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Instant Messaging and Relationship Satisfaction Across Different Ages and Cultures

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Abstract

Research suggests that using IM is generally beneficial for maintaining personal relationships, yet well-being benefits are likely to be conditional on micro- and macro-level variables. This study investigates the link between IM use and relationship satisfaction across age groups using survey data collected from 19 countries (N = 20,358, age range 18–94, M_{age} = 41.0, SD = 14.6). The multilevel regression results revealed that (1) overall IM use with strong ties is positively related to individuals' satisfaction with their relationships across all countries and (2) this link is weaker among older people compared to younger ones. The hypothesized cross-level interactions were not statistically significant overall, yet comparing individual countries (e.g., Germany and Indonesia), which are on the opposite ends of the autonomy-embeddedness value dimension, suggests that the use of IM might indeed be more important for relationship satisfaction in more embeddedness-oriented cultures and relationship benefits may be more similar across age groups than in autonomy-oriented cultures. More large-scale cross-cultural studies and multilevel theories are needed to arrive at a more contextualized understanding of IM as a global communication phenomenon.

Keywords: relationship satisfaction; instant messaging; culture; wellbeing; age groups

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Introduction

Instant messaging (IM) is a type of social media that allows users to engage in real-time online chats via text or audio transfers to share hyperlinks, pictures or videos. Most apps enable peer to peer communication as well as group chat options. IM is today an integrated feature in most social media and its use has been significantly rising over the past years (Bonavia, 2017). WhatsApp alone has topped 2 Billion users in 2020 (Horwitz, 2020).

Ever since social media became popular, there have been research efforts to better understand their link with users' well-being (for an overview, see Valkenburg, 2017). The evidence to date paints an ambiguous picture (see for example, McCrae et al., 2017; Orben, 2020; Valkenburg, 2022) because it seems that well-being benefits derived from social media use depend on a host of other factors (such as the type of social media, the way it is used—actively or passively, and by whom and with whom as well as the well-being outcome assessed).

Moreover, most studies were conducted on young populations, yet not all social media users are adolescents or young adults, leading to an under-representation of middle-aged and older users (Manzi et al., 2018). Furthermore, there is cumulative evidence that culture influences psychological processes (Lehman et al., 2004), which should extend to the domain of online communication tools. Even though social media have become a global phenomenon, not all regions of the world are equally represented in the literature. Early research focused predominantly on users from the U.S. or Western Europe (Wilson et al., 2012), while only recently has the literature focused on Asian (e.g., Pang, 2021; Tang & Hew, 2022) or African populations (Kritzinger & Petzer, 2020). Nevertheless, large-scale cross-cultural studies remain scarce (for exceptions, see Błachnio et al., 2016; J. H. Liu et al., 2020).

In this study, we aim to address these research gaps by focusing on a specific type of computer-mediated communication and well-being outcome: we examine how the use of IM is associated with relationship satisfaction, considering the possibility of individual and cultural differences as well as interactive effects between these two levels of analysis.

Instant Messaging (IM) and Relationship Satisfaction

Empirical findings about the general effects of computer-mediated technology on well-being outcomes are inconclusive because studies differ widely in regard to study characteristics, such as the type of technology that is examined (e.g., Internet use in general vs IM in particular), the well-being measures used (e.g., general life satisfaction measures vs specific facets of well-being, such as relationship satisfaction), and the population targeted (countries and age groups of participants). Some studies report negative effects of IM use, such as increased stress from frequent interruptions (Fox et al., 2009) or increased risk of experiencing cyberbullying (Kowalski & Limber, 2007). However, a recent meta-analysis of 124 studies showed that texting was positively correlated to psychological well-being while using IM had a non-significant correlation; these findings, interestingly, were not moderated by culture or age (D. Liu et al., 2019). Well-being measures included multiple indicators spanning from satisfaction with life, mental health (depression, anxiety, stress) to loneliness and self-esteem and were not differentiated in the analysis. However, examining well-being as a very broad concept, without considering its facets, might obscure specific associations between certain types of computer-mediated communication and social aspects of well-being. In a similar vein, experimental studies examining the effect of social media on loneliness either exclude messaging apps from their intervention (e.g., Brown & Kuss, 2020) or conflate abstinence from social networking sites with abstinence from instant messaging (e.g., Hunt et al., 2018). Hence, it is not clear how using IM in particular affects social aspects of well-being and whether there are any boundary conditions.

IM is a specific type of social media that is usually characterized by active engagement with significant others. It is especially interesting to examine because it allows people to spontaneously communicate via various channels in the form of texting, audio and/or video which allow for differing levels in the richness of communication (Sheer & Chen, 2004). Given that IM is set up to facilitate connections between specified known users (usually via a contact list), individuals rarely make new friends or contacts when using IM but use it most of the time to support already existing relations¹. This very powerful feature can potentially help to further develop and maintain social relationships with individuals people care about, such as friends and family members (Burke & Kraut, 2016). These connections can be regarded as strong ties that exist between close-knit members (characterized by frequent interactions as well as emotional intensity, intimacy, and reciprocity). By contrast, weak ties exist for distant social relationships and infrequent interactions, such as between acquaintances, and with strangers (Granovetter, 1973).

Many studies have been conducted on how computer-mediated technology affects relationships because it is an inherently *social* technology. Here, we will focus on how using IM is related to relationship satisfaction. Goodman-Deane and colleagues (2016) found in a correlational study with participants from three countries (Australia, UK, and U.S.) that IM use was negatively associated with relationship satisfaction with the immediate family, but was non-significant with the extended family, close friends, or distant friends. On the other hand, a few studies have investigated the key motives of IM use through the lens of uses and gratifications theory (see Sundar & Limperos, 2013). This body of research provides support for the importance of strong ties when people engage in IM activities. For example, a study conducted in Taiwan suggests that relationship maintenance is among the most important motives for using IM (Ku et al., 2013). Likewise, IM was found to meet the needs of relationship maintenance and development among Canadian students (Quan-Haase & Young, 2010). A recent study on interpersonal media use with extended family members in the U.S. showed a positive link between medium use

frequency and relational closeness (Ledbetter et al., 2016). Other research has also found that the use of IM is linked to higher relationship satisfaction in romantic long-distance relationships (Holtzman et al., 2021), fulfils the need of belongingness (Cui, 2016) and is conducive for building interpersonal relationships or providing social support (Timmis, 2012).

Taken together and considering that IM is a social technology tool and has the potential for rich communication (allowing for instant feedback, use of multiple cues, use of natural language and personal focus of the medium; Sheer & Chen, 2004), it is conceivable that IM use fosters closeness, intimacy, and maintenance of social relationships. In this study, we will examine whether this is indeed the case across a wide range of different samples when holding constant the way relationship satisfaction and IM use is operationalized.

Hence, we expected that:

H1: The frequency of using instant messaging (IM) with strong tie others (i.e., family and friends) is positively related to individuals' overall satisfaction with their relationships.

Age as a Micro-Level Moderator

Media effects are conditional in that they can be enhanced or reduced by both individual differences and social context variables, yet such multilevel interactive processes have received little attention (Valkenburg et al., 2016). Age is probably one of the most important moderating variables because of intergenerational and life course differences in the way digital media proficiency has been acquired and adopted.

Adolescents and young adults are eager users of social media (e.g., Antheunis et al., 2016) and it has been argued that this is partly due to their developmental need for social connectedness which is crucial for identity building in this phase of life (Sun & Subrahmanyam, 2017). Past research has indeed shown that IM apps were mostly used to communicate with existing friends in this age group and this positively predicted well-being via the mediating variables (a) time spent with existing friends and (b) quality of these friendships (Valkenburg & Peter, 2007a). The authors explained these results through adolescents' need for intimate self-disclosure that cannot be attained in public chats. Other studies have also found that IM conversations significantly contribute to the well-being of distressed adolescents (Dolev-Cohen & Barak, 2013). Hence, frequently using IM to stay in touch with friends and family members seems to provide younger people with a sense of social connectedness that satisfies their need of belongingness, and therefore, translates into relationship satisfaction. For older age groups, however, the benefits may not be as strong.

The bulk of the literature on interpersonal media use focuses on adolescents or young adults (Manzi et al., 2018) and less is known about middle-aged and older people and the way they interpret and process social media (Cotten, Schuster, & Seifert, 2022). In fact, several theories have been developed that allow predicting well-being benefits from using computer-mediated communication, such as the uses and gratifications approach, yet a life-span perspective is usually not considered. Some studies report that older people derive benefits from using computer-mediated technology in general in one form or the other (for a mini-review, see Leist, 2013). For example, a few cross-sectional studies linked Internet use to lower levels of loneliness among the elderly (Erickson & Johnson, 2011; Sims et al., 2017; Sum et al., 2008). Recently, Szabo and colleagues (2019) provided longitudinal evidence that using the Internet to connect with family and friends indirectly improved well-being by decreasing loneliness and increasing social engagement for older adults. They argued that their results provide support for the role of online social activity in creating offline social capital: the possibility to connect with family and friends helps older adults to maintain their sense of belonging and to receive social support. This can be particularly important when families are geographically dispersed. Overall, the sparse evidence points to generally positive relational effects when older people use Internet tools to engage with others. However, there are also important intergenerational differences which may attenuate the well-being benefits compared to younger people.

The literature suggests that younger users (between 17 and 34 years old) are more likely to prefer social media for interaction with friends and family than older age groups (Bolton et al., 2013; Palfrey & Gasser, 2008). This points to important differences in the way social media communication may be appraised. Younger age groups seem to reinforce their social relationships with social media communication which is conducive for their wellbeing. However, older age groups (e.g., the Baby Boomers born between 1946 and 1964 in most developed countries) did not grow up or were not born into the digital revolution but had to adapt to it. This points to important differences in the way social media may be approached by different age groups. According to socioemotional selectivity theory (SST; Carstensen, 2006), the perception of lifetime left plays a central role in how

individuals select and pursue their social and emotional goals. While younger adults tend to select goals to build their identity and acquire knowledge that might be useful in the future, older adults focus on a limited number of strong ties that are emotionally rewarding in the present to satisfy their needs for social belonging, finding meaning in life, and maintaining relational intimacy with others. Hence, limited-time perception results in the activation of motivational goals that are more person-focused (e.g., seeking emotion and meaning) as opposed to future-focused (e.g., gaining new knowledge and establishing new social contacts). SST emphasizes selective social interaction with increasing age which offers testable predictions about age differences in the way social media communication is appraised (Hofer, 2020). Older people tend to prioritize emotionally closer relationships over less fulfilling ones which should also be expressed in preferences regarding the mode of communication with others. The most meaningful and richest communication method is face-to-face communication because it allows for instant feedback, multiple cues (e.g., body language), the use of natural language and a personal focus of the medium (Sheer & Chen, 2004). Selection, optimization, and compensation (SOC; Baltes & Baltes, 1990) theory can explain why older adults still engage in the use of new communication technologies despite its limitations compared to face-to-face communication (Joshi et al., 2020): older people selectively invest resources in activities that help them optimize gains and minimize their losses. Hence, they negotiate their use through balancing benefits of such use (maintaining social ties) with its costs (the risk of superficial interaction, failures to adapt to the technology).

There is some empirical evidence that supports the tenets of SST and SOC for older people within the realm of computer-mediated communication in general. A study with 11,000 Internet users aged over 65 data revealed that older people's face-to-face interactions were not replaced by online communication, but rather acted as a complimentary and strengthening factor for the former. Nevertheless, respondents who communicated with their family and friends over the Internet also reported that they still preferred to meet people in person (Lelkes, 2013). A recent observational study on the impact of Internet use on the well-being of 271 older adults aged between 60 and 94 years also showed that the time spent online was inversely related to perceived offline emotional and affective social support (Benvenuti et al., 2020). The authors argued that the more older people are compelled to use the Internet to stay in touch with others, the more they perceive a loss in bonding and social capital. Hence, engaging with strong ties via the Internet may not necessarily replace face-to-face interactions, but can compromise the perceived quality of relationships. A few studies explicitly tested SST in the realm of computer-mediated communication. Chang et al. (2015) examined age differences in the size of Facebook networks in a representative sample of 1,000 Facebook users from the U.S. aged between 18 to 93 and found increased selectivity of Facebook social partners with age. The friend networks of older people were smaller but contained more individuals considered to be actual friends compared to younger people. In a similar vein, a study with 130 older adults in Brazil (over 60 years of age) confirmed that increasing age was associated with a reduction in social media network size in Facebook which in turn was associated with increased emotional closeness to the network ties (Chiarelli & Batistoni, 2021).

Evidence from qualitative studies provide in-depth insight into whether older adults appraise the use of social media along the tenets of SST and SOC. A focus group study on Internet use with 14 post-retirement-community-dwelling individuals aged between 66 to 86 from Scotland revealed that overall participants were open to using at least a limited set of applications, but many were also afraid of getting caught up in digital life which could divert from more rewarding activities (Knowles & Hanson, 2018). Han et al. (2021) interviewed 16 older adults between 60 and 80 years of age in Singapore and found that interviewees identified benefits of using social media (e.g., the ability to keep up with others), but also costs, such as a more impersonal quality of communication. Joshi et al. (2020) explored older adults' use of new computer-mediated communication tools specifically under the framework of SST and SOC theory. Their results from 28 interviews with older adults aged 65 and older from the U.S. corroborated that their use of any communication tools was subjected to a cost-benefit analysis. Using social media was seen negatively by almost all, for example, regarding losing time with irrelevant information and the lack of meaningful conversation with loved ones. Yet, it was also deemed as indispensable to keep in touch with family members, especially grandchildren. Moreover, new communication technologies were often perceived as imposed by others, and required to just stay in touch with family members. To conclude, compared to younger people, older people seem to be more ambivalent in their appraisal of social media use. Hence, we expected that the well-being benefits of IM communication may not be as strong for older people as they are for younger people.

H2: Age moderates the relationship between IM use and relationship satisfaction, such that this positive relationship is weaker for older people compared to younger ones.

Cultural Context as a Macro-Level Moderator

The social and cultural context also plays an important role in the way in which media are perceived (Valkenburg et al., 2016). Most research on social media and well-being focuses on micro-level variables and does not consider the possibility of macro-level cultural differences, and a lack of large-scale samples has been pointed out as one of the major limitations in the field (Dienlin & Johannes, 2020). Moreover, individual-level studies are usually conducted in a single country, with Western and Asian samples being over-represented, which raises questions about the generalizability of previous empirical evidence (Henrich et al., 2010). There are only a few exceptions in this domain that involve larger-scale cross-cultural comparisons. Researchers in this area have found that the dimension of individualism-collectivism is useful to explain cross-cultural differences. Individualism-collectivism describes a normative mode of relations between individuals and the groups they belong to. Individualism is defined as the preference for a loosely-knit social framework in which individuals are expected to be independent and take care of themselves (Hofstede, 2001). Collectivism refers to a preference for a tightly-knit framework in which individuals are embedded in an ingroup, and this ingroup is expected to take care of and provide assistance to its members.

A recent 19-country longitudinal study by Páez and his colleagues (2020)² examined whether social interaction via the Internet in general (a composite score including interaction with strong ties, e.g., via email, IM) affected life satisfaction and anxiety and found no evidence for any moderating effects of Hofstede's (2001) individualism-collectivism dimension. Yet, the null results were based on very broad indicators and may obscure specific associations between IM use with strong ties and relationship satisfaction. Others have also noted that people from individualistic and collectivistic cultures use social media for different purposes—with seeking entertainment being the prime concern for U.S. students, compared to obtaining emotional support for Koreans (Kim et al., 2011). The same may hold true for IM usage: in individualistic cultures it may be less beneficial since it is less important to stay connected, whereas in collectivistic cultures it meets the culturally prescribed need to maintain relationships. In this way, social media may mirror offline functions of social communication for collectivists: social media becomes a tool that serves the goal of being connected to others and to fulfil one's social needs and obligations and is, therefore, experienced as more satisfying.

More recently, Schwartz (S. H. Schwartz, 2006) proposed the cultural value orientation Autonomy vs. Embeddedness which is conceptually similar to Hofstede's (2001) individualism-collectivism distinction, but has the methodological advantage that more recent country data is available, and hence country scores are more up-to-date³. In Autonomy cultures, people regard themselves as unique and independent individuals, while in cultures high on Embeddedness they feel strongly as a part of a group and find meaning through social relationships and group identification. By adopting Schwartz' operationalization of individuals' *interdependence* as a cultural value in the form of Embeddedness, we expected a cross-level interaction in that Embeddedness would boost the IM-relationship satisfaction link:

H3: Embeddedness moderates the relationship between IM use and relationship satisfaction, such that this positive relationship is stronger in Embeddedness cultures.

Age and Culture as Moderators

Apart from the 2-way interaction effects hypothesized above, we also considered whether the positive effect of IM on relationship satisfaction is conditioned by both individuals' age and the cultural context they come from. Above we drew on socioemotional selectivity and selection, optimization and compensation (SOC) theory to propose that older people show a more ambivalent appraisal of social media compared to younger ones. Yet, these age differences might not be the same across different cultures. Embeddedness cultures prefer a tightly knit social framework in which individuals are seen as fundamentally connected and related through relationships and group memberships (S. H. Schwartz, 2006). Hence, there is a cultural imperative which requires ingroup members to be strongly involved with strong ties. A recent statistical report from China, a country considered to be collectivistic (Hofstede, 2001), has shown that the top Internet activity was IM, and the primary reason why non-habitual users of the Internet have started to use it is to facilitate communication with their family or relatives (CINIC, 2020). Individuals of different ages in these cultures might be equally motivated to use IM with friends and family, and therefore, equally benefit from using it because it helps fulfil a cultural imperative to connect with strong ties (i.e., family). Moreover, *intergenerational* IM communication is more likely to occur due to a sense of filial obligations to engage in good conduct and to show consideration and support towards one's parents and elders (J. H. Liu

et al., 2000; S. J. Schwartz et al., 2010) which in turn should be conducive to older people's well-being. For instance, Li and Zhou (2021) analyzed representative data from the China Family Panel Studies involving 7,862 older adults aged 60 and over and found that parent-child contact and parent-child relationship sequentially mediated the link between Internet use and older adult's subjective well-being. In a similar vein, Wu and colleagues (2020) surveyed 153 older adults (aged 60 years and above) in Taiwan and found that those who were familiar with social media perceived more social support and marginally better intergenerational relationships than those who were unfamiliar with it. Hence, due to cultural norms of honoring elders, younger generations should be more likely to actively involve older family members into conversations by means of IM with positive outcomes regarding older people's perception of their relationships. In contrast, younger people in more individualistic cultures tend to use digital tools to connect primarily with friends (Palfrey & Gasser, 2008), which leaves older people to communicate mainly with people of their own age. This, together with a general feeling of ambivalence towards new computer-mediated communication means that older people from low Embeddedness cultures may lag behind younger ones in terms of well-being benefits from using IM compared to those from high Embeddedness cultures.

Hence, we propose the following three-way interaction:

H4: Embeddedness moderates the interaction effect of age and IM use on relationship satisfaction, such that age differences regarding the effect of IM on relationship satisfaction are less pronounced in countries valuing Embeddedness.

Methods

Sample and Procedure

We used data from the World Digital Influence Project with data collected online during September 2015 from 19 countries and 20,358 respondents. This includes a total of 1,480 (7%) cases with missing values on at least one of the variables involved in the analysis. We opted for multiple imputation to make use of all the available data. The imputation was conducted in the R package "mice" (van Buuren & Groothuis-Oudshoorn, 2011).

The data were collected from the Americas, Asia, Europe, and South Africa. In order to achieve the most comparable and reliable data set among different countries with different languages, researchers relied on a large group of participating scholars from each country involved to perform the translation of all items. The survey was administrated via an online poll survey platform Qualtrics with the help of the international polling company Nielsen who curate a large pool of potential respondents and who generated the representative sample in each country by using stratified quota sampling techniques (stratified by gender, age, and region of residence).⁴ The cooperation rate was relatively high, averaging 77% across the countries. More detailed information about the projects' samples and sampling method can be obtained from the main method paper (Gil de Zúñiga & Liu, 2017).

The age of the sample in the current study ranged from 18 to 94 with a mean of 40.9 and standard deviation of 14.6. The gender and age characteristics of the sample are listed in the Table 1. The study was approved by the ethics committee at Massey University (MUHECN 15/053). Informed consent was provided by provision of an information sheet, after which participants were requested to continue as indication of consent (or exit if consent was not granted).

Measures

Instant Messaging

Frequency of IM use was measured with the question *In general, how often do you do the following: Connect via instant messaging (e.g., text, SMS, social media) to stay in touch with family and friends* with seven response option from *Never* (1) to *Always* (7).

Satisfaction With Relationships

Satisfaction with relationship was measured with a question *All things considered, how satisfied are you these days with your relationships?* With seven response options from *Completely Dissatisfied* (1) to *Completely Satisfied* (7). This item was obtained from the seven-item Relationship Assessment Scale (RAS-7, Hendrick, 1988) which has been

proposed as a generic measure of romantic relationship satisfaction that can also be applied to other types of relationships (e.g., friendships) as has been done in previous research on communication technology and relationship satisfaction (e.g., Goodman-Deane et al., 2016). A recent validation study compared the one-item measure (RAS-1) to the full scale and showed that the latter had the highest correlation with the full scale, the highest standardized factor loadings, the highest corrected item-total correlation, the lowest skewness and kurtosis values, and best covered the content of the definition of relationship satisfaction suggesting that it is a representative item for the overall construct of relationship satisfaction (Fülöp et al., 2022). Moreover, the one-item measure was equally adequate for measuring relationship satisfaction as the full scale with respect to its convergent validity. Even though there was no explicit reference to the type of relationship in this item, several preceding questions in the survey always referred to family and friends and it is assumed that participants had this frame of reference in their minds when answering the item.

Table 1. *Description of the Samples.*

	Mean age (SD)	Percent female	Mean satisfaction with relationship (SD), 7-point scale	Mean IM use for staying in touch (SD), 7-point scale	Embeddedness score	N
Argentina	40.77 (14.30)	51%	5.51 (1.38)	6.07 (1.30)	3.52	1,146
Brazil	35.87 (12.04)	49%	5.33 (1.66)	5.74 (1.52)	3.62	1,086
China	38.66 (11.98)	44%	5.06 (1.14)	5.22 (1.29)	3.74	1,004
Estonia	47.80 (17.16)	48%	5.38 (1.35)	3.85 (1.72)	3.81	1,168
Germany	45.10 (15.07)	52%	5.40 (1.25)	4.28 (2.01)	3.10	1,053
Indonesia	32.75 (9.88)	39%	5.29 (1.25)	5.72 (1.20)	4.27	1,080
Italy	41.72 (13.15)	55%	5.09 (1.50)	5.42 (1.55)	3.46	1,041
Japan	46.69 (12.88)	42%	4.21 (1.34)	3.31 (1.89)	3.49	975
Korea	38.87 (12.71)	46%	4.41 (1.26)	4.96 (1.63)	3.68	943
New Zealand	49.54 (17.32)	56%	5.35 (1.48)	4.78 (1.76)	3.27	1,157
Philippines	34.18 (10.99)	59%	5.40 (1.41)	6.00 (1.29)	4.03	1,064
Poland	41.96 (14.51)	53%	5.09 (1.27)	5.05 (1.56)	3.86	1,060
Russia	38.15 (12.79)	50%	5.09 (1.48)	4.66 (1.69)	3.81	1,145
Spain	40.94 (12.63)	52%	5.41 (1.34)	5.54 (1.39)	3.31	1,019
Taiwan	36.29 (10.89)	50%	4.70 (1.21)	5.19 (1.45)	3.82	1,008
Turkey	33.92 (10.97)	43%	4.49 (1.67)	4.97 (1.56)	3.77	961
UK	50.61 (15.60)	53%	5.23 (1.53)	4.10 (2.06)	3.34	1,064
Ukraine	33.90 (9.40)	43%	4.96 (1.24)	3.95 (1.70)	3.93	1,223
USA	49.76 (16.43)	59%	5.39 (1.39)	4.23 (2.10)	3.67	1,161
Total	41.02 (14.64)	51%	5.11 (1.43)	4.89 (1.81)	3.66	20,358

Control Variables

The control variables included an indicator of respondents' subjective socio-economic status and gender (0 = *male*, 1 = *female*). Subjective socio-economic status was assessed with an adapted version of the MacArthur Scale of Subjective Social Status which has been shown to predict wellbeing outcomes better than objective SES measures (Adler et al., 2000): *On a scale of 1 to 10, with 10 being people who are the most well off in society, and 1 being the people who are the least well off, where would you describe your position?* Additional models controlled for face-to-face communication and time that individuals spend online, as these variables are likely to affect both IM use and wellbeing and therefore could confound the relationship between the focal variables of interest. Although these two variables could be considered mediators according to some theoretical models (see e.g., Valkenburg & Peter, 2007b), this was not our central concern. We wanted to make sure the hypothesized effects could be reproduced

after controlling for these as potential confounds. Face-to-face communication was measured by the question *In general, how often do you do the following: Meet face to face to stay in touch with family and friends* with 7 response options from *Never* (1) to *Always* (7). Frequency of being online was measured in hours per day and in days per week, (with two multiplied together for the final measure).

Autonomy vs. Embeddedness Cultural Values

At the country level we employed Schwartz cultural values (S. H. Schwartz, 2006) which describe differences between countries with seven dimensions. From the seven values available, we employed Embeddedness because this dimension indicates the degree to which an emphasis is placed on the importance of social relationships resulting in social obligations and the preservation of social harmony (S. H. Schwartz, 2008). The scores were produced on the basis of a survey of matching samples of schoolteachers and students across 70+ countries. Embeddedness had high association with items such as “social order”, “respect tradition”, “politeness”, “honor elders”, among others. The data were provided by Shalom Schwartz based on his multinational survey of students and teachers (S. H. Schwartz, 2008) In our sample, Indonesia had the highest (4.27) and Germany had the lowest (3.10) Embeddedness score. The scores are listed in Table 1.

Analytical Strategy

Since the individual-level data were nested in 19 countries and multilevel hypotheses were formulated, we employed multilevel regression analysis (Hox et al., 2017). Prior to analysis, all variables were standardized on the whole sample, and all the predictors except Embeddedness were additionally centered within countries. We tested models by increasing their complexity stepwise, from the basic main-effects model to models with controls, random effects, and cross-level interactions. The models were quite complex for a relatively small sample of countries, so they were fitted with the restricted maximum likelihood estimator, which allowed for convergence. For the same reason we refitted all the models using Bayesian estimation, see Table A1. The effect sizes were indicated by f^2 coefficients, $f^2 < .01$ as negligible, $f^2 \in [.01; .15]$ as small, $f^2 > [.15; .35]$ as medium, and $f^2 > .35$ as large effects (Cohen, 1992).

The R code that produced the results and the raw data are available at the Open Science Directory <https://osf.io/7s4hy/>.

Results

The intraclass correlation coefficient of satisfaction with relationships was .07 indicating that 7% of its variance is due to country differences. Table 2 shows the results of the regression analysis. Model M1 demonstrates a positive effect of frequency of IM use. It implies that more frequent users of IM are more satisfied with their relationships. This result confirms our first hypothesis (H1) and the effect of frequency of IM use remains significant even after adding control variables and random effects. The effect size of IM use in this model was relatively small⁵ ($f^2 = .03$).

Model M2 added age and the interaction between IM use and age. As expected, age had a positive association with relationship satisfaction (H1) and the interaction between age and IM use was negative and significant in all models. The significant interaction effect supports hypothesis H2 showing that the link between IM use and satisfaction is weaker in older groups, whereas in younger groups, IM use is more closely related to higher satisfaction with relationship. Figure 1 illustrates this interaction using model M2. Model M3 added control variables, which decreased but kept significant the effects of IM use and age, as well as their interaction. The effect size of IM use in this model remained the same ($f^2 = .03$).

Model M4 introduced random effects of key variables, allowing effects of IM use, age, and their interaction to vary across countries. The variances of the random effects were significantly different from zero as indicated by bootstrapped confidence intervals. It indicates that associations between IM use, age, and their interaction with relationship satisfaction differed across countries. Figure 2 presents the random slopes of frequency of IM use, age, and their interaction. Panel A shows that the effect of IM use on relationship satisfaction was positive in all countries in our sample, but somewhat weaker in countries from the European region (e.g., Estonia, Germany) compared to countries from the Asian region (China, the Philippines). Panel C demonstrates a similar pattern of differences in interactions with age: they were all negative, but more negative in countries from the larger Western

region (e.g., UK, Germany, USA) compared to countries from the larger Eastern region (e.g., Turkey, the Philippines, China). The negative interaction term suggests that the use of IM might be less important for relationships satisfaction in Western compared to Eastern countries, and that the age differences in this link (i.e., interactions) are stronger in countries from the West.

Table 2. Multilevel Regression Model Predicting Relationship Satisfaction.

	Dependent variable: All things considered, how satisfied are you these days with your relationships?						
	M1	M2	M3	M4	M5	M6	M7
<i>Individual level</i>							
Frequency of IM use	.14*** (.01)	.16*** (.01)	.13*** (.01)	.14*** (.02)	.15*** (.01)	.15*** (.02)	.10*** (.01)
Age		.10*** (.01)	.11*** (.01)	.10*** (.01)	.10*** (.01)	.09*** (.01)	.08*** (.01)
Interaction of frequency of IM use × Age		-.04*** (.01)	-.03*** (.01)	-.03*** (.01)	-.02** (.01)	-.02** (.01)	-.02* (.01)
Gender (female)			.03*** (.01)	.03*** (.01)	.03*** (.01)	.04*** (.01)	.03*** (.01)
Subjective Social Status			.25*** (.01)	.25*** (.01)	.25*** (.01)	.24*** (.02)	.23*** (.02)
Time spent online							-.03*** (.01)
Frequency of Face-to-Face communication							.18*** (.01)
<i>Country level</i>							
Cultural value of Embeddedness × Frequency of IM use		-.03 (.06)	-.03 (.06)	.03 (.06)	-.03 (.06)	-.11* (.05)	-.11* (.05)
× Age					.02 (.02)	.01 (.02)	.01 (.01)
× Interaction of frequency of IM use and Age					-.03* (.01)	-.04** (.01)	-.03** (.01)
Deviance	56,067	55,834	54,409	54,335	54,279	54,274	53,588
AIC	56,075	55,848	54,427	54,371	54,321	54,326	53,644
BIC	56,107	55,904	54,498	54,514	54,487	54,532	53,866
Number of parameters	4	7	9	18	21	26	28
<i>Random effect variances</i>							
intercepts	.069	.071	.071	.075	.063	.075	.075
residuals	.915	.904	.842	.837	.837	.833	.805
effects of frequency of IM use				.004	.003	.004	.003
effects of age				.003	.002	.002	.002
interaction of frequency of IM use × age				1,5-E4	.5-E4	.8-E4	.9-E4
subjective social status						.004	.004

Note. Numbers in brackets are standard errors. ICC (empty model) = 7%, $N = 20,358$ in all models, $N(\text{country}) = 19$. All random effect variances are larger than zero at $p < .05$ confidence level based on the bootstrapped ($N_{\text{simulations}} = 500$) confidence intervals. * $p < .05$, ** $p < .01$, *** $p < .001$.

Figure 1. Interaction Between Frequency of IM Use and Age as Estimated by Model M2.

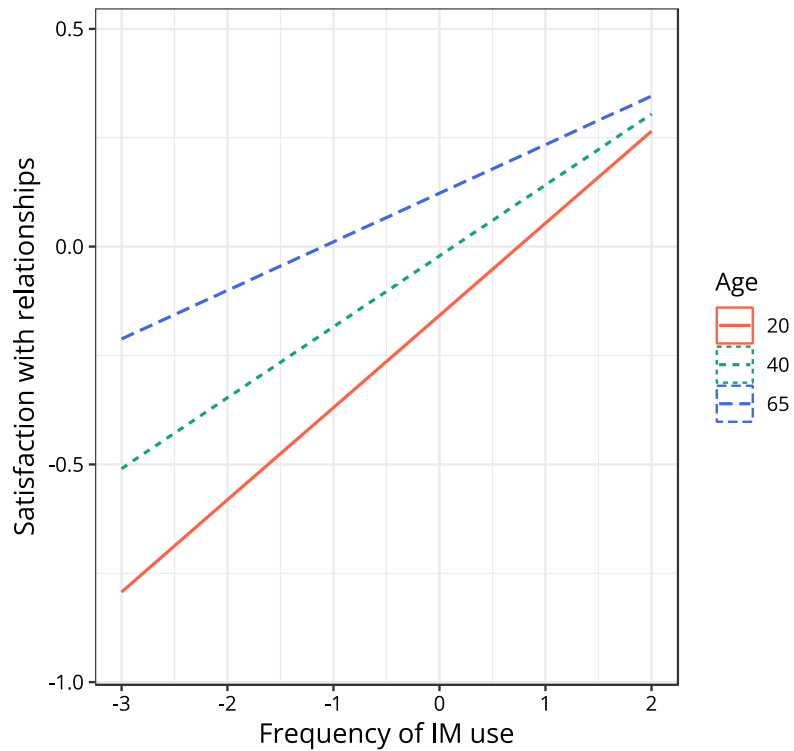
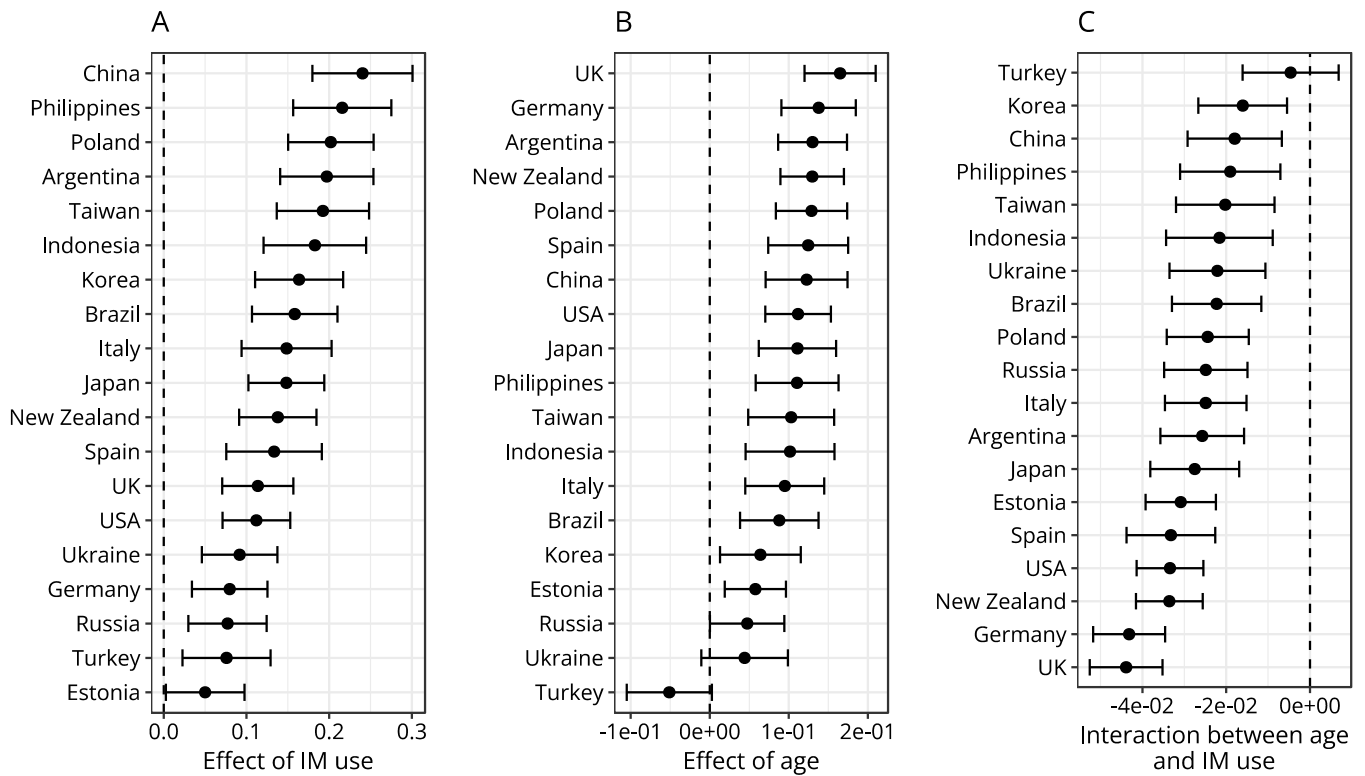


Figure 2. Predicted Random Slopes of Frequency of IM Use, Age, and Their Interaction Across Countries (as Estimated by Model M3).

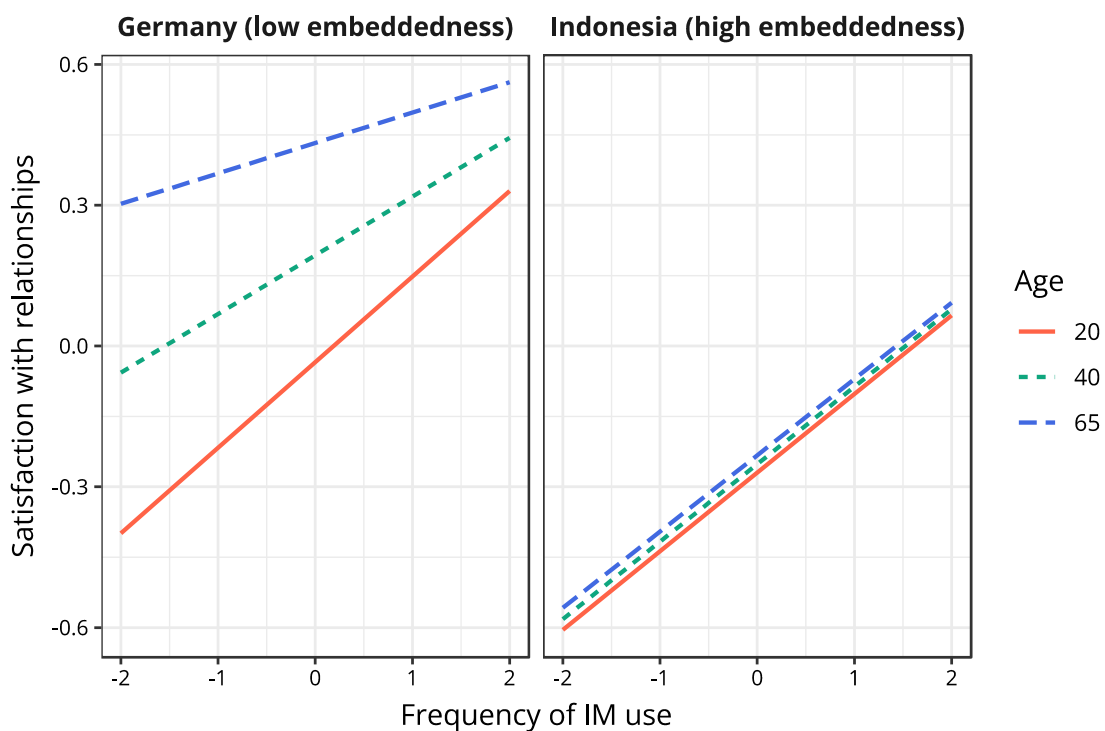


Model M5 attempted to explain these random effects with Embeddedness cultural values by including a cross-level interaction effect. However, the two-way interactions of Embeddedness with IM use as well as the three-way interaction of Embeddedness, IM use, and age were non-significant. Moreover, entering these interaction effects did not improve fit statistics: compared to M4, AIC of M5 substantially increased, whereas variances of random

effects of frequency of IM use, age, and their interaction stayed significant and did not decrease. Consequently, the effect of IM use on relationship satisfaction is approximately equal across countries that vary on the Embeddedness value dimension which rejects our hypothesis H3. Likewise, the age differences in the effect of IM use on relationships satisfaction were not associated with the levels of Embeddedness across countries. Thus, hypothesis H4 should be rejected as well.

Nevertheless, a closer look at the two countries that fall into the extreme ends of the distribution of Embeddedness shows the following. In Germany—which scores the lowest on Embeddedness—the interaction between IM use and age is strong and negative. It implies that among older German people there is only a weak positive effect of IM use on relationship satisfaction. In contrast, this positive effect is much stronger among younger Germans (see Figure 3). In contrast, in Indonesia—a country which had the highest Embeddedness score in our sample—the interaction between IM use and age was non-significant, implying that association between IM use and satisfaction with relationships is similar across both younger and older Indonesians (see also Figure 3).

Figure 3. Predicted Slopes for Countries With Different Levels of Embeddedness Values. As Estimated by Model M5. The Bands Represent 95% Confidence Interval.



All the reported models also included Embeddedness cultural values as a main effect, and this did not show a significant association with relationship satisfaction. Models M3-M7 also included individual-level control variables: Female gender⁶ and subjective socio-economic status were positively associated with relationship satisfaction. Adding these variables into the model did not affect the predictive power of the key variables.

Model M6 included a random effect of one of the control variables, namely effect of subjective social status which showed substantial variability across countries. After controlling for differences in effects of social status, the interaction of Embeddedness with age turned out to be significant, yet this is not further interpreted because this term does not involve the effect of IM use and was not a focus of our study. Finally, model M7 extended model M6 by including two possible confounds, frequency of face-to-face communication as well as time spent online. The results show that the coefficients barely changed. The only differences with model M6 were slightly decreased coefficients.⁷ Time spent online showed a negative effect on relationships satisfaction ($f^2 = -.001$) whereas face-to-face communication had an expectedly positive coefficient ($f^2 = .03$).

Discussion

Using cross-national data with representative samples from 19 countries, this study aimed to contribute to the existing literature by examining the link between instant messaging (IM) and relationship satisfaction across different age groups and countries. To the best of our knowledge, this is the first study of this link to adopt a multilevel approach and to consider cross-level interaction effects.

The results support our individual-level hypotheses by showing that using IM frequently to stay connected with strong tie others is positively associated with individuals' relationship satisfaction. This is consistent with the literature showing one of the key motives for using IM as a tool is to facilitate engagement with significant others (Burke & Kraut, 2016; Ku et al., 2013). Previous findings showed that IM helps to maintain relationships with strong ties and, therefore, serves the need of belongingness (Cui, 2016; Ledbetter et al., 2016; Quan-Haase & Young, 2010; Timmis, 2012). Hence, using IM communication likely plays a less contradictory role for well-being outcomes concerning relationship satisfaction than has been found for the use of social media in general (e.g., Guo et al., 2014; McCrae et al., 2017; Valkenburg & Peter, 2007a). We found that other (control) variables were also associated with relationship satisfaction as was expected based on previous research. As in many studies about general subjective well-being (e.g., Diener et al., 1999), social status demonstrated a larger ($f^2 = .07$) positive effect. Likewise, face-to-face communication was significantly positively associated with satisfaction with relationships ($f^2 = .04$), which is to be expected (Ahn & Shin, 2013). Even though the effect size of IM was not particularly large, it was similar to the effect sizes that are usually found in country-comparative research (e.g., Fischer & Schwartz, 2011), and this relationship held despite controlling for these other variables. As we observed a substantial heterogeneity of this effect, the overall estimate was moderate, whereas a large effect would only be possible if the association was universal across countries and age groups.

By drawing on socioemotional selectivity theory (Carstensen, 2006) as well as selection, optimization, and compensation theory (Baltes & Baltes, 1990), we also suggested that younger people could derive more relational benefits from using IM than older people because the computer-mediated communication serves younger people's developmental need for social connectedness which is seen as key for identity building at this stage of life (Sun & Subrahmanyam, 2017). In contrast, older people would engage with new communication technologies because of its benefits to stay connected, but they would also find this type of communication less meaningful, and gratifying given that it is less rich than face-to-face communication. Consistent with previous research among very young populations (Valkenburg & Peter, 2007a), younger people demonstrated a positive association between satisfaction and frequent IM use. However, older age groups had weaker associations which may point to a more ambivalent appraisal of IM: it may be seen as a necessary tool for maintaining relationships nowadays, but also as requiring more effort and, therefore, less gratifying. Our measures did not allow examining specific age differences in the appraisal of IM, yet future research could explore this question in greater depth to arrive at a more thorough understanding of cohort/age differences in IM use and its perceived value.

We also aimed to examine the role of contextual factors in moderating the link between IM and relationship satisfaction for different age groups across countries. There is very little theory and research that helps in hypothesizing cross-level interaction effects in this domain. Therefore, we derived our hypothesis from the cultural models of individualism-collectivism (Hofstede, 2001) and the related concept of Embeddedness (S. H. Schwartz, 2006). These tap into the most important dimension of cultural values (Oyserman et al., 2002) and has been widely used to explain differences between cultural groups. We reasoned that because cultural Embeddedness requires people to maintain a particular set of relationships, using IM with strong ties may mirror offline functions of social communication. Therefore, it can serve as a tool to be socially connected and to fulfill one's social duties, thereby effectively satisfying a normative cultural model. However, the cross-level interaction of IM with a country-level measure for Embeddedness as well as the three-way interaction of IM, age, and Embeddedness were not significant. A post-hoc power analysis demonstrated that a much larger country-level sample size ($N > 100$) would be needed to render these two- and three-way interaction effects statistically significant at $p < .05$, given the relatively small effect size. Considering that there are only 195 countries in the world, it seems virtually impossible to reach the minimum sample size for this type of analysis. Nevertheless, future research may purposefully sample a more diverse set of countries, which might achieve larger interaction effects, and therefore reduce the required sample size of countries, which may be due to the relatively small variance of Embeddedness scores in the current sample. Moreover, the Schwartz Embeddedness scores are not based on representative samples and were measured two decades prior to our study, whereas cultures can and do change (e.g., Inglehart, 1997).

Other country-level variables might also be worth considering in future research with more countries. While connecting with others via instant messaging has been shown to be gratifying across different social groups (e.g., Cui, 2016; Holtzman et al., 2021; Ku et al., 2013; Ledbetter et al., 2016; Quan-Haase & Young, 2010; Timmis, 2012), the strength of the link between IM use and relationship satisfaction may differ across different societal contexts. For instance, Inglehart (2008) argued that postmaterialist values, with an emphasis on nonmaterial goals, such as self-expression, quality of and meaning in life, become more important with increasing prosperity, while materialistic goals, such as economic and physical security, are valued in less prosperous societies. Our results suggest that older individuals, who were born and brought up during a time of prosperity (such as the baby-boomer generation in many industrialized countries) might derive somewhat less relationship benefits from using IM with significant others. Evidence from qualitative studies using socioemotional selectivity theory (Carstensen, 2006) and selection, optimization and compensation theory (Baltes & Baltes, 1990) as theoretical frameworks also suggest that meaningful conversations are a key concern for older adults from industrialized societies (e.g., Scotland, Singapore, U.S.) when it comes to the appraisal of social media (Han et al., 2021; Joshi et al., 2020; Knowles & Hanson, 2018). This would suggest that the economic context could also exacerbate the effects expected from these theories. Unfortunately, the limited number of nations in our study did not permit including these variables together with Embeddedness. Yet, exploratory follow up analyses showed that the socio-economic context (assessed via logarithm of GDP per capita, see Table A4) was not an important cross-level moderator either.⁸

Despite the sample size limitations at the country level, the results showed some trend towards what we expected: using IM is less important for relationship satisfaction in some countries than in others. More specifically, a country-specific follow up analyses showed that age differences in the IM-relationship satisfaction link were more pronounced in Germany than in Indonesia which are two countries that have been categorized at the extremes of the individualism-collectivism continuum (Hofstede, 2001). More research is needed to confirm this pattern, ideally by using a larger and more diverse sample of countries given that participants from low-Embeddedness cultures were over-represented in this sample. A first step could be to conduct a cross-cultural comparative study with mixed methods to better understand differences in appraisals of IM between generations and cultures and their implications for relationship satisfaction.

Another limitation of the current study is the use of one-item measures to assess IM usage and relationship satisfaction. Ideally, these should be measured with multiple items. Nevertheless, items included in this survey were carefully developed, (back)translated, and pilot tested to ensure cross-cultural comparability. The one-item relationship satisfaction measure has recently been shown to be as valid as the seven-item measure and has been recommended for use in large scale studies (Fülöp et al., 2022). Assessing Internet or social media use with just one item is also very common in the literature (for a recent example, see Li & Zhou, 2021), because it has great face validity. And Allen and colleagues (2022) recently argued that single item measures are not necessarily inferior to multi-item measures.

Our study makes an important contribution by examining the link between IM use and relationship satisfaction across different samples while holding constant the way they are operationalized (see also Cotten, Schuster, & Seifert, 2022). But a limitation is that we were not able to differentiate between friends and family members which could be critical when comparing different age groups. It is also noteworthy that there was no explicit reference to the type of relationship in the relationship satisfaction item, even though the preceding questions in the survey always referred to family and friends and it is assumed that participants had this frame of reference in their minds when answering the item. Previous research has shown that the strength of the associations between communication method and satisfaction with a relationship varied depending on the type of the relationship, but it was consistently positive (Goodman-Dean et al., 2016).

Finally, we hypothesized that frequently using IM predicts relationship satisfaction, yet the direction of effects might in fact also be reversed. It is also conceivable that individuals who are in more satisfactory relationships use IM to communicate more often than those individuals who are less satisfied with their strong ties. Valkenburg and Peter's (2009) study is one of the rare ones examining causality in this domain, and it found, in line with our hypothesis, that using IM improved friendship quality among adolescents in the long run. Nevertheless, the causal direction of effects should be further tested using experimental study designs.

To summarize, this study is an important step forward towards a better understanding of age differences in the well-being benefits associated with social media use by focusing on instant messaging and relationship satisfaction. There is a clear lack of theories regarding age differences in this domain, yet socioemotional selectivity

theory (Carstensen, 2006) as well as selection, optimization and compensation theory (Baltes & Baltes, 1990) are promising theoretical approaches that can be applied to better understand the way computer-mediated communication is approached and what the implications are. Our study also points to potential insights into cultural differences. We suggest that new theories are needed that take life-span and multilevel perspectives on such a clearly globalized phenomenon. The study is pertinent when considering that IM has often become the main tool to stay connected to significant others during the COVID pandemic. Yet, the pattern of results suggests that this may not be equally beneficial for everyone and everywhere. More large-scale cross-cultural research is urgently needed to test this pattern and to further tackle the Western and monocultural bias in the field of technology mediated communication.

Footnotes

¹ We acknowledge that it is not always the case. Sometimes group chats are large and provide opportunities for making new connections. There is a tendency for social networks to merge with IM use, but this merger is almost never complete or perfectly 1-1.

² This study is based on the same dataset as the current study, yet Paez et al. (2020) used a subsample of participants from wave 1 ($N = 7,122$) of the project to examine the longitudinal effects of Internet use (in general) on subjective well-being (life satisfaction and anxiety). Hence, the variables and samples differ across the two studies (see also our method section for more information).

³ Most of the Hofstede country level scores are based on data that is more than a half a century old.

⁴ No previous research using this dataset has examined the association between IM use and relationships satisfaction. For a publication listing of this dataset with studies focusing on well-being and/ social media, see Supplementary References in the Appendix.

⁵ This is our *conservative* judgment in line with widespread conventions. Should we apply another conventional measure of effect size, this figure would turn into Cohen's $d = .35$ which is conventionally recognized as a medium (Cohen, 1992) effect size. Moreover, such effect size is larger than 75% of commonly reported effects in the literature on individual differences (Gignac & Szodorai, 2016). This points to a non-negligible nature of this effect.

⁶ One of the reviewers suggested that not just age, but also gender can moderate the effect of social media use. When testing this, we found the interaction with gender to be non-significant (see Table A3).

⁷ We refitted the other models as well controlling for face-to-face communication and time spent online. The results listed in Table A2 confirm that our main conclusions remained intact.

⁸ Technically, in some models p-value of the three-way interaction was .03 and .01.

Conflict of Interest

The authors have no conflicts of interest to declare.

Authors' Contribution

Christin-Melanie Vauclair: conceptualization, methodology, writing—original draft, writing—review & editing. **Maksim Rudnev:** formal analysis, software, methodology, visualization, writing—original draft, writing—review & editing. **Joep Hofhuis:** conceptualization, writing—original draft, writing—review & editing. **James Liu:** data curation, funding acquisition, investigation, project administration, writing—review & editing.

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Appendix

Table A1. Recalculation of Models With Bayesian Methods.

	<i>Dependent variable: All things considered, how satisfied are you these days with your relationships?</i>						
	M1	M2	M3	M4	M5	M6	M7
<i>Individual level</i>							
Frequency of IM use	.14* (.007)	.16* (.007)	.13* (.007)	.14* (.02)	.15* (.02)	.15* (.02)	.10* (.02)
Age		.10* (.007)	.11* (.007)	.10* (.01)	.10* (.01)	.09* (.01)	.08* (.01)
Interaction of frequency of IM use and Age		-.04* (.006)	-.03* (.006)	-.03* (.008)	-.02* (.008)	-.02* (.008)	-.02* (.008)
Gender (female)			.03* (.007)	.03* (.007)	.03* (.007)	.04* (.006)	.03* (.006)
Subjective Social Status			.25* (.006)	.25* (.006)	.25* (.007)	.24* (.02)	.23* (.02)
Time spent online							-.03* (.006)
Frequency of face-to-face communication							.18* (.007)
<i>Country level</i>							
Cultural value of embeddedness		-.03 (.07)	-.03 (.07)	.01 (.08)	-.03 (.07)	-.09 (.07)	-.09 (.07)
× Frequency of IM use					.02 (.02)	.01 (.02)	.01 (.02)
× Age					-.03 (.01)	-.03* (.01)	-.03* (.01)
× Interaction of frequency of IM use and age					.01 (.008)	.01 (.009)	.01 (.009)
<i>Random effects</i>							
Standard deviation of intercepts	.29* (.05)	.29* (.06)	.29* (.05)	.31* (.06)	.30* (.06)	.30* (.06)	.30* (.06)
residuals	.91* (2e-05)	.90* (2e-05)	.84* (2e-05)	.84* (2e-05)	.84* (2e-05)	.83* (2e-05)	.80* (2e-05)
effects of frequency of IM use				.07* (.02)	.07* (.02)	.07* (.02)	.06* (.01)
effects of age				.05* (.01)	.04* (.01)	.04* (.01)	.04* (.01)
interaction of frequency of IM use and age				.02* (.01)	.01* (.01)	.01* (.01)	.01* (.01)
subjective social status						.07* (.01)	.07* (.01)
WAIC	55,985 (226)	55,731 (226)	54,274 (227)	54,187 (227)	54,186 (227)	54,110 (228)	53,411 (232)

Note. The models were fit with R package “brms” based on Stan language (Buerkner, 2018; The Stan Development Team, n. d.). The models were fit with the fully Bayesian approach but non-informative (or weakly informative) priors following defaults of “brms” package. The convergence of the models was diagnosed with potential scale reduction factor which in all cases was smaller than 1.1. The models were estimated using 4 Markov chains with 2,000 iterations each (1,000 for warmup), no thinning was used. The presence of autocorrelations was checked visually for each individual parameter using autocorrelation plots. * 95% credible interval do not include zero. WAIC is widely applicable information criterion, standard error in parentheses.

Table A2. Models M1–M5 Controlling for the Frequency of Face-To-Face Communication and Time Spent Online.

	M1a	M2a	M3a	M4a	M5a
<i>Individual level</i>					
Frequency of IM use	.09*** (.01)	.11 *** (.01)	.08 *** (.01)	.10 *** (.01)	.10 *** (.01)
Age		.09 *** (.01)	.09 *** (.01)	.09 *** (.01)	.08 *** (.01)
Interaction of frequency of IM use and age		-.03 *** (.01)	-.02 *** (.01)	-.02 * (.01)	-.02 * (.01)
Gender (female)			.03 *** (.01)	.03 *** (.01)	.03 *** (.01)
Subjective Social Status			.23 *** (.01)	.23 *** (.01)	.23 *** (.01)
Time spent online	-.04 *** (.01)	-.03 *** (.01)	-.03 *** (.01)	-.03 *** (.01)	-.03 *** (.01)
Frequency of face-to-face communication	.21 *** (.01)	.20 *** (.01)	.18 *** (.01)	.18 *** (.01)	.18 *** (.01)
<i>Country level</i>					
Cultural value of embeddedness		-.03 (.06)	-.03 (.06)	.01 (.06)	-.03 (.06)
× Frequency of IM use					.02 (.01)
× Age					-.02 (.01)
× Interaction of frequency of IM use and Age					.01 (.01)
<i>Random effects</i>					
Variance of intercepts	.26	.27	.27	.27	.25
residuals	.93	.93	.90	.90	.90
effects of frequency of IM use				.05	.05
effects of age				.04	.03
interaction of frequency of IM use and age				.02	.01
Abs. deviance	55,079	54,924	53,649	53,601	53,529
Nparameters	6	9	11	20	23
AIC	55,091.39	54,941.97	53,671.09	53,641.10	53,575.21
BIC	55,138.92	55,013.26	53,758.22	53,799.53	53,757.39

Note. Numbers in brackets are standard errors. * $p < .05$, ** $p < .01$, *** $p < .001$.

Table A3. Testing the Differential Effect of IM Use by Gender.

	M1b	M2b	M3b	M4b	M5b	M6b	M7b
<i>Individual level</i>							
Frequency of IM use	.13*** (.01)	.13*** (.01)	.13*** (.01)	.14*** (.02)	.15*** (.02)	.14*** (.02)	.10*** (.01)
Gender (female)	.02** (.01)	.02** (.01)	.03*** (.01)	.03* (.01)	.03* (.01)	.03* (.01)	.03* (.01)
Frequency of IM use X Gender (female)		-.01 (.01)	-.01 (.01)	-.00 (.01)	.00 (.01)	-.00 (.01)	-.00 (.01)
Age			.11*** (.01)	.10*** (.01)	.10*** (.01)	.10*** (.01)	.09*** (.01)
Social Status			.25*** (.01)	.25*** (.01)	.25*** (.01)	.25*** (.02)	.23*** (.02)
Time spent online							-.03*** (.01)
Face-to-face communication							.18*** (.01)
<i>Country level</i>							
Embeddedness	-.03 (.06)	-.03 (.06)	-.03 (.06)	.01 (.06)	-.04 (.06)	-.11* (.05)	-.11* (.05)
× gender					-.03* (.01)	-.03* (.01)	-.02* (.01)
× Frequency of IM use					.03* (.02)	.03 (.02)	.02 (.01)
× Frequency of IM use × Gender					.01 (.01)	.01 (.01)	.01 (.01)
<i>Random variances</i>							
intercepts	.27	.27	.27	.27	.27	.28	.28
residuals	.96	.96	.92	.91	.91	.91	.90
gender				.05	.04	.04	.04
IM use				.07	.06	.06	.05
IM use X Gender				.02	.02	.02	.02
social status						.07	.06
Abs. deviance	56,059	56,065	54,393	54,298	54,314	54,243	53,550
Nparameters	6	7	9	18	21	26	28
AIC	56,071	56,078	54,410	54,334	54,356	54,295	53,605
BIC	56,118	56,133	54,482	54,476	54,522	54,500	53,827

Note. Numbers in brackets are standard errors. * $p < .05$, ** $p < .01$, *** $p < .001$.

Table A4. Testing the Effect of Socio-Economic Context.

	M2c	M3c	M4c	M5c	M6c	M7c
<i>Individual level</i>						
Frequency of IM use	.16*** (.01)	.13*** (.01)	.14*** (.02)	.15*** (.02)	.15*** (.02)	.10*** (.01)
Age	.10*** (.01)	.11*** (.01)	.10*** (.01)	.09*** (.01)	.09*** (.01)	.08*** (.01)
Interaction of frequency of IM use × Age	-.04*** (.01)	-.03*** (.01)	-.03** (.01)	-.02** (.01)	-.02* (.01)	-.01 (.01)
Gender (female)		.03*** (.01)	.03*** (.01)	.03*** (.01)	.04*** (.01)	.03*** (.01)
Subjective Social Status		.25*** (.01)	.25*** (.01)	.25*** (.01)	.24*** (.02)	.23*** (.02)
Time spent online						-.03*** (.01)
Frequency of Face-to-Face communication						.17*** (.01)
<i>Country level</i>						
GDPpc (logarithm)	-.02 (.07)	-.02 (.07)	-.13* (.06)	-.02 (.07)	.12* (.05)	.10 (.05)
× Frequency of IM use				-.03 (.02)	-.02 (.02)	-.01 (.01)
× Age				.03 (.01)	.05*** (.01)	.04*** (.01)
× Interaction of frequency of IM use × Age				-.02* (.01)	-.02* (.01)	-.02 (.01)
<i>Random variances</i>						
intercepts	.27	.27	.28	.27	.30	.29
residuals	.95	.92	.91	.91	.91	.90
age			.05	.04	.05	.04
IM use			.06	.06	.06	.05
IM use X age			.01	.00	.01	.01
social status					.07	.06
Abs. deviance	55,819	54,375	54,300	54,309	54,236	53,546
Nparameters	7	9	18	21	26	28
AIC	55,832	54,393	54,335	54,351	54,287	53,602
BIC	55,888	54,464	54,478	54,517	54,493	53,824

Note. * $p < .05$, ** $p < .01$, *** $p < .001$. Numbers in brackets are standard errors.

Supplementary References: Digital Influence Bibliography of Outputs on Social Media and Wellbeing

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