have inspired much research in the past decades, especially as more technologies are diffused into society.

Recent works on mediated communications and well-being tended to support the augmentation perspective. For example, *meta*-analyses showed that phone calls and texting were related to psychological well-being (Liu et al., 2019), though these uses were not specific to mobile phones. An analysis of adults in three countries (Australia, UK and US) showed that landline phone, mobile talk, email and video calls were related to overall satisfaction with life while text messaging, instant messaging and social networking sites were negatively related (Goodman-Deane et al., 2016). Specific studies of mobile phones also showed that mobile talk, but not mobile online communications (Chan, 2015) was related to psychological well-being; and mobile social media apps (Chen and Li, 2017) and the number of text messages sent and received satisfaction (Park et al., 2016) was positively related to well-being and relationship satisfaction, respectively.

These findings are consistent with Campbell's (2019) argument that the "zero-sum" arguments of the displacement perspective holds less sway for mobile communications because mobile phones "softens the constraints of space and time, lowering the threshold for interacting with others, information, and content" (p. 58). All things being equal, the mobile phone compared to other communication technologies provides exponentially more opportunities for communicating with others and sustaining social bonds with others, which supports the notion that mobile communications supplement face-to-face communications to fulfil humans innate need for interpersonal attachments that engenders well-being (Baumeister and Leary, 1995). To confirm this assertion for the current study context we propose the following hypothesis:

H1. *Frequency of face-to-face communications is positively related to communicative uses of the smartphone.*

Several research gaps remain. First, previous mobile studies tended to focus on one specific communication channel (e.g. voice, texting, social network sites) so they only provide a partial picture of the relationship. Second, with few exceptions (e.g. Chan (2015)) previous studies did not control for face-to-face communications. Without this baseline or inclusion of other communicative uses of the mobile, the effects of a specific mobile communication channel on psychological outcomes may be inflated (Walther, 2011). Third, it is relatively unclear why certain uses of the mobile are conducive to well-being while others are not. Thus, there is a need for

a theoretically informed and holistic examination of different mobile uses and their implications for well-being.

2.2. Different channels, different outcomes? A media richness explanation

Media richness theory (Daft and Lengel, 1986) proposed that different kinds of communication media vary in their capacity to transmit information. Originally conceived to explain how selection of different channels can overcome communication uncertainty and ambiguity in work environments, the theory has recently been adopted to explain the diverse effects of different digital communications on well-being (Goodman-Deane et al., 2016; Liu et al., 2019). According to the theory, media richness varies according to a channel's ability to provide immediate feedback, transmit a variety of sensory cues, be personalizable, and facilitate a variety of language types (Daft and Lengel, 1986). Face-to-face is the richest channel because complex information, ideas and feelings can be communicated unequivocally through natural language and the use of multiple visual, oral, and auditory sensory cues, such as body language and tone of voice. Feedback is immediate and communication is more personal and emotional. Voice communication either through landlines or mobile phones is less rich because it lacks visual cues, but it is comparable to face-to-face communications in other aspects. Indeed, previous studies have consistently demonstrated a positive relationship between these channels and well-being. Liu et al.'s (2019) *meta*-analysis showed that voice calls had the largest average effect ($r = 0.10$, $p < .001$) among all channels examined in over 100 studies. Goodman-Deane et al (2016) showed that face-to-face, landline calls, and mobile calls were positively related to overall satisfaction with life and overall relationship satisfaction. Moreover, Chan's (2018) multi-age cohort study found that face-to-face communication was the only positive predictor of friendship satisfaction and psychological well-being across all age groups examined.

These consistent findings are understandable from an evolutionary perspective. Humans have for a long time communicated in "a co-located and synchronous manner" (Kock, 2012, p. 384), such that we are hard-wired for face-to-face interactions to sustain social relationships and bonds that are vital to well-being. The human face is one of the richest social communication tools because it conveys exponentially more information to others, such as personality and emotions (Jack and Schyns, 2015). Voice communications lack visual cues, but they can still convey complex information and it can be powerful in expressing a range of emotions (Cowen et al., 2019) and engenders greater presence or the "perceptual illusion of nonmediation" (Lombard and Ditton, 2006), such that people behave as if they were communicating in face-to-face settings even when though they may be using a mobile phone for voice calls. Given the strong evidence we pose the following hypothesis:

H2. *Face-to-face and mobile voice communications with friends are positively related to psychological well-being.*

Beyond mobile voice the extant findings linking mediated communications and well-being have been mixed, though it is important first to distinguish the various types of mobile channels available for interactions with friends in the context of China. Texting (SMS) typically entails the sending and receiving of short text messages through cellular networks. Mobile instant messaging provided by internet-enabled apps extends the communicative capabilities of SMS, such as the ability to send and receive videos and photos.

WhatsApp and Facebook Messenger are perhaps the most recognizable messaging apps in the world. In China, however, WeChat is the most popular messaging app with over a billion users since its release in 2011. In addition to facilitating text and voice chat between individuals and groups like WhatsApp, WeChat also includes social networking features such as the Moments function, which facilitates a semi-closed network where WeChat 'friends' can share information and comment on each other's photos (Harwit, 2017). WeChat also offers the Twitter-like ability to follow public WeChat accounts such as those of organizations and public figures. More recently, the platform also added capabilities to play games and conduct financial transactions (Montag et al., 2018). WeChat has thus become a multipurpose mobile platform with features far surpassing those of WhatsApp and Messenger. Yet, it should be emphasized that despite its diverse features, texting still accounts for its main use as over 45 billion texts per day were sent in 2018 (Lee, 2019).

Another popular homegrown Chinese platform is the microblogging service Weibo, which is used by almost half a billion users (Weibo, 2019). Weibo functions essentially like Twitter and allows users to post short messages on different topics to one's followers, such as on politics and public affairs (Chan et al., 2012). Like WeChat the platform has evolved over time with new and revised features, such as allowing followers to comment on posts made by other followers and increasing the 140-word Chinese character limit to 2000 words.

From a media richness theory perspective WeChat and Weibo are relatively "lean" channels of communication because they rely predominantly on asynchronous text-based interactions and therefore has a lower capacity to deliver complex and affectionate messages to others. Of course, it must be acknowledged that these apps allow people to send recorded voice and video messages as well as personalize messages with various emoticons. But communication through text messages is very much still the norm.

The literature in general have offered conflicting findings on the effects of these channels on well-being. Liu et al.'s (2019) *meta*-analysis showed that texting was positively related to well-being whereas instant messaging was not. Interestingly, while social network sites were negatively related to well-being, social network site use for interactions was positively related to well-being, which is consistent with Chen and Li's (2017) finding that communicative uses of mobile social media were positively related to well-being. Conversely, Goodman-Deane et al. (2016) showed that text messaging, instant messaging and using social network sites were all negatively related to overall satisfaction with life, while studies of WeChat showed that intensity of use was related to life satisfaction (Wen et al., 2016). Given the conflicting evidence, we pose the following research question:

RQ1: Are mobile-mediated communications (not including voice calls) positively or negatively related to psychological well-being?

Several factors may account for the different patterns of previous results, such as the communicative context (e.g. with friends),

nature of sample (e.g. student versus adult), and measurement of key variables (e.g. generic versus platform specific measures of use). Another possibility is that the relationships between different types of predominantly text-based mobile communications and psychological well-being are not direct but are indirect through other pertinent variables and mechanisms.

2.3. An integrated model of mobile communications and psychological well-being

While lean communications such as texting may not directly engender psychological well-being, there is much evidence suggesting that such channels are conducive for social bonding and improving the quality of people's relationships. Early research of the mobile phone showed that it strengthened close-tie bonds by supplementing face-to-face and landline phone communications (Ling, 2008; Wei, 2006). Studies on instant messaging also showed that it engendered greater "closeness to friends" because texting facilitated another channel in which people can disclose their feelings and problems with others so as to obtain greater social support (Valkenburg and Peter, 2007). Closeness to friends in turn was related to well-being and the variable positively mediated the relationship between online communications and well-being. Another outcome of such closeness was that individuals perceived their relationships to be stronger and of higher quality (Valkenburg and Peter, 2009a).

More recent studies also demonstrated several indirect mechanisms from mediated communications to well-being. Two prominent mediators were bonding and bridging social capital. Individuals with higher social capital for example have people that they can turn to in times of need and have a circle of friends that share common values and beliefs. Chan (2015) showed that while mobile online communications through messaging apps, emails, and social network sites were not directly related to psychological well-being, the indirect effect was positive and significant through bonding and bridging capital. Similarly, Chen and Li (2017) found that bonding and bridging social capital mediated the relationship between communicative uses of the mobile phone and well-being. These findings were replicated for WeChat in a study by Pang (2018), which found that social integration, bonding relationships and bridging relationships mediated the relationship between time spent on WeChat and well-being. Other important mediators include social support and relationship satisfaction. Chan (2018) showed that while WhatsApp communications with friends did not directly predict psychological well-being, it was related to social support and friendship satisfaction, which in turn were related to well-being. These studies show that even communication channels considered to be less rich can be vital for developing and sustaining social relationships, which in turn leads to greater relationship satisfaction, and then engenders psychological well-being.

The mechanisms highlighted in the studies above are not novel, but were articulated over a decade ago by Valkenburg and Peter (2009b) and their proposed *Internet-enhanced self-disclosure hypothesis* model. The utility of the model is twofold. First, it provided a parsimonious framework to explain the inconsistent findings between online communications and well-being. Past studies and *meta*-analyses suggested that the direct relationship was negative (Huang, 2010). The key insight of the model was that the overall relationship can be positive if other important mediators are considered. For example, the negative direct relationship between Internet communication and well-being became positive once the variable closeness to friends was included as the mediator (Valkenburg and Peter, 2007). Second, the model proposed a serial mediation pathway from online communications to well-being through two mediators: "online self-disclosure" and "quality relationships". The serial mediation model is held together by three core assumptions. First, mobile-mediated communications provide more opportunities for individuals to disclose their feelings and obtain social support from others (Assumption 1). Recent studies have shown that intensity of WeChat use (Wang et al., 2019) and frequency of WhatsApp use (Chan, 2018) were positively related to online and offline social support. Second, self-disclosure and social support from others in turn leads to greater relationship satisfaction (Assumption 2) because individuals embedded in networks of social ties that can provide emotional and material support in times of need are more satisfied with their relationships (Dush and Amato, 2005). Third, high relationship satisfaction engenders greater well-being (Assumption 3) because people in satisfactory relationships feel happier and are more content with life (Diener, 2013). Although the model was conceived to explain the social consequences of online communications for the adolescent population, its underlying logic are equally applicable to the examination of smartphone communications and psychological well-being among the general adult population. Thus, we propose the final hypothesis in accordance to the model:

H3. *Mobile SMS, email, Weibo, and WeChat communications with friends are indirectly related to psychological well-being through social support and relationship satisfaction.*

Fig. 1 summarizes the hypotheses and research question posed in the study. In sum, we expect face-to-face and mobile voice communications with friends to directly predict psychological well-being because they are richer channels that can convey more complex information, immediacy, and intimacy. Moreover, the relationship should be indirect for other mobile-mediated communications that are predominantly text-based. The proposed model does not discount the possibility of other potential indirect pathways, such as from Weibo use to relationship satisfaction and then to psychological well-being. But this study tests specifically the assumptions of the Internet-enhanced self-disclosure hypothesis so other potential pathways are indicated with dashed lines.

3. Methodology

Data was collected between July 18–25, 2019 through online surveys distributed through Wenjuanxing (https://www.wjx.cn), which is an integrated survey design and dissemination platform used by many companies and universities in China for conducting online surveys (Mei and Brown, 2017). It also provides a sampling pool of more than 260 million registered users in China who participate in online surveys in exchange for financial incentives. After uploading the survey questions to the platform, we adopted quota sampling and specified to Wenjuanxing that the age of the sample invited to complete the survey from the sampling pool should be representative of the smartphone user population in China up to age 55.[1] Qualifying respondents were contacted by Wenjuanxing

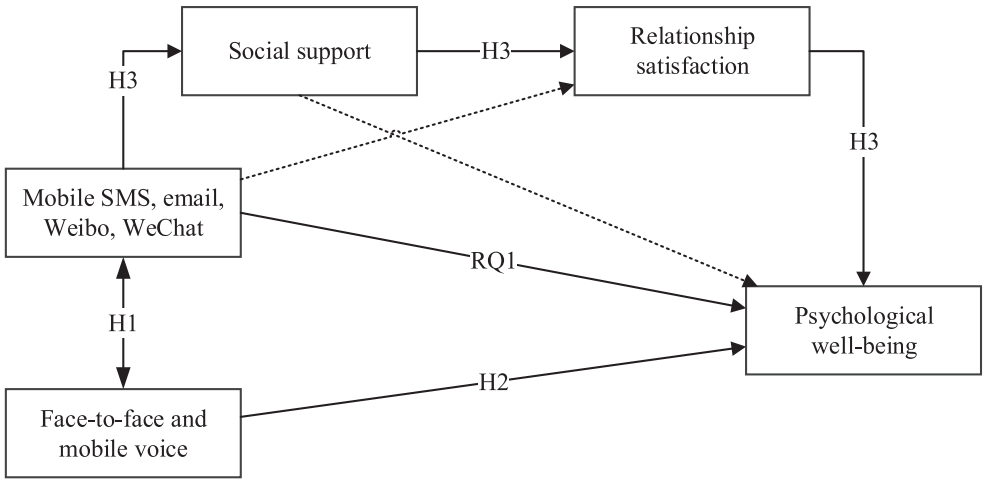

Fig. 1. Proposed theoretical model incorporating the *Internet-enhanced self-disclosure hypothesis* (Valkenburg and Peter, 2009b).

through social media and directed to the online survey. Upon arrival, respondents answered the filter question: "Do you currently use a smartphone?" and only those who answered affirmatively proceeded with the remainder of the online survey. When the quota of a certain age group has been reached, respondents of that age group are no longer invited to complete the survey. The procedure yielded a total of 909 completed and valid surveys. In terms of demographics, 53.1% of the sample is female, 74.4% had at least an undergraduate degree, 53.5% have a monthly income of RMB5001 and above. The mean age was 4.83 (4 = 25–29, 5 = 30–34), where 12.7% were under 18, 43.8% were between 18 and 34 years old, and 43.5% were between 35 and 54 years old.

3.1. Mediating and dependent variables

3.1.1. Social support

To measure the extent in which people perceive that their friendships provide emotional and instrumental resources, we adopted the 'emotional and informational support' subscale of the Medical Outcomes Study (MOS) social support survey (Sherbourne and Stewart, 1991). The wording of the 4-item scale was the same as Leung and Lee (2005). Respondents answered how often (i.e. 1 = "None of the time" to 5 = "All of the time" the following kinds of support that were available to them: 1) "Someone whose advice you really want", 2) "Someone to give you good advice about", 3) "Someone to give you information to help you understand a situation", and 4) "Someone to turn to for suggestions about how to deal with a personal problem." Items were combined and averaged to form a scale (M = 3.58, SD = 0. 67, alpha = 0. 71).[2]

3.1.2. Relationship satisfaction

An adapted version of the Dyadic Adjustment Scale (DAS-4) (Sabourin et al., 2005) was used to measure individuals' overall evaluations of the quality of relationships with their friends. The original scale was created to measure relationship satisfaction among spouses, but it is also commonly adapted by researchers for friendship contexts (Cheung and McBride-Chang, 2014). Respondents answered their level of agreement (i.e. 1 = "Strongly disagree" to 5 = "Strongly agree") to the following: 1) "My relationships with my friends are going well", 2) "I am able to confide in my friends", and 3) "I am happy with my relationships with my friends." Items were combined and averaged to form a scale (M = 3.90, SD = 0. 66, alpha = 0.75).

3.1.3. Psychological well-being

The 8-item psychological well-being (PWB) scale was adopted to measure well-being (Diener et al., 2009). In contrast to general measures of subjective well-being that focus on peoples' overall evaluations of their life, PWB is a holistic measure emphasizing "optimal human functioning" that comprises several aspects such as having meaning and purpose in one's life, being optimistic about life, and being respected by others (Diener et al., 2009). Respondents answered their level of agreement (i.e. 1 = "Strongly disagree" to 5 = "Strongly agree") to the following statements: 1) "I lead a purposeful and meaningful life", 2) "My social relationships are supportive and rewarding", 3) "I am engaged and interested in my daily activities", 4) "I actively contribute to the happiness and well-being of others", 5) "I am competent and capable in the activities that are important to me", 6) "I am a good person and live a

[1] This is based on a Statista report (2020) showing that 12.2% of smartphone users in China were aged below 18; 41.7% were aged from 18 to 34; 38.1% were from 35 to 54; and 8.1% were aged above 55. We did not sample those over 55 because online panels in China typically do not have sufficient numbers of older users for sampling purposes.

[2] We focus on this subscale because this study focuses on the affective and cognitive dimensions of social support in the context of friend-based relationships. The other subscales focus on practical dimensions such as material aid and availability of others, which is less relevant for this study.

Table 1
Partial correlations of key variables after controlling for demographics.

		1	2	3	4	5	6	7	8
1	Face to face	–							
2	Mobile voice	0.26***	–						
3	Mobile SMS	0.05	0.25***	–					
4	Mobile email	0.18***	0.16***	0.05	–				
5	Mobile Weibo	0.06#	0.21***	0.26***	0.26***	–			
6	Mobile WeChat	0.13***	0.23***	0.03	0.02	0.17***	–		
7	Social support	0.20***	0.17***	0.06*	0.16***	0.20***	0.22***	–	
8	Relationship satisfaction	0.17***	0.09**	0.03	0.18***	0.16***	0.19***	0.48***	–
9	Well-being	0.21***	0.19***	0.07*	0.18***	0.19***	0.20***	0.49***	0.62***

*** = $p < .001$, ** = $p < .01$, * = $p < .05$, # = $p < .10$.

good life", 7) "I am optimistic about my future", and 8) "People respect me." Items were added to form a scale (M = 30.70, SD = 4.40, alpha = 0. 80, Minimum = 13, Maximum = 40).

3.2. Face-to-face and mobile communication channels

Prior to the survey two face-to-face focus groups were conducted with smartphone users of different ages and respondents shared which channels they typically used on their mobile phones to communicate with their friends. The most common channels mentioned in the focus groups were included in the survey. Thus, respondents answered the frequency (i.e. 1 = "Never" to 5 = "A lot") in which they use different channels to communicate with friends on a typical day, including: face-to-face (M = 3.41, SD = 0. 86), mobile phone voice call (M = 3.41, SD = 0.91), mobile WeChat (M = 4.33, SD = 0.75), mobile email (M = 2.45, SD = 1.15), mobile Weibo (M = 2.26, SD = 1.11) and mobile SMS through their cell service provider (M = 2.20, SD = 0.80). WeChat is the most often used channel for communication with friends followed by face-to-face and mobile voice, and then mobile email, mobile Weibo, and mobile SMS. In terms of use or non-use, 99.2% communicated via WeChat, 98.8% via face-to-face, 98.6% via voice, 83.3% via SMS, 77.8% via email, and 69.9% via Weibo.

4. Results

We conducted the analyses in three incremental stages. First, partial correlation analyses were conducted after controlling for demographics to provide an initial assessment of the relationships among the variables. Table 1 shows that the various modes of communications were weakly correlated among themselves and with the outcomes (r values from 0.06 to 0.26) whereas social support and relationship satisfaction had moderate relationships with well-being. (r = 0.48 and r = 0.62). With regards to the relationship between face-to-face communication and smartphone uses for communication (H1), the hypothesis was supported for mobile voice, mobile email and mobile WeChat. It was marginally significant for mobile Weibo, and not significant for mobile SMS.

In the second stage we conducted hierarchical regression analyses to examine the extent in which communication channels predicted social support, relationship satisfaction and psychological well-being. The models are summarized in Table 2 below and all were significant: social support (R^2 = 0.15, F(10,898) = 15.65, $p < .001$), relationship satisfaction (R^2 = 0. 11, F(10,898) = 10.55, $p < .001$), and well-being (R^2 = 0. 48, F(12,896) = 68.07, $p < .001$). The models showed that face-to-face, mobile e-mail, mobile Weibo, and mobile WeChat all predicted social support, relationship satisfaction and psychological well-being. Mobile voice was only related to well-being and mobile SMS was not related to any outcome.

In the final stage we used structural equation modelling (SEM) based path analyses to examine the direct and indirect pathways from communication channels to well-being. A SEM approach allows all pathways to be examined simultaneously. The partial correlation matrix in Table 1 was entered into *Mplus 7* program and path analyses were conducted using maximum likelihood estimation. The initial model was specified based on the significant relationships uncovered by the regression analyses in Table 2.

The fit for this initial model was good: χ^2 (2) = 5.93, p = ns; CFI = 0. 99, TLI = 0.96, RMSEA = 0.05, SRMR = 0. 01, based on Hu and Bentler's (1999) suggested cut-off criteria of CFI/TLI ≥ 0.95, RMSEA ≤ 0.06, and SRMR ≤ 0.08. A respecified model was then tested by removing insignificant pathways from the initial model ($p > .05$) and the subsequent model fit improved slightly: χ^2 (7) = 14.44, $p < .05$; CFI = 0.99, TLI = 0.98, RMSEA = 0.03, SRMR = 0.02. Fig. 2 visualizes the final model and shows that face-to-face and mobile voice directly predicted psychological well-being, which supported H2. No other mobile-mediated communication channel predicted psychological well-being (RQ1). However, mobile email, mobile Weibo and mobile WeChat indirectly predicted well-being via social support and relationship satisfaction. Thus, H2 was supported for all mobile uses except for SMS. Table 3 further summarizes the direct and indirect pathways.

5. Discussion

The smartphone is becoming ubiquitous around the world and for many people it is an indispensable device for fulfilling their everyday needs and wants. One of them is the "need to belong" which is a fundamental psychological drive within individuals for

Table 2
Regression of variables on social support, relationship satisfaction, and well-being.

	Social support	Relationship satisfaction	Well-being
Block 1			
Age	−0.04*	−0.01	0.22**
Gender	0.06	0.04	0.03
Education	0.11***	0.03	0.03
Income	0.07**	0.08**	0.59***
R^2	0.04	0.02	0.05
Block 2			
Face to face	0.11***	0.09***	0.75***
Mobile voice	0.05	−0.02	0.38*
Mobile SMS	−0.01	−0.01	0.01
Mobile email	0.05**	0.08***	0.39**
Mobile Weibo	0.08***	0.06**	0.45***
Mobile WeChat	0.14***	0.14***	0.81***
R^2	0.11	0.09	0.11
Block 3			
Social support			1.41***
Relationship satisfaction			3.19***
R^2			0.32
Final R^2	0.15	0.11	0.48
N	908	908	908

Figures are unstandardized beta coefficients. *** = $p < .001$, ** = $p < .01$, * = $p < .05$.

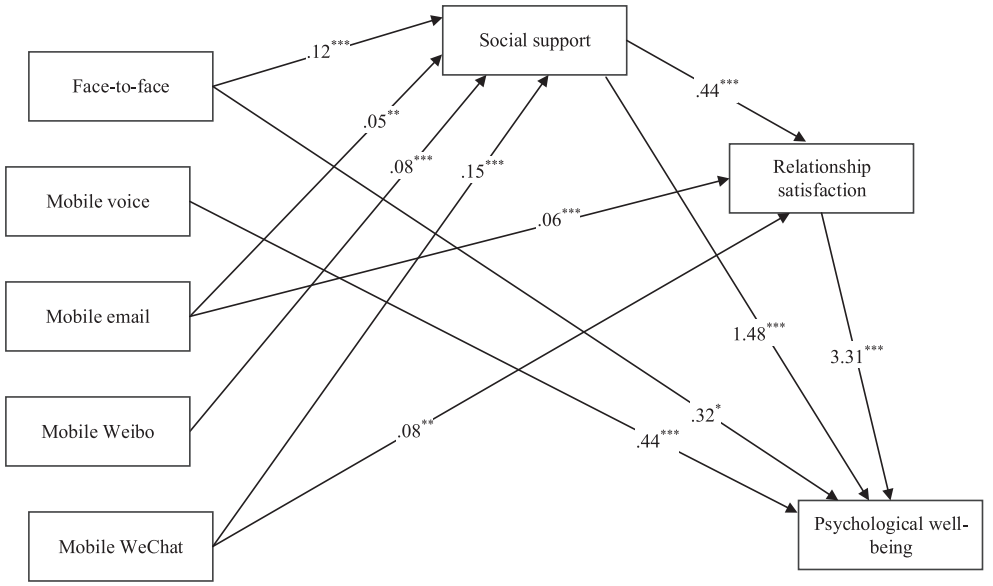

Fig. 2. Final mediation model of communication channels and psychological well-being. Figures are unstandardized beta coefficients. *** = $p < .001$, ** = $p < .01$, * = $p < .05$.

establishing and maintaining social relationships that lead to well-being (Baumeister and Leary, 1995). Therefore, the role of mobile communications to engender psychological well-being needs to be examined given the demonstrated health and economic benefits that accrue with positive well-being. Yet, the extant research on mobile communication just like the research on internet-mediated communication several decades earlier have offered conflicting findings. This study provided a theoretically informed examination of *why* certain channels of mobile communication are related to well-being and under *what conditions* they are related. It contributes to the literature in several ways.

First, the study reaffirms the augmentation perspective of mobile communications supplementing face-to-face communications with friendship ties. As Table 1 shows, none of the coefficients linking face-to-face and mobile communications were negative. Only mobile SMS exhibited a non-significant relationship. In other words, people who speak with friends face-to-face more frequently communicate more in various ways through the mobile phone, which provides “an added layer of connectivity in all realms of social life” (Campbell, 2019).

Second, the study demonstrates the importance of employing a SEM-based analysis that can simultaneously examine the multiple

Table 3
Summary of indirect effects from smartphone uses to psychological well-being.

Pathways	Direct pathway	Indirect pathway
Face-to-face → Psychological well-being	0.32*	
via social support		0.18***
via relationship satisfaction → social support		0.18***
Mobile voice → Psychological well-being	0.44***	ns
Mobile email → Psychological well-being	ns	
via social support		0.08**
via relationship satisfaction		0.20***
via relationship satisfaction → social support		0.08**
Mobile Weibo → Psychological well-being	ns	
via social support		0.13***
via relationship satisfaction → social support		0.12***
Mobile WeChat → Psychological well-being	ns	
via social support		0.22***
via relationship satisfaction		0.27**
via relationship satisfaction → social support		0.22***

Notes: *** = $p < .001$, ** = $p < .01$, * = $p < .05$. All models controlling for age, gender, education, and income. Unstandardized betas are shown.

direct and indirect pathways from communication to psychological well-being. At first sight, the regression analyses in Table 2 suggested that all communication channels except for mobile SMS were positively related to well-being. This went against the expectations of media richness theory and H2. However, the picture becomes clearer once the mediators of social support and relationship satisfaction were added to the SEM model. The final model showed that the direct relationship between communication and well-being was only significant for face-to-face and mobile voice communications, as suggested in recent large-scale studies (Goodman-Deane et al., 2016; Liu et al., 2019). This is understandable from the perspective of human evolution as face-to-face interactions have for millennia been the primary way to develop and sustain meaningful social relations that are vital for well-being. The findings suggest that at least for close tie relationships with friends, channels with a diverse range of sensory cues (i.e. visual, oral, and auditory) that can transmit different kinds of intimate and emotional language are more conducive for psychological well-being. Voice communication lacks visual cues but maintains the verbal characteristics and nuances of face-to-face communications, which are more effective to engender well-being directly compared to communication channels that have fewer cues. It should be emphasized that we do not imply that face-to-face communication is the "gold standard" in which mediated communications have to measure up to as previous researchers have cautions against this "FtF fallacy" (Sundar, 2008). Rather, it provides an important reference point when examining communication technology use and well-being (Walther, 2011). As an example, we ran the same regression analysis to predict psychological well-being minus the face-to-face variable in the model. The results showed inflated betas across the various mobile measures.

Third, the findings demonstrated the utility of applying the model based on the Internet-enhanced self-disclosure hypothesis (Valkenburg and Peter, 2009b). In line with expectations, the serial mediation model showed that social support and relationship satisfaction in sequence completely mediated the relationship from mobile email, WeChat and Weibo to psychological well-being. Even though the model was originally conceived to explain online communications and well-being among the adolescent population, our findings suggest that its three assumptions can also be applied to the study of a general adult population. Primarily text-based communications may not directly lead to well-being, but they can be very important to engender stronger social bonds and closeness with ones' friends (Chan, 2015; Chen and Li, 2017; Pang, 2018). In particular, the smartphone provides always-available though not always synchronous communications with friends, and this kind of perpetual connectivity provides the peace of mind that one's friends are a text away if social support is needed (Assumption 1), which in turn enriches one's perceived relationship satisfaction (Assumption 2) and eventual well-being (Assumption 3). This finding is not limited to just WeChat use, but also mobile email and Weibo even though individuals use them much less (M = 4.33 v. 2.45 v. 2.26) to communicate with friends. The relatively larger coefficients for WeChat are perhaps due to its greater number of "gratification niches" (Ramirez et al., 2008). For example, WeChat can accomplish many of the same tasks as email through both synchronous and asynchronous communications, so it has a broader niche of features to communicate with friends. Email has been shown to support existing relationships (Baym et al., 2007), but it is perhaps more suited for crafting longer and more emotionally meaningful messages that does not come with an expectation of an immediate response. Interestingly, no evidence of direct nor indirect effects of mobile SMS use on any of the outcomes were evident. A possible reason is that the messaging function for everyday communications with friends has been subsumed by WeChat such that mobile SMS is only used in very specific situations.

Fourth, this is one of the first studies on multiple uses of smartphones that focuses on China. Despite it having the largest number of smartphone users and being at the forefront of smartphone technology development and diffusion (e.g. rolling out the world's largest 5G networks in late 2019) there have been very few studies of smartphone communication and well-being in China focusing on an adult sample. This study thus provides an important frame of reference for future mobile communication and well-being research in the Chinese context.

More generally, the findings have important theoretical and practical implications for our understanding of the relationship between smartphone communications and well-being. Many mobile communication studies are atheoretical (Kim, et al., 2017). By

combining media richness theory and the Internet-enhanced self-disclosure hypothesis model, we demonstrated that the mobile communication and well-being relationship is more nuanced and indirect. Future research on smartphones should continue to incorporate and test extant theories and their assumptions that may engender well-being. For example, the focus on the attributes of the communication channel (i.e. media richness theory) can be supplemented with the examination of underlying motivations and rationales for using different forms of smartphone communications (i.e. uses and gratifications theory, media choice theories etc.), and their subsequent effects on well-being. Future studies can also explore other important mediators, such as amount of self-disclosure and bonding/bridging social capital.

5.1. Limitations and conclusion

Before concluding the study, it is necessary to address several limitations and suggest avenues for further research. First, it should be noted that the findings were based on cross-sectional data so the direction of the effects – though drawn from established theory – needs to be interpreted with caution. Second, while we used focus groups to develop our communication measures inductively, we only focused on general WeChat and Weibo use. While these platforms are primarily used for text communications, they also feature multimodal functions with varying levels of media richness such as video and voice calls. The Moments feature of WeChat for example facilitates communication among semi-closed networks that typically comprise close ties that are more conducive for well-being. Thus, more detailed studies of these different features will provide a more comprehensive account of the roles of WeChat and Weibo on well-being in China. Third, although media richness theory provided a logical explanation why face-to-face and mobile voice communications directly predicted well-being and other mobile uses did not, more research is needed to explicate what specific attributes are responsible for the difference. Is it the synchronous nature of these communications that are more immediate, the voice cues that enhance the emotional quality of such social interactions, or combinations of both or other factors? Future research can further examine the specific attributes of the medium and the specific ways they may affect different psychological outcomes such as well-being. Consideration of the theory of interactive media effects (TIME) (Sundar et al., 2015) may be useful in this regard. Fourth, the use of self-reported measures of use may not adequately gauge actual use. Future studies should attempt to use log-based data to obtain more accurate measures of use (Boase and Ling, 2013). Fifth, this study focused on the context of close tie communications and relationships and the findings may not be applicable to other types and stages of social relationships, such as those in the early stages of relationship formation and specific communities or types of relationships that are online-based. Moreover, this study focuses on the positive social uses of the smartphone whereas there is another important body of literature that emphasizes on the ways in which the smartphone may *interfere* with social interactions. For example, following a similar logic to the Internet-enhanced self-disclosure hypothesis, smartphone use can disrupt cognitive process, which in turn disrupt relationship process, which ultimately can lead to negative well-being outcomes like depression and loneliness (Sbarra et al., 2019). Future studies may attempt to reconcile and integrate these different approaches.

Despite the above limitations, this study has taken an important step to explain the direct and indirect mechanisms in which different smartphone uses are related to well-being. Theoretically, it provides a systematic account of how and why different smartphone communications influence psychological well-being. Methodologically, it demonstrates the importance of incorporating face-to-face communication and the simultaneous examination of different mobile uses to better test and understand the relationships.

Declarations

All authors have agreed to this submission and the manuscript is not currently being considered for publication by any other print or electronic journal.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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