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Mobile-mediated multimodal communications, relationship quality and subjective well-being: An analysis of smartphone use from a life course perspective

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ABSTRACT

This study examined the relationships among different smartphone uses (i.e. voice, email, SMS, Facebook, WhatsApp), perceived relationship quality and subjective well-being (SWB). Results showed that face-to-face communications and friendship satisfaction were related to psychological well-being and positive emotions across all age cohorts. Mobile voice was related to friendship satisfaction and social support for the older cohorts (35–54 and 55–70+); but also to more negative emotions for the younger cohorts. Facebook use and number of Facebook friends were related to social support and psychological well-being for the 18–34 cohort, while WhatsApp use was related to social support for all cohorts. Some mobile uses however were also related to increased feelings of entrapment and negative emotions for the younger cohorts. The findings are framed in line with the life course literature, and the outcomes suggest that future studies of smartphones and SWB may better be served with more explicit dialectical perspectives and approaches.

1. Introduction

In the past decade, the rapid diffusion and use of smartphones, Internet-enabled mobile devices that integrates many of the features and functions of personal computers and other consumer electronics, has fundamentally shaped the way people communicate in and maintain their interpersonal relationships. In 2016, the mobile messaging service WhatsApp and daily use of Facebook through mobiles both passed the 1 billion user benchmark (Facebook, 2016; WhatsApp, 2016). And despite being a technology that is over half a century old, email remains one of the most popular uses on smartphones, even more so than social network sites (Smith, 2015). Each additional channel of communication afforded by the smartphone provides people incrementally more opportunities to stay and feel connected with others, whether it is through voice calls, texting, email or receiving a comment on one's Facebook profile. The convergence of Internet-based technologies and its 'traditional' functions means that mobiles have become multimodal devices (Chan, 2015a; Helles, 2013). Yet, the implications of *mobile-mediated multimodal communications* on individuals' relationship quality and subjective well-being (SWB) is still unclear.

Scholars have noted the utility and importance of mobiles to facilitate access to and maintain bonds with meaningful ties (Ling, 2008; Rainie & Wellman, 2012) while others have argued that the ubiquity of mobiles have led to the deterioration in the quality of interactions as

people focus more on making "connections" rather than "conversation" (Turkle, 2015). From a more nuanced perspective based on dialectical theory, Hall and Baym (2011) highlighted the inherent tensions between the desire for close relationships vis-à-vis the need for independence from obligations. Taking a more historical view of technology diffusion and use, Stafford and Hillyer (2012) point out that "ICTs are ultimately tools for the same relational talk we have always had" (p. 307). Current findings reflect the diversity of these perspectives, with studies showing both positive and negative well-being outcomes related to mobile use. However, the literature on mobile communication and SWB is largely based on non-representative samples, typically college students, and measures that often examine only one aspect of mobile communication, such as voice (e.g., Jin & Park, 2013) or texting (e.g., Park, Lee, & Chung, 2016).

This study adopts a more holistic perspective with a representative sample that considers the most common uses of smartphones for social interactions with close friends, including social media platforms such as Facebook and WhatsApp; and their broader impact on relationship satisfaction, feelings of entrapment, social support, and SWB (which comprises both psychological and emotional well-being). Moreover, it adopts a life course perspective, which suggest possible generational differences in the relationships among mobile communications, relational quality and SWB because people at different life stages may have different experiences with technology (Chesley & Johnson, 2014) and

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motivations for maintaining social relations (Carstensen, Isaacowitz, & Charles, 1999). The sample is based in Hong Kong, one of the most mobile-centric cities in the world with smartphone penetration exceeding 200% (OFCA, 2016)¹ and where WhatsApp and Facebook is used by 81% and 72% of all Internet users, respectively (TNS, 2016). Thus, it provides an appropriate setting to study the social and psychological implications of mobile-mediated multimodal communications across different generations.

This study is structured as follows. First, it elucidates the theoretical bases in which mobile communications can be related to positive and negative outcomes. Second, the life course literature is examined to explain possible generational differences among the relationships. This is followed by the reporting of regression analyses derived from representative survey data that tests the relationships using broad measures of mobile use, relationship quality and SWB. Implications of the findings and suggestions for future research are then discussed.

2. Literature review

Because of the conflicting views in the literature on the positive and negative SWB outcomes of mobile communications, it is first necessary to review the respective bodies of research.

2.1. Linking mobile communication with 'positive' outcomes

Humans are fundamentally social beings. And the need to establish and maintain social relationships is one of the most basic motivations for attaining SWB (Baumeister & Leary, 1995), which comprises the emotional components of positive and negative affect as well as cognitive judgements of life satisfaction (Diener, Emmons, Larsen, & Griffin, 1985). It is desirable because it is linked to greater levels of health, community engagement, productivity, and other outcomes that contribute to a better society (Diener, 2013; Helliwell, Layard, & Sachs, 2013). Therefore, the ways in which communications, especially those mediated by digital technologies, are related to relationship quality and SWB, have been of much interest to scholars and policy makers alike.

Proposed by Baumeister and Leary (1995), the *belongingness hypothesis* has two assumptions. First, individuals need frequent cordial social interactions with others. Second, they feel that the relationships are meaningful and sustainable. Communication thus plays a fundamental role in relationships and SWB because it is through social connectedness that people fulfil their "need to belong" and maintain meaningful relationships. Indeed, research into early communication technologies such as the landline phone and email found that they had important uses for relationship maintenance and socializing with close ties because they facilitated convenient communications beyond face-to-face settings and provided a sense of reassurance (Dimmick, Kline, & Stafford, 2000; Dimmick, Sikand, & Patterson, 1994).

Early mobile research based on uses and gratifications theory exhibited similar findings, showing that mobiles fulfilled individuals' need to have access to and maintain relations with family and friends; and offered initial evidence that social uses of mobiles had positive relations with SWB in the form of decreased loneliness and shyness (Leung & Wei, 2000; Reid & Reid, 2007; Wei & Lo, 2006). More recent studies examining voice-based and online-based mobile (e.g., apps, social media, email) (Chan, 2015a) as well as mobile texting (Park et al., 2016) also demonstrated a positive relationship with intimacy, relationship satisfaction and SWB. By affording anytime anywhere communications, mobiles enhance relationship quality and gratifies the need to belong.

What is less known, however, is whether the relationships will hold when different uses of the mobile are examined together, and whether the distinctive features of social media may also contribute to

relationship quality and SWB. This is especially the case for smartphones, a technology that offers many of the same communication tools and channels as desktop computers and tablets as well as those designed specifically for mobiles (e.g., texting). Facebook for example was originally designed for large monitor screens, yet daily access to the social network site through mobiles has grown exponentially in recent years to reach 91% of its 1.13 billion users (Facebook, 2016). While previous studies on Facebook and SWB did not distinguish mode of access, much of the evidence supports the notion that Facebook fulfills the need to establish and maintain social relations (Quan-Haase & Young, 2010) and points to a positive relationship (e.g. Valenzuela, Park, & Kee, 2009), especially personalized communications with strong ties (i.e. comments, messages and wall posts received from friends) (Burke & Kraut, 2016). In addition to facilitating social connectedness, Facebook can also be an important source of social capital and emotional support, i.e. the tangible and intangible resources that can be called upon in times of instrumental need or emotional distress. Past studies suggest that number of Facebook friends matter. The higher the number, the more social support one believes that one can receive, which in turn results in lower stress and positive SWB (Kim & Lee, 2011; Nabi, Prestin, & So, 2013).

Recent research has also begun to pay attention to mobile messaging apps such as WhatsApp, which is important given that 2013 was the tipping point in which the volume of messages delivered through such services overtook that of more traditional short message service (SMS) (BBC, 2013) and continues to grow exponentially. While both technologies offer similar functionalities, such as socializing and coordination, research have shown that WhatsApp is more popular for keeping in touch with close friends because messages are more conversational compared to text messaging and have fewer technical limitations (Church & de Oliveira, 2013). In addition, the 'group chat' feature facilitates the convenient sending and receiving of one-to-many messages to pre-categorized 'communities' based on different relational domains, such as family, friends and work colleagues (Aharony & Gazit, 2016). Even though the user may not be the original recipient of a message within the group, he or she nevertheless still receives the message and can take part in the conversation by being a member of the group, which engenders a sense of belonging to the group even though one may not be an active participant. Thus, when considering the use of Facebook and WhatsApp on smartphones, it is not only necessary to consider frequency of use, but also the relative size of the social networks contained within each platform given the suggestive evidence that larger networks may provide access to more resources and social support.²

In sum, perspectives and theories pointing to the positive SWB outcomes of mobile communications emphasize the expanded opportunities for communication with important others driven by the psychological need for social connectedness, and access to emotional and instrumental support in times of need.

2.2. Linking mobile communication with 'negative' outcomes

Perspectives and research on the negative relational and SWB consequences of communication technologies emphasize the reduced quality of mediated communications and the problem of 'over-connectedness'. In contrast to 'complementary' perspectives of communication technology, 'displacement' perspectives focused on diminished face-to-face interactions by technologies considered to be less rich and meaningful (Ruppel & Burke, 2015). Noted communication technology critic Turkle (2011) for example argue that individuals, particularly digital natives, are eschewing face-to-face for mediated

² Of course, there are other social network sites and mobile messaging apps beyond Facebook and WhatsApp. But, given their global dominance and in this study's context of Hong Kong, they will be the focus of the current research.

¹ Defined in terms of 2.5G/3G/4G mobile telecommunications technology standards.

interactions so as to maintain psychological distance with others. The results are increased loneliness as well as less authentic and empathetic interactions between people, even in situations where they are co-present, as individuals prefer to expend energy on the process of making connections rather than engage in substantive and deep conversations (Turkle, 2015).

Others emphasize the cognitive demands of reciprocal communications because having access to others also means that one is accessible in return (Stafford & Hillyer, 2012), which can lead to “the feeling of being inundated by the expectations of being always on, always available ...” (Quan-Haase & Collins, 2008, p. 539). Such a ‘burden’ from technology has long been noted by work-life balance research, showing that heavy volume of work-related emails and mobile calls often spill over to and interfere with the family lives of working adults, which in turn increases stress and diminishes life satisfaction (Barley, Meyerson, & Grodal, 2011; Chesley, 2005). Studies of mobiles that focus on *volume* of use also had similar conclusions. For example, time spent texting is related to less relationship satisfaction (Park et al., 2016) and general mobile voice calls to loneliness (Jin & Park, 2013). These findings stand in contrast to the literature showing that ‘social’ uses of mobiles are generally related to relationship satisfaction and SWB. However, the body of mixed evidence for positive and negative outcomes of mobile communications may not necessarily be contradictory of each other, but be more of a reflection on the different foci and measures of different studies.

What the above studies highlight are the inherent tensions between mobile-mediated connectedness and the social obligations of having to be available to others. This was acknowledged in Hall and Baym's (2011) dialectical approach to studying mobile communications in close relationships among students. Their results showed that expectations of mobile communications can engender both dependence and overdependence on one's relationships. While greater dependence was positively related to friendship satisfaction, overdependence was negatively related through feelings of ‘entrapment’ (i.e. the perceived stress of having to be available to others). So, while mobiles may fulfill the need to belong, there is a cost to one's sense of agency. Given the ubiquity of smartphones in many societies and their ever-increasing tools and channels to stay connected with others, a broad examination of the relationships between mobile communications, relationship quality and SWB would need take into account such feelings of entrapment so as to provide a more balanced picture of people's relationship quality, and subsequent relations with well-being.

Based on the review of the above literature, some research questions can be proposed. Given that face-to-face communication is often the baseline in which mediated communications are compared, the following questions are first set:

RQ1. Do mobile-mediated communications complement or displace face-to-face communications?

RQ2a. To what extent do face-to-face communications predict relationship quality with close friends?

RQ2b. To what extent do face-to-face communications predict SWB?

In line with the reviewed literature and the dialectical approach of Hall and Baym, three dimensions of relationship quality will be examined: 1) friendship satisfaction, 2) perceived social support, and 3) feelings of entrapment. In terms of mobile-mediated communications, this study will examine the most common uses of smartphones in the context of Hong Kong: voice, email, SMS, Facebook and WhatsApp. In addition to frequency of use, the relative network composition of the social media platforms will also be examined. Rather than state formal hypotheses for every instance of mobile use and its outcomes, which will generate over 50 statements, the following guiding research questions are thus raised:

RQ3a. To what extent do mobile-mediated communications predict

relationship quality with close friends?

RQ3b. To what extent do mobile-mediated communications predict SWB?

2.3. Differences across the life course

While mobile-mediated multimodal communications may help sustain social connectedness and SWB, evidence from the life course literature suggest that the relationships and influences may vary according to age (Chesley & Johnson, 2014). A long-noted phenomenon observed in the gerontology literature is that of the “satisfaction paradox”, relatively consistent findings showing that SWB does not necessarily diminish with aging despite the associated challenges and concerns that older people face with economic security and health (Ulloa, Møller, & Sousa-Poza, 2013). One explanation comes from *socio-emotional selectivity theory* (Carstensen et al., 1999) and the argument that perceptions of time, and hence mortality, provides a strong motivation for older people to actively seek out positive experiences, emotions and well-being. Conversely, for young people who feel that they have the world ahead of them, their primary focus is on attaining instrumental needs and goals. This has implications on how people shape their social networks. Though strong ties are generally important for people of all ages, weak ties are particularly important for younger people because they provide access to more diverse networks that may derive instrumental benefits and outcomes (Granovetter, 1973). Older people generally prioritize positive emotions and well-being, so they focus on the maintenance of close tie relationships while reducing the number of weak ties at the periphery (English & Carstensen, 2014). The theory thus suggests a stronger ‘need for well-being’ as one ages, which complements the ‘need to belong’ as communications for older individuals are more purposeful in sustaining quality relationships and well-being.

Recent studies drawing from the theory provide support for the assumptions. For example, Chan (2015b) found that the use of multiple communication channels to interact with the same close ties was related to psychological well-being for older age groups, but not for the youngest group. In their study of Facebook use by those aged between 18 and 93 years old, Chang, Choi, Bazarova, and Löckenhoff (2015) found that while older adopters had fewer Facebook ‘friends’, a higher proportion of them were actual real-world friends; and the higher ratio was associated with less feelings of social isolation and loneliness. This study provided the first evidence that older people do not necessarily use social media platforms to extend their social networks by making new friends, but rather to strengthen social connectedness with their existing offline networks.

Of course, it is important to note that the adoption of new communication technologies such as Facebook and WhatsApp among the older population trails the younger generation by relatively large margins (Duggan, 2015). But, for those who use the technologies, the evidence suggests that the SWB benefits of mediated communications are more pronounced. Inherent motivations to attain well-being as one ages is just one part of the explanation. Another reason is the adoption process. Because they are not digital natives, the adoption process of new technologies for older people is often influenced by their partners and younger members of the family. This form of social influence can be a strong motivator because they are willing to expend time and energy to learn how to use new tools in order to communicate and maintain intimate ties with family, such as their children and grandchildren (Luijckx, Peek, & Wouters, 2015). Given the possible role of the life course in the relationships among communication, relationship quality and SWB, and supportive evidence for socio-emotional selectivity theory, the last research question is thus raised:

RQ4. How do the relationships stated in RQ1, RQ2 and RQ3 differ across different age groups?

3. Method

Computer-assisted telephone interviewing (CATI) was conducted from June 22–30, 2016 by a university-affiliated research center in Hong Kong based on the most updated residential landline directories. For unlisted numbers, the last two digits were replaced by random values between 00 and 99 and the most recent birthday method was used to select respondents within each household. Respondents were all local Cantonese-speaking residents aged between 18 and 70 + and 925 valid interviews were completed.³ The response rate was 77.2% following AAPOR RR6 (AAPOR, 2016) with a margin of error of $\pm 3.2\%$ and confidence interval of 95%. All respondents possessed a smartphone. Informed by previous studies examining communication technology use from a lifespan perspective (i.e. Chan, 2015b; Sinclair & Grieve, 2017) the sample was separated and grouped according to age ranges of 18–34 (N = 238), 35–54 (N = 347) and 55 and above (N = 341).

3.1. Measures of subjective well-being (SWB)

Psychological well-being. Respondents stated the extent in which they agreed (1 = *strongly disagree* to 5 = *strongly agree*) to eight statements from the psychological well-being (PWB) scale (Diener et al., 2009): “I lead a purposeful and meaningful life”, “My social relationships are supportive and rewarding”, “I am engaged and interested in my daily activities”, “I actively contribute to the happiness and well-being of others”, “I am competent and capable in the activities that are important to me”, “I am a good person and live a good life”, “I am optimistic about my future”, and “People respect me.” Scores were then added to form the scale (M = 28.45, SD = 5.48, Min = 12, Max = 56, Alpha = .78, CR = 0.82).

Positive and negative emotions. Respondents indicated the frequency (1 = *never* to 5 = *very often*) of experiencing different emotions in the previous month according to the Scale of Positive and Negative Experience (SPANE) (Diener et al., 2009b): (1) Positive, (2) Happy, (3) Good, (4) Joyful, (5) Contented, (6) Afraid, (7) Angry, (8) Bad, (9) Negative, and (10) Sad. Scores for positive emotions were combined to indicate positive feelings (SPANE-P) (M = 16.42, SD = 4.40, Min = 6, Max = 22, Alpha = .79, CR = 0.85) as were scores for negative feelings (SPANE-N) (M = 10.07, SD = 3.57, Min = 5, Max = 18, Alpha = .72, CR = 0.79).

To further establish that the three measures are distinct dimensions of SWB, all the question items were factor analyzed using a principal components extraction and Varimax rotation. All items loaded cleanly into the respective three factors and explained 59% of the total variance. Factor loadings ranged from 0.54 to 0.78 for PWB, 0.76 to 0.85 for SPANE-P, and .72 to .75 for SPANE-N, which were then used to calculate the composite reliability (CR) of the respective scales (Raykov, 1997). Consistent with theoretical expectations, correlation analyses showed that PWB was positively related to SPANE-P ($r = 0.42$, $p < .001$) and negatively to SPANE-N ($r = -0.17$, $p < .001$), which was in turn negatively related to SPANE-P ($r = -0.26$, $p < .001$).

3.2. Measures of relationship quality

Friendship satisfaction. Items were adapted from the Dyadic Adjustment.

Scale (DAS-4) (Sabourin, Valois, & Lussier, 2005). Respondents stated the extent in which they agreed (1 = *strongly disagree* to 5 = *strongly agree*) to three statements: “My relationships with my

friends are going well”, “I am able to confide in my friends”, and “I am happy with my relationships with my friends” (M = 3.93, SD = 0.84, Alpha = .76, CR = 0.80). The remaining item from DAS-4 (i.e. thinking about terminating a relationship) was not included as it was judged to be overly sensitive for the Hong Kong context.

Social support. Items were adopted from Leung and Lee's (2005) measures of emotional and informational support, which was in turn based on the MOS Social Support Survey (Sherbourne & Stewart, 1991). Respondents were asked: “How often is each of the following kinds of support available to you if you need it?” and stated the frequency (1 = *None of the time*, 2 = *A little of the time*, 3 = *Some of the time*, 4 = *Most of the time*, 5 = *All of the time*) to the statements: “Someone whose advice you really want”, “Someone to give you good advice about”, “Someone to give you information to help you understand a situation”, and “Someone to turn to for suggestions about how to deal with a personal problem” (M = 2.80, SD = 1.09, Alpha = .70, CR = 0.84).

Entrapment. Items were adapted from Hall and Baym (2011). Respondents stated the extent in which they agreed (1 = *strongly disagree* to 5 = *strongly agree*) to three statements: “I feel pressure to respond quickly to calls and texts from my friends”, “If I don't respond quickly to my friends' calls and texts, they get annoyed with me”, and “I feel stressed by the amount of interaction with my friends” (M = 2.20, SD = 1.00, Alpha = .75, CR = 0.81).

3.3. Measures of communication and networks

Communication with friends. Respondents answered from 1 to 5 (1 = *Never*, 2 = *Rarely*, 3 = *Sometimes*, 4 = *Often*, 5 = *A lot*) for frequency of communications on a typical day with friends through the following mobile channels: e-mail (M = 1.49, SD = 0.78), mobile voice (M = 2.51, SD = 0.97), mobile Facebook (M = 2.00, SD = 1.23), WhatsApp (M = 3.18, SD = 1.41) and SMS (M = 1.64, SD = 0.95). The same scale was also used to measure frequency of face-to-face communications (M = 3.07, SD = 1.04).

Network composition. For number of close friends, respondents stated the number of people in their social network that they considered “close friends that they can trust and confide in” (M = 4.84, SD = 5.17). For number of Facebook friends, respondents answered from 0 to 4: 0 = “non-user”; 1 = “1–100 Friends”; 2 = “101–250 Friends”; 3 = “251–500 Friends”; 4 = “501 = Friends” (M = 1.02, SD = 1.24). For number of WhatsApp groups, respondents answered from 0 to 3: 0 = “non-user”; 1 = “1–5 groups”; 2 = “6–10 groups”; 3 = “11 + groups” (M = 2.44, SD = 1.07).

3.4. Demographics

Demographic and relational variables that have been demonstrated to predict SWB (Dolan, Peasgood, & White, 2008) were included as statistical controls. Therefore, respondents in the interviews were asked to indicate their age (M = 7.14, SD = 3.36; 6 = 40–44, 7 = 45–49, 8 = 50–54; increments of 5 years), level of education (M = 4.48, SD = 1.82; 4 = Grades 10–12, 5 = Grades 13–14), monthly household income (M = 3.99, SD = 2.20; 4 = HK\$30000–HK\$39999; increments of HK\$10000), gender (52.4% female), whether they believed in a religion (Yes = 36.3%), marital status (61% married) and whether they had children (Yes = 66.3%). Descriptive statistics for total sample and age cohort sub-samples are summarized in Table 1. The full questionnaire and frequency tables of demographic data are available upon request.

4. Results

Table 1 summarizes the descriptive statistics and results of ANOVA tests for the key variables. The 18–34 cohort communicate more frequently through face-to-face, SMS, Facebook and WhatsApp compared

³ Even though smartphone penetration is very high in Hong Kong a centralized sampling frame of smartphone users does not exist that facilitates the random sampling procedure. Therefore, residential landlines, which have 92% penetration (OFCA, 2016) were used. Regarding the general population, Hong Kong is ethnically very homogenous that is 92% Chinese, so Cantonese is spoken by the majority of the population.

Table 1
Descriptive statistics of key variables in study.

	18–34		35–54		55–70+		All		Differences	
	M	SD	M	SD	M	SD	M	SD	F	p
<i>Demographics</i>										
Age	2.55	1.06	6.80	1.10	10.67	1.16	7.14	3.36		
Education	6.07	1.27	4.54	1.56	3.34	1.56	4.48	1.83		
Income	4.49	2.04	4.39	2.08	3.23	2.22	3.99	2.20		
Gender (female)	48.5%		57.4%		50.1%		52.4%			
Religious	28.1%		37.0%		41.2%		36.3%			
Married	18.4%		79.7%		71.6%		61.0%			
Have children	15.0%		78.1%		90.0%		66.3%			
<i>Communication</i>										
Face to face	3.29	0.89	3.04	1.05	2.93	1.11	3.07	1.04	8.75	< .001
Mobile voice	2.55	0.95	2.57	0.90	2.42	1.05	2.51	0.97	2.28	ns
Email	1.39	0.73	1.59	0.80	1.47	0.79	1.49	0.78	4.30	< .01
SMS	2.18	1.04	1.58	0.91	1.32	0.76	1.64	0.95	70.66	< .001
Facebook	2.82	1.22	2.04	1.24	1.40	0.86	2.00	1.24	115.04	< .001
WhatsApp	4.03	1.02	3.34	1.24	2.43	1.44	3.18	1.42	116.23	< .001
<i>Network composition</i>										
Close friends	6.09	5.02	4.52	4.76	4.28	5.54	4.84	5.17	9.61	< .001
Facebook Friends	2.34	1.22	0.86	1.03	0.28	0.52	1.02	1.24	333.51	< .001
WhatsApp Groups	2.93	0.91	2.55	0.99	1.98	1.06	2.44	1.07	66.90	< .001
<i>Study variables</i>										
Relationship satisfaction	4.06	0.70	3.95	0.80	3.81	0.96	3.93	0.84	6.64	< .001
Social support	3.09	1.20	2.84	1.06	2.56	1.00	2.80	1.09	16.52	< .001
Entrapment	2.21	0.96	2.21	1.00	2.17	1.02	2.20	1.00	.14	ns
PWB	28.24	4.75	28.65	5.49	28.38	5.95	28.45	5.48	.74	ns
SPANE-P	16.27	3.87	16.73	4.10	16.21	5.00	16.42	4.40	1.60	ns
SPANE-N	11.40	3.18	10.30	3.47	9.07	3.63	10.12	3.57	32.43	< .001

to the older cohorts while the 35–54 cohort communicate more frequently through email compared with others. There were no significant cohort differences in the use of mobile voice. Interestingly, WhatsApp was the most frequent form of communication for the 18–34 and 35–54 cohorts, even exceeding face-to-face, and was second most popular channel for the 55–70 + cohort. In terms of network composition, the 18–34 cohort have larger networks than the other cohorts and higher levels of relationship satisfaction and social support. However, they also have significantly higher levels of negative emotions. There were no significant cohort differences for entrapment, psychological well-being and positive emotions. More detailed results of post-hoc analyses between cohorts are available upon request.

4.1. Face-to-face communications and mobile-mediated multimodal communications

To examine whether mobile-mediated communications complement or displace face-to-face communications (RQ1), correlation analyses were conducted for all the communication variables while controlling for demographics. Partial correlations (see Table 2) showed that all the significant relationships between frequency of face-to-face communications and mobile-mediated communications were in the positive direction, with little evidence of displacement.

Table 2
Partial correlations of face-to-face communications and mobile-mediated communications.

	Face-to-face communications			
	18–34	35–54	55–70+	All
<i>Smartphone uses</i>				
Voice	.08	.34***	.45***	.34***
Email	.12#	.08	.08	.09*
SMS	.02	.12*	.09#	.08*
Facebook	.17**	.21***	.06	.14***
WhatsApp	.23***	.17***	.19***	.19***

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

4.2. Predicting relationship quality among the cohorts

Hierarchical linear regression analyses using listwise deletion for missing values were conducted to examine the extent in which face-to-face (RQ2a) and mobile-mediated communication (RQ3a) among the three age cohorts (RQ4) predicted relationship quality (see Table 3). Demographics were entered as the first block of variables followed by communication and network composition. All final models were significant (18–34: $R^2 = 0.15$, $F(16,221) = 2.42$, $p < .001$; 35–54: $R^2 = 0.10$, $F(16,330) = 2.26$, $p < .01$; 55–70+: $R^2 = 0.16$, $F(16,324) = 3.92$, $p < .001$); as were those predicting social support (18–34: $R^2 = 0.22$, $F(16,221) = 3.75$, $p < .001$; 35–54: $R^2 = 0.25$, $F(16,330) = 6.71$, $p < .001$; 55–70+: $R^2 = 0.25$, $F(16,324) = 5.20$, $p < .001$). However, only the models for the 18–34 and 35–54 cohorts significantly predicted entrapment (18–34: $R^2 = 0.13$, $F(16,221) = 2.05$, $p < .05$; 35–54: $R^2 = 0.13$, $F(16,330) = 2.96$, $p < .001$).

Controlling for demographics, results showed that face-to-face interactions and number of close friends predicted friendship satisfaction for all age cohorts. Moreover, the number of close friends were negatively related to feelings of entrapment. A deeper examination of specific mobile uses showed that mobile voice predicted friendship satisfaction and social support for the 35–54 and 55–70 + cohorts; and WhatsApp use was related to friendship satisfaction for the 18–34 and 55–70 + cohorts, and social support for all the cohorts. Email use was negatively related to relationship satisfaction for the 18–34 cohort but positively related to social support for the 55–70 + cohort and entrapment for the 35–54 cohort. Mobile Facebook use showed only one significant relationship with social support for the 18–34 cohort, while SMS use was related to entrapment also for that cohort. In terms of network composition, the number of close friends was positively related to social support for the 35–54 and 55–70 + cohorts. The number of Facebook friends was related to social support for the 18–34 and 35–54 cohorts, and negatively related to entrapment for the 18–34 cohort. The number of WhatsApp groups an individual has was positively related to entrapment for the 18–34 cohort.

Table 3
Linear regression models predicting friendship relationship quality.

	Friendship satisfaction			Social support			Entrapment		
	18–34	35–54	55–70+	18–34	35–54	55–70+	18–34	35–54	55–70+
<i>Controls</i>									
Age	.18*	.02	.10 [#]	.14*	.01	-.05	-.15*	-.12*	-.04
Education	.07	.03	.24***	.20**	.24***	.24***	.06	.01	-.04
Income	.07	.08	.07	.08	.10 [#]	.07	-.05	-.22***	-.09
Gender	-.04	-.15**	-.26***	-.03	-.01	.02	-.14*	.15**	.05
Religion	.07	.10 [#]	-.03	.14*	.20***	.12*	.09	.02	.11 [#]
Marital status	-.18 [#]	.06	.04	.04	.01	.01	.16	.01	-.01
Children	.03	-.09	-.01	-.07	.05	.03	-.13	.04	-.06
R ²	.05	.04	.11	.10	.15	.10	.05	.07	.03
<i>Communication</i>									
Face to face	.15*	.14*	.10*	-.07	.04	.18**	-.08	-.10	-.09
Mobile voice	-.09	.08*	.09*	-.08	.12*	.11*	.05	-.01	-.05
Email	-.13*	.06	-.07	.08	.07	.17**	-.01	.14*	.02
SMS	-.10	.01	.06	.06	.01	.01	.15*	-.01	.04
Facebook	-.05	.09	-.01	.11*	.09	-.02	-.05	.04	.02
WhatsApp	.16*	.03	.11*	.19**	.16**	.17**	.03	-.06	-.01
R ²	.06	.04	.04	.08	.07	.13	.03	.04	.01
<i>Network composition</i>									
Close friends	.21**	.14*	.12*	.05	.14**	.13 [#]	-.18**	-.13*	-.10 [#]
Facebook Friends	-.03	.03	-.06	.26**	.15*	.04	-.19*	-.09	.02
WhatsApp Groups	.02	.03	.01	-.04	.03	.08	.17*	-.02	-.05
R ²	.04	.02	.01	.04	.03	.01	.05	.02	.01
Final R ²	.15	.10	.16	.22	.25	.25	.13	.13	.05

Note: *** = $p < .001$, ** = $p < .01$, * = $p < .05$, [#] = $p < .10$. Gender (0 = female, 1 = male). Religion, marital status and children (1 = Yes).

4.3. Predicting subjective well-being among the cohorts

Hierarchical linear regression analyses using listwise deletion for missing values were conducted to examine the extent in which face-to-face (RQ2b) and mobile-mediated communication (RQ3b) among the three age cohorts (RQ4) predicted SWB (see Table 4). All models predicting psychological well-being (PWB) were significant (18–34: $R^2 = 0.36$, $F(19,218) = 6.67$, $p < .001$; 35–54: $R^2 = 0.40$, F

(19,327) = 11.66, $p < .001$; 55–70+: $R^2 = 0.34$, $F(19,321) = 8.77$, $p < .001$), as well as those for positive emotions (SPANE-P) (18–34: $R^2 = 0.33$, $F(19,218) = 5.96$, $p < .001$; 35–54: $R^2 = 0.19$, F (19,327) = 4.03, $p < .001$; 55–70+: $R^2 = 0.24$, F (19,321) = 5.36, $p < .001$) and negative emotions (SPANE-N) (18–34: $R^2 = 0.25$, F (19,218) = 4.11, $p < .001$; 35–54: $R^2 = 0.14$, F (19,327) = 2.92, $p < .001$; 55–70+: $R^2 = 0.13$, F (19,321) = 2.94, $p < .001$).

Across all cohorts, face-to-face communication was related to PWB

Table 4
Linear regression models predicting psychological and emotional well-being.

	Psychological well-being (PWB)			Positive emotions (SPANE-P)			Negative emotions (SPANE-N)		
	18–34	35–54	55–70+	18–34	35–54	55–70+	18–34	35–54	55–70+
<i>Controls</i>									
Age	.18*	.04	.08	-.11	.06	.08	.06	-.22***	-.15*
Education	-.01	.03	.20***	.20**	.03	.04	.03	.08	.04
Income	.14*	.22***	.10 [#]	.16*	.15*	.18**	.01	-.06	-.07
Gender	-.10	-.16**	-.06	-.16*	-.17**	-.18**	-.20**	-.01	-.07
Religion	.26***	.13*	.09	.10 [#]	.10 [#]	.06	.06	-.01	.15**
Marital status	-.20*	-.05	.06	-.11	-.03	.04	-.01	.01	.01
Children	.26**	.15*	.06	.25**	.17**	-.02	-.07	-.02	-.01
R ²	.17	.12	.08	.14	.10	.07	.04	.06	.05
<i>Communication</i>									
Face to face	.15*	.19***	.12*	.14*	.17**	.18**	-.04	-.06	.03
Mobile voice	-.05	.12*	.01	.03	-.01	.05	.12*	.10*	.04
Email	-.05	.01	.08 [#]	.01	.06	.03	.08	-.03	.10
SMS	-.16*	.08	.01	-.04	.02	.09	.07	-.08	-.11
Facebook	.16*	-.03	.03	.04	.10	-.04	.24**	.05	.05
WhatsApp	.02	-.04	.12*	-.01	-.03	.06	-.01	.05	.07
R ²	.07	.06	.05	.02	.05	.06	.10	.02	.01
<i>Network composition</i>									
Close friends	.17**	.05	.18**	.04	.06	.17**	-.07	-.01	-.06
Facebook Friends	.15*	-.13	.02	.01	-.11	.06	.09	.07	.08
WhatsApp Groups	.10	.18**	.01	.16*	.13*	.07	-.11	-.03	-.09
R ²	.05	.03	.03	.02	.02	.03	.00	.00	.00
<i>Relationship quality</i>									
Friendship satisfaction	.26***	.45***	.46***	.28***	.12*	.26***	-.30***	-.19***	-.26***
Social support	.10 [#]	.15**	.09 [#]	.07	.06	.06	.07	.08	.05
Entrapment	-.09 [#]	-.10*	-.08 [#]	-.24***	-.04	-.16**	.11 [#]	.16**	.06
R ²	.07	.19	.18	.15	.02	.08	.11	.06	.07
Final R ²	.36	.40	.34	.33	.19	.24	.25	.14	.13

and SPANE-P. Looking at the relationship quality measures in more detail, results showed that the degree of friendship satisfaction was significantly related to increased PWB and SPANE-P and reduced SPANE-N across all cohorts; while social support and reduced feelings of entrapment were related to increases in PWB. In terms of communication and network composition; less SMS, more Facebook use, and having more real world and Facebook Friends were related to increased PWB for the 18–34 cohort. Mobile voice communications and number of WhatsApp groups were related to PWB for the 35–54 cohort; and email and WhatsApp use were related to PWB for the 55–70 + cohort. No mobile communication variables were related to SPANE-P for any cohort, but the number of WhatsApp groups was positive related to SPANE-P for the 18–34 and 35–54 cohorts. Interestingly mobile voice communications were positively related to SPANE-N for the 18–34 and 35–54 cohorts.

As the results showed, the relationships among communication, network composition, relationship quality and subjective well-being offered both universal as well as varied findings across the different age cohorts. Implications of the findings will be discussed next.

Note: *** = $p < .001$, ** = $p < .01$, * = $p < .05$, # = $p < .10$. Gender (0 = female, 1 = male). Religion, marital status and children (1 = Yes)

5. Discussion

The growth of smartphone ownership has risen exponentially in the past few years, especially in developing countries (Poushter, 2016) as Internet infrastructures improve and online data plans become more affordable among the general population. The convergence of mobile phone technologies with social media services means that mobile-mediated multimodal communications afford anytime anywhere communications with important others through diverse channels. The need to belong is a fundamental drive for people to attain positive well-being, and communication serves an essential role to engender relationship quality, psychological well-being and positive emotions. This study contributes to the literature by examining in detail the important role of smartphones among the relationships. By using a national sample, it was also possible to adopt life course perspectives to examine possible variations in the relationships among different age groups.

Overall, the findings provide strong evidence for the inextricable linkages among communication, meaningful social relationships and SWB. Regardless of age, higher levels of friendship satisfaction and social support, and lower levels of entrapment, were linked to higher psychological well-being. Friendship satisfaction was also linked to more positive emotions and less negative emotions, supporting Baumeister and Leary's (1995) assertion that "solidifying social attachments generally produces positive emotion, whereas real, imagined, or even potential threats to social bonds generate a variety of unpleasant emotional states" (p. 520).

Focusing more specifically on communication, face-to-face was related to relationship satisfaction (RQ2a) as well as psychological well-being and positive emotions (RQ2b) for all age cohorts (RQ4). This is not too surprising from an evolutionary perspective of social relations (Reis, Collins, & Berscheid, 2000) because for much of human history face-to-face communications with strong ties were the primary means to fulfil the need to belong and maintain social relations as sources of well-being and personal safety. While some scholars have raised concerns that communication technologies may to some extent displace face-to-face interactions, the results for RQ1 showed that mobile-mediated communications by and large complemented face-to-face interactions, particularly the use of WhatsApp across all age cohorts. Other uses were significant based on generational lines, such that mobile voice complemented face-to-face for the older cohorts while Facebook complemented face-to-face for the younger cohorts.

5.1. Mobile-mediated multimodal communication and relationship quality

The findings for mobile-mediated multimodal communications and relationship quality (RQ3a) were more diverse when face-to-face communication was statistically controlled. Facebook use and number of Facebook friends predicted perceived social support and less entrapment for the 18–34 cohort who were the heaviest users of social media technologies through mobiles. For this cohort, growing up with communication technologies and the early adoption of social network sites like Facebook provide new and alternative forms of connectedness that may be distinct from offline connectedness. Moreover, they are used to and more willing to disclose their feelings and thoughts through social media (Park, Jin, & Jin, 2011) and adopt self-presentation strategies, such as tailoring their content and messages to present an 'idealized self' to others (Walther, 1996).

For the 35–54 and 55–70 + cohorts, mobile voice predicted friendship satisfaction and social support, suggesting that relationship satisfaction for older people is better sustained through more intimate one-to-one interactions. This is understandable given that older people are more likely to have known their close friends for many years or even decades, which allows for deeper interactions. It is also worth noting that voice transmission was the original affordance of mobiles and so it is likely that older people have already been using this channel for a very long time. This may also explain why mobile email predicts social support specifically for the 55–70 + cohort because they may have been using the older technology since the early stages of its life cycle for maintaining interpersonal relationships (Stafford, Kline, & Dimmick, 1999).

While the consequences of mobile voice, email and Facebook are quite distinct along generational lines, the situation of WhatsApp is more intriguing. For the 18–34 and 35–54 cohorts, it is the most frequent form of communication while for the 55–70 + cohort it only trails face-to-face communications. This is reflective of the growing popularity of mobile messaging apps, which has become the 'killer app' of smartphones. Across all cohorts, WhatsApp use is related to social support and for the 18–34 and 55–70 + cohorts it is related to friendship satisfaction. Granted, there have been relatively few studies of mobile messaging apps in the literature, but the initial evidence suggest that WhatsApp is more than just a text messaging service (Church & de Oliveira, 2013). To start, the app itself is multimodal, allowing users to also send and receive images, videos, asynchronous voice messages and voice calls, which can facilitate a variety of informal and formal exchanges and conversations for different purposes. Then there is WhatsApp's technological architecture that automatically scans a phone's existing contact list and identifies other users based on the mobile number. Because mobile numbers are most often shared among close ties, WhatsApp is tailor-made for maintaining strong tie and social support networks.

5.2. Mobile-mediated multimodal communication and SWB

In terms of SWB (RQ3b), Facebook use and number of Facebook friends predicted psychological well-being for the 18–34 cohort. This is in line with the findings of Grieve, Indian, Witteveen, Tolan, and Marrington (2013) who showed that for young people, feelings of social connectedness on Facebook were related to higher well-being and less depression and anxiety. While none of the smartphone uses predicted positive emotions, it is interesting that number of WhatsApp groups an individual belongs to is related to psychological well-being for the 35–54 cohort, and positive emotions for the 18–34 and 35–54 cohorts. This may be attributed to app's group function that allows users to construct their own pre-defined communities based on different relationship domains. For example, one group can be based exclusively on familial ties, another on work ties, and another based on a social club. By compartmentalizing their social networks, users can conveniently send one-to-many messages and through the continued exchanges

engender a sense of solidarity and emotional bonding among constituent group members. Given that WhatsApp appears to be popular across the age cohorts and is the most popular use of smartphones, future studies can examine in more detail whether there are indeed differences in usage patterns based on the life course. For example, do its different features appeal to specific age cohorts? Do older people adopt WhatsApp due to familial social influence as is often the case for other communication technologies (e.g., Lwijk et al., 2015)?

Overall, there could be two feasible explanations for the distinct pattern of findings among the cohorts found for relationship satisfaction and SWB. First, following socio-emotional selectivity theory, people strive for more emotionally-satisfying and intimate relationships with close ties as they age, which can be better supported through one-to-one mobile voice and email communications because they facilitate lengthier and substantive interactions. Facebook on the other hand facilitate connections to both close and peripheral ties and is more suited for sending short messages, which is in line with the more instrumental communication needs of younger people. Second, the life cycle of a technology to some degree parallels with that of the life course. Therefore, older people may prefer email because it is the technology they are most familiar and comfortable with. Future studies may consider integrating technology life cycle and human life course perspectives to explore this possibility further. For example, when present-day millennial reaches a later stage in life would email still be relevant? Or will they carry over their Facebook uses and experiences into older age?

Of course, while the findings demonstrate the positive influences of smartphone use, findings also show some negative associations, particularly for the youngest cohort. For them email use and number of WhatsApp groups were related to feelings of entrapment while mobile voice and Facebook use were related to negative emotions. For the 35–54 cohort email was related to entrapment and mobile voice related to negative emotions. Because of the social norm of reciprocity in friendships, having access to one's friends comes with the expectation that one is accessible to other, and psychological tensions may arise when the need to belong clashes with the need for privacy and personal space (Stafford & Hillyer, 2012). This is especially the case for the younger cohorts who are the heaviest users of smartphones. For example, while frequency of WhatsApp use is related to friendship satisfaction, the number of WhatsApp groups is related to increased entrapment. How does one disentangle this somewhat contradictory finding? One approach would be the adoption of an explicit dialectical approach (e.g., Hall & Baym, 2011) to better understand the contributing factors behind the tensions of smartphone use and the conditions in which positive and negative outcomes may arise. Frequency of use may engender SWB, but having to manage and compartmentalize multiple groups may also lead to more stress. Interestingly, the oldest cohort did not exhibit any negative consequences from mobile mediated communications, suggesting that the tensions may diminish over age as older people are more motivated to sustain good quality relationships and positive well-being (English & Carstensen, 2014).

5.3. Limitations and future research

Some limitations of this study need to be addressed. First, the results of the study are inevitably bound to the social and technological context of one single society, Hong Kong, which is characterized by high smartphone penetration that exceeds 100%. This is due largely to a highly competitive industry where mobile data plans are relatively cheap and the popular practice of 'trading in' older phones and pay a reduced price for the latest smartphones means that people in Hong Kong are generally early adopters of the latest mobiles. Moreover, Hong Kong is a highly urbanized and geographically small city state, which is more conducive to face-to-face interactions as compared to much larger countries where people may be more dependent on smartphones to maintain social relations with others. Thus, the study findings may not be representative of other countries that have very different economic,

geographic, and cultural characteristics. Comparative studies are needed to assess the generalizability of the findings in other contexts. Second, the study adopted a biological conception of age and the cross-sectional research design only provided a 'snapshot' of relationships within pre-defined cohorts. More ambitious designs that can examine change in technology use, relationship quality and well-being over time would be better placed to test life course theories more explicitly (Pitts & Hummert, 2015). Third, like much of the literature the study focused on strong friendship ties and well-being, though recent literature suggest that weak ties (i.e. acquaintances) may also be an important predictor of life satisfaction (Sandstrom & Dunn, 2014). Fourth, the study did not distinguish between desktop and mobile uses of technologies, such as email and Facebook. Does the affordance of mobility lead to substantively different uses of such technologies? Would the kind of posts that one sends or shares on Facebook on the fly be different to those sent from the relative comfort of a tablet or desktop? These limitations open several avenues for further research.

To conclude, recent years have seen the exponential growth of smartphone adoption across the globe, affording individuals a diverse array of channels to interact with others. While face-to-face contact with close friends remain the most consistent predictor of relationship quality and subjective well-being, the impact of mobile-mediated multimodal communications is less clear cut, especially when observed from a life course perspective.

The key contributions of this study show that face-to-face communications are still vital for relationship quality and SWB, and that the advent of mobile-mediated multimodal communications through the smartphone has not, as least yet, displaced the frequency of such interactions. Rather, the findings show that in many instances the smartphone actually complements face-to-face communications in increasing friendship satisfaction, social support and psychological well-being. Rather than focus on whether communication technologies are 'good' or 'bad', the findings in this study suggest that it would be more fruitful for future studies to acknowledge and examine the inherent tensions that arise from perpetual connectivity and both their positive and negative implications for interpersonal relationships and SWB. A life course perspective would further sensitize researchers to how the relationships may differ due to different communication motivations, life experience, and relationship needs as people grow older.

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