Mobile instant messaging techno-stressors: Measurement, dimensionality, and relationships with type of usage

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Abstract

Increasingly popular mobile instant messaging (MIM) apps allow users to interact anytime and anywhere with different purposes, such as coordinating work-related issues, staying in touch with people they love, or passing the time. But recent research suggests that MIM may create excessive demands on people and become a source of technostress. For example, users may experience communication overload, invasion of their face-to-face activities, pressure to respond to messages with urgency, or ambiguity regarding the intention or tone of their interactions. Building on these ideas, we develop a specific, multidimensional measure of MIM technostress and explore how it relates to different uses. To do so, we use survey data from a diverse sample of 1,259 residents in Spain. Exploratory and confirmatory factor analyses conducted on different halves of the sample supported a four-dimensional, second-level construct of MIM stress. Furthermore, structural equation model results suggest that not all uses are equally associated with MIM stress. Relatedness and intimacy uses were not positively related to MIM stress or any of its dimensions. Conversely, work uses, coordination of social activity, and even passing the time were positively associated with all techno-stressors. We discuss our findings with an eye toward promoting healthy use of MIM apps.

Keywords

Mobile instant messaging; Mobile instant messaging uses; Technostress; Techno-stressor; Overload; Invasion; Urgency; Ambiguity; Measurement; Scale.

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1. Introduction

Over the last few decades, researchers from a variety of disciplines have taken an interest in the field of technostress, briefly defined as stress triggered by interaction with computer-based technologies (**Tarafdar**; **Cooper**; **Stich**, 2019). A significant portion of published studies have placed special emphasis on technostress in the workplace and showed concern about its adverse outcomes (see **Fuglseth**; **Sørebø**, 2014; **Tarafdar**; **Tu**; **Ragu-Nathan**, 2010). When dealing with information and communication technologies (ICTs) in general, workers may evaluate some of their characteristics as threatening or damaging, which turns these characteristics into techno-stressors. It is important to correctly identify techno-stressors because they are placed early in the technostress process, and they often lead to strain. For example, *overload* is the feeling that technology forces users "to work faster and longer" and "deal with excess information and features," *invasion* relates to perceptions that 'anytime, anywhere' ICTs make users' personal lives more permeable to work-related issues, *complexity* refers to perceived lack of skills to properly integrate the technology into their work, *insecurity* deals with the idea that ICTs threat their job stability, and *uncertainty* connects with the demands of having to adapt to changes and upgrades in ICTs (**Tarafdar**; **Cooper**; **Stich**, 2019, p. 3; **Tarafdar** *et al*., 2007, p. 315).

Outside the work setting, techno-stressors and the larger technostress process can be qualitatively and quantitatively different. For example, people are not equally forced to integrate technology into their personal lives, and threats to job security are less relevant sources of stress in private uses. In addition, different technologies with specific characteristics may involve the perception of different techno-stressors. Given the extensive use of 'anytime, anywhere' MIM apps for work and personal life, we think a more detailed examination of their role in the technostress process can provide important insights and facilitate further research on its antecedents, relevant coping strategies, outcomes, or even design-related aspects to alleviate technostress (see **Tarafdar**; **Cooper**; **Stich**, 2019). Some preliminary qualitative findings do suggest that MIM-specific *overload*, *invasion*, *urgency of response*, and *ambiguity* may induce technostress in personal and professional contexts (**Ardèvol-Abreu** *et al*., 2022).

Drawing on our and others' previous research, this study contributes to the current debate about technostress in two important ways. First, we address the call for "context-specific studies […] entailing specific types of technologies" (**Tarafdar**; **Pullins**; **Ragu-Nathan**, 2015, p. 104) by developing and validating a multidimensional, MIM-specific measure of technostress. This measure looks beyond the organizational context and includes more general demands arising from personal uses, which may be useful in further studies on MIM stress. Second, based on the idea of stress as a changing relationship between the person and its environment (**Lazarus**; **Folkman**, 1987), we explore if and how different uses of MIM trigger the stress process through different techno-stressors. Only with a sound knowledge of the MIM techno-stressors and their relationships with specific uses will it be possible to develop effective strategies for minimizing this specific source of stress.

2. MIM-specific techno-stressors

The technostress process involves the relationship or 'transaction' between the individual and their technological environment, and results from perceptions of imbalance between the demands posed by a given technology and their "resources or ability to cope with those demands" (**Quine**; **Pahl**, 1991, p. 59; see also **Folkman**; **Schaefer**; **Lazarus**, 1979; **Tarafdar**; **Cooper**; **Stich**, 2019). According to this transactional and systemic approach, technostress cannot be directly observed or measured. What is observable is an "interdependent system of variables" that includes, among others, technology environmental conditions, techno-stressors, coping responses, and a variety of short- and long-run outcomes (**Lazarus**; **Folkman**, 1987, pp. 142-143; **Tarafdar**; **Cooper**; **Stich**, 2019). As we shall see below, the first two elements are particularly relevant for this study.

Technology environmental conditions are events or characteristics of technology –for example, technology-related interruptions, mobility, or ubiquity– that "have the potential to create a demand in the individual" (**Tarafdar**; **Cooper**; **Stich**, 2019, p. 10). When an individual interacts with a certain technology and appraises some of its characteristics as threatening, these become techno-stressors. Techno-stressors may subsequently activate some forms of coping and lead to negative outcomes (strain) (**Ayyagari**; **Grover**; **Purvis**, 2011).

Against this background, MIM-specific stress can be defined as stress that individuals experience due to their interaction with MIM apps. Indeed, a recent qualitative study (**Ardèvol-Abreu** *et al*., 2022) found four main techno-stressors associated with MIM use: *overload*, *invasion*, *urgency*, and *ambiguity*. First, MIM users may experience feelings of *overload*, which

may resemble to what **Tarafdar** and colleagues (2007) defined as techno-overload in their general model of technostress: "Situations where ICTs force users to work faster and longer" (2007, p. 315). From a proxemic perspective, **Shin**, **Seok**, and **Lim** (2018) referred to this by describing "the territory" of MIM as s "too crowded" space: Some users may perceive that they need to deal with an excessive number of contacts and group conversations, that the stream of messages and notifications is unmanageable, or that they are not able to "keep [their] MIM applications clean" (p. 8). Another exploratory study on WhatsApp use and wellbeing found that engaging with many one-on-one MIM conversations is positively associated with a single-item measure of perceived stress (**Blabst**; **Diefenbach**, 2017).

Second, MIM technology may in some instances facilitate the *invasion* of one's face-to-face, offline spaces, which can happen not only when users deal with work-related issues outside of working hours, but also when MIM interactions get in the way of their daily routines. In the realm of social media, previous studies have identified invasion (e.g., when individuals have to "sacrifice their leisure time to remain current on the latest developments in their communities or networks") as a major stress-inducing factor (**Bucher**; **Fieseler**; **Suphan**, 2013, p. 1656; see also **Tarafdar** *et al*., 2007). More relevant to the present work, **Lee**, **Lee**, and **Suh** (2016) found that work-related MIM interactions after working hours sometimes create stress because they associate with certain techno-stressors (e.g., perceived social insecurity, invasion of life, and work-home conflict) and lead to technology-related exhaustion and, indirectly, lower productivity.

Third, some characteristic of MIM apps (last seen, read receipts) may fuel feelings of *urgency* due to others' (and self-) expectations of quick response, which in turn may associate with increased perceptions of stress (see **Blabst**; **Diefenbach**, 2017). This is in line with the qualitative evidence presented by **Karapanos**, **Teixeira** and **Gouveia** (2016): WhatsApp creates expectations of immediacy while providing "limited cues regarding one's availability to respond," which sometimes leads to conflict and other negative outcomes (p. 894).

Fourth, technology-induced ambiguity (for example, role ambiguity at work) has been previously identified as a major techno-stressor and a predictor of strain (**Ayyagari**; **Grover**; **Purvis**, 2011). In the context of this study, MIM *ambiguity* is more specifically defined as the "lack of human presence" and reduced non-verbal cues, which sometimes make it harder to understand the tone and intention of MIM-mediated conversations (**Ardèvol-Abreu** *et al*., 2022). Based on these arguments and empirical findings, we posit the following hypothesis:

> H: MIM stress is a second-order construct that consists of the following first-order dimensions: *overload*, *invasion*, *urgency*, and *ambiguity.*

3. MIM uses and techno-stressors

Not everyone uses MIM in the same way or with the same goals. As with any other media, MIM users are "active, discerning, and motivated" when interacting with the app (**Quan-Haase**; **Young**, 2010, p. 351; see also **Rivas-Herrero**; **Igartua**, 2021). This view of the media as means to satisfy specific needs is at the heart of the Uses and Gratification Theory (U&G). For example, when a person wants to involve and satisfy their basic need for relatedness, they may resort to instant messaging and interact with someone they love (**Karapanos**; **Teixeira**; **Gouveia**, 2016; **Reeve**, 2009).

Previous research has adopted the U&G theoretical approach to explain gratifications obtained from the use of MIM. For example, a highly cited study by **Quan-Haase** and **Young** (2010) compared uses of instant messaging with uses of Facebook and found a similar pattern of gratifications obtained from both types of media. The comparison, however, relied on an earlier work about motives for chatting on the instant messaging tool ICQ ("I seek you"), which used survey data from 1999 (**Leung**, 2001). ICQ was mainly a desktop instant messaging software at the time, and therefore one cannot readily extrapolate findings from ICQ to modern mobile messaging. A more recent qualitative study on WhatsApp uses and motivations among teenagers (aged 12 to 17) provided a catalogue of usages associated with private (one-on-one) and group interactions. These include "talking and meeting up with friends and family," "catching up with lessons and homework," "playing videogames," or "humor," among others (**Costa-Sánchez**; **Guerrero-Pico**, 2020).

Among adults, the most common use of MIM seems to be for *relatedness*, *intimacy*, and *social interaction* purposes, which connects with the basic psychological need of relatedness (**Ardèvol-Abreu** *et al*., 2022; **Reeve**, 2009). Other frequent uses of MIM among adults include *work, business, and study*; *political and civic*; *domestic and other non-work commitments*; and *pastime and entertainment* (**Ardèvol-Abreu** *et al*., 2022; see also **Pont-Sorribes**; **Besalú**; **Codina**, 2020). With this variety of usage types in mind, our departure standpoint is that different uses of MIM will associate with MIM stress differently –both when considering the overall measure of MIM stress and its component dimensions. This is because each use tends to have a particular pattern of demands and constraints and may therefore be more likely to associate with certain techno-stressors and not with others. For example, *work- and study-related uses* are probably more likely to trigger feelings of invasion than are *political and civic uses*, while *social interaction uses* are presumably more connected to *ambiguity* than are *domestic and other non-work commitments*. Given the large number of potential associations between MIM uses and MIM techno-stressors, we pose two open research questions rather than directional hypotheses:

> RQ1: How do different uses of MIM relate to the overall measure of MIM stress?
>
> RQ2: How do different uses of MIM relate to the component dimensions of MIM stress –i.e., MIM techno-stressors?

4. Methods

This study uses survey data from a larger, two-wave study on individual and societal impacts of mobile and internet technologies funded by the Universidad de La Laguna. The research team relied on the literature discussed in the previous sections and first developed 20 items aligned with the four proposed (**Ardèvol-Abreu** *et al*., 2022) dimensions of MIM stress (five items per dimension). Items included statements such as "When you use MIM, you are forced to interact [through text, voice, etc.] with too many people at the same time" (for MIM *overload*); "You feel that MIM gets in the way of your daily routines" (for MIM *invasion*); "The features of MIM apps force you to reply to messages too quickly (for MIM *urgency*); or "One has to give a lot of thought to the messages one exchanges so as not to misinterpret them" (for MIM *ambiguity*). The syntactic structure of these items imitates that of earlier technostress measurement scales (for example, that of **Tarafdar** *et al*., 2007). This approach helps achieve content validity of the main construct and its component dimensions. Answers were given on a 5-point scale, ranging from 1 = *never* to 5 = *all the time*.

Second, we also created a list of 28 items about different uses of MIM that were adapted from previous studies and opinion polls (**Costa-Sánchez**; **Guerrero-Pico**, 2020; **Gil de Zúñiga**; **Ardèvol-Abreu**; **Casero-Ripollés**, 2021; **Gil de Zúñiga**; **Jung**; **Valenzuela**, 2012; *Pew Research Center*, 2015; **Quan-Haase**; **Young**, 2010). These items were aimed to reflect a variety of uses belonging to categories and subcategories such as *relatedness, intimacy, and social interaction* (e.g., "Generally speaking, how often would you say you use MIM apps to stay in touch with family and friends?"), *study* (e.g., "[…] to ask or answer questions related to your studies?"), or *pastime and entertainment* (e.g., "[…] to entertain yourself?") (see the complete list of categories in **Ardèvol-Abreu** *et al*., 2022). All items were also measured on five-point scales (1 = *never* to 5 = *all the time*).

Finally, the questionnaire incorporated the European Spanish version of the Perceived Stress Scale (**Remor**, 2006), which is a translation of the 14-item Perceived Stress Scale (PSS) of **Cohen**, **Kamarck**, and **Mermelstein** (1983). The PSS is not a measure of technostress, but an instrument that seeks to measure "the degree to which individuals appraise [general] situations in their lives as stressful" (**Cohen**, 1986, p. 716; text within brackets is ours). We use the PSS, which is theoretically related to our main construct of interest, as an external standard to further assess its validity (see **Muñiz**; **Fonseca-Pedrero**, 2019). It contains items such as "How often have you felt that you were effectively coping with important changes that were occurring in your life?" Cronbach's alpha coefficient for the PSS showed satisfactory internal consistency (complete sample; $\alpha = .85$, $M = 25.14$, $SD = 7.45$).

The survey was hosted on the survey site *Qualtrics* and open to responses between July 5 and 8, 2021. We contracted with the international online research company Netquest to recruit a national sample whose demographic composition approximated the Spanish population in terms of age, gender, and education level. For this purpose, *Netquest* distributed the survey links to 3,458 of their Spanish panelists. After giving their informed consent, 1,259 of them provided valid responses. Respondents were uniquely identified by an anonymous ID, but we did not collect any personal identifying information. The questionnaire was written in Spanish, and respondents received economic compensation for their time. Our final sample comprises 52.1% females, reported a mean age of 45.66 years ($SD = 14.99$; 10.9% younger than 25 years, 14.9% between 25 and 34, 22.3% between 35 and 44, 38.3% between 45 and 64, and 13.6% aged 65 or over), and a median education level of high school graduate ($M = 3.79$, $SD = 2.09$; ranging from 1 = *primary education* to 7 = *postgraduate and doctoral studies*; 14.3% had only primary education, while 37.2 had some university education or more).

5. Statistical analyses

> "Mobile instant messaging (MIM) apps may be a specific source of technostress"

To develop our latent measures of MIM stress and MIM uses, we first employed exploratory factor analysis (EFA) with geomin rotation. This allowed us to "determine the number of continuous latent variables that are needed to explain the correlations among [our] set of observed variables" (**Muthén**; **Muthén**, 2017, p. 43). In each EFA, we defined lower and upper limits on the number of factors to be extracted (see **Muthén**; **Muthén**, 2017, p. 46). Then, we continued with confirmatory factor analysis (CFA) to test the structure identified in the EFA. Since "using the same sample for both EFA and CFA [is] an undesirable practice" (**Lorenzo-Seva**, 2021), we generated two approximately equal subsets of the sample by using the routine 'select random sample of cases' (*SPSS* v. 25): $n_1 = 613$, $n_2 = 646$. We utilized the first subsample to conduct EFAs on the items of MIM stress, on the one hand, and MIM uses, on the other. Then we used the second subset of respondents to separately confirm both measurement models through confirmatory factor analyses (CFAs). Finally, we tested the structural model (SEM) of MIM uses on MIM techno-stressors using the whole sample ($N = 1,259$). Analyses were conducted with the aid of the statistical package *MPlus 8.0* (**Muthén**; **Muthén**, 2017)

6. Results

To test our hypothesis, we first performed EFA on the 20 stress items. For this analysis, we used maximum likelihood (ML) estimation and extracted factors in a range from 3 to 7. After examining fit indices and factor loading patterns, we decided on a four-factor model. In this solution, however, some items showed large cross-loadings or low factor loadings. After four iterations of the EFA, we removed two items from the *invasion* dimension and two more from *urgency*. The resulting 16-item, four-factor solution showed good fit indices: $\chi^2/df = 2.78$; CFI = .98; TLI = .97; RMSEA

= .05; SRMR = .02; BIC = 21821.27. A simpler three-factor solution, with *invasion* and *urgency* items collapsed into a single factor, showed a worse chi square to df ratio (5.58), a suboptimal TLI (.92), and increased RMSEA (.09) and BIC (21984.15).

> We develop and test a four-dimensional, second-level measure of MIM techno-stress

We then applied the four-factor solution to a second-order CFA of MIM stress using the other half of the sample and ML as estimator. The model showed a good fit on some indices, but the RMSEA value was somewhat high and the TLI suboptimal (χ^2/df = 4.84; CFI = .95; TLI = .94; RMSEA = .08; SRMR = .05; BIC = 22580.74). After considering suggested modification indices, we included two residual covariance paths (see **Monacis** *et al*., 2017) between two items on the *MIM overload* factor and two items on the *ambiguity* factor, respectively (see Fig. 1). The modified model provided a better fit to the data: χ^2/df = 3.94; CFI = .96; TLI = .96; RMSEA = .07; SRMR = .04; BIC = 22495.46. All factor loadings reached statistical significance in a range from .71 to .90. Each specific dimension of stress showed very good levels of internal consistency, with all Cronbach's alphas above .80. Our hypothesis was therefore supported. Sample means and standard deviations for each dimension were as follows: *overload* (averaged five-item measure, *M* = 2.34; *SD* = 0.85), *invasion* (averaged three-item measure, *M* = 2.27; *SD* = 1.00), *urgency* (averaged three-item measure, *M* = 2.34; *SD* = 0.90), and *ambiguity* (averaged five-item measure, *M* = 2.49; *SD* = 0.92). As expected, correlations of MIM stress and its dimensions with the external standard of perceived stress in daily life (PSS) were positive and significant, ranging from .13 to .22: MIM stress and PSS, r = .21, p < .001; overload and PSS, r = .13, p < .001; invasion and PSS, r = .16, p < .001; urgency and PSS, r = .19, p < .001; ambiguity and PSS, r = .22, p < .001. The exact wording of the 16 MIM stress items can be found in the Annex.

To explore and confirm the factor structure of the 28 MIM use items, we followed an analogous procedure, but in this case we did not treat the dependent variables as continuous because some MIM uses were rare in our sample and responses gathered in the first category (*never*). This applies especially to the items referring to job search, study-related uses, political participation and, to a lesser degree, sale/purchase transactions. For this reason, we declared MIM use variables as categorical and used weighted least square mean and variance adjusted (WLSMV) estimation. The rotated EFA using the first subsample produced a well-fitting 10-factor solution, but some of the resulting factors had less than three defining items (e.g., two items for job search, two items for advertising and sale/purchase transactions) or collectively assessed very low-frequency behaviors (e.g., four items for political participation with an averaged mean value of 1.67 in a 1 = *never* to 5 = *all the time* scale).

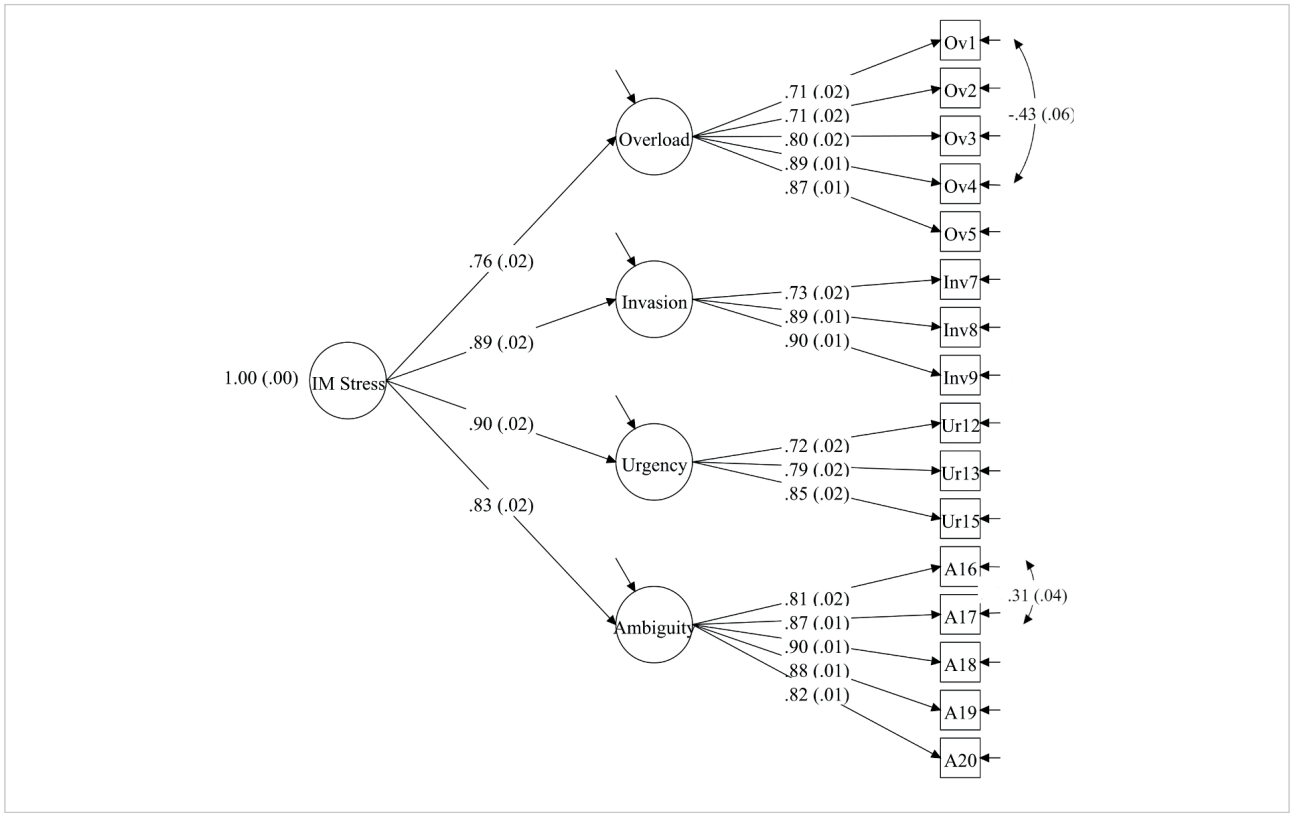

Figure 1. Second-order confirmatory factor analysis of MIM stress.
Note: n = 642. Coefficients are STDYX estimates. The model uses ML as estimator. Goodness of fit: χ^2/df = 3.94; CFI = .96; TLI = .96; RMSEA = .07; SRMR = .04; BIC = 22495.46. All factor loadings reached statistical significance. Long straight arrows represent paths from latent variables (BY paths). Curved arrows refer to residual covariances. Short, straight arrows are residual arrows.

To furnish a more parsimonious, truly representative of MIM uses solution, we decided to retain those factors connected with work-related uses, news, social interaction, and pastime. In the subsequent EFA on the remaining 13 items, a four-factor solution showed poor fit (χ^2/df = 17.22; CFI = .98; TLI = .96; RMSEA = .16; SRMR = .03), while a five-factor model provided much better indices (χ^2/df = 1.24; CFI = 1.00; TLI = .99; RMSEA = .02; SRMR = .01). The latter solution disaggregated the items of *relatedness, intimacy, and social interaction* into two factors with two items each: *relatedness and intimacy*, and *coordination of social activity*. Although the rule of thumb is not to retain two-item factors, it can be done "if the items are highly correlated (i.e., $r > .70$) and relatively uncorrelated with other variables" (**Worthington**; **Whittaker**, 2006, p. 821). Our two pairs of social interaction items correlated .66 and .79, respectively, and their correlations with the rest of variables ranged from .18 to .57. Considering all this, we decided not to collapse the two pairs of items and retain them as separate factors.

We then proceeded to confirm the five-factor structure of MIM uses with the second subsample. A CFA of MIM uses (also with WLSMV estimation) showed a good fit to the data: χ^2/df = 2.64; CFI = .99; TLI = .99; RMSEA = .05; SRMR = .02. Factor loadings for all the items in the five factors were significant and ranged from .83 to .96 (STDYX standardization, see item wording in the Annex). Furthermore, each type of MIM use showed good levels of internal consistency as indicated by their Cronbach's alpha coefficients, with values of at least .80. Sample means and standard deviations for each use were as follows: *work-related uses* (averaged three-item measure, $M = 2.55$; $SD = 1.18$), *news* (averaged three-item measure, $M = 2.61$; $SD = 1.02$), *relatedness and intimacy* (averaged two-item measure, $M = 3.81$; $SD = 0.92$), *coordination of social activity* (averaged two-item measure, $M = 3.31$; $SD = 1.02$), and *pastime* (averaged three-item measure, $M = 3.13$; $SD = 1.00$). The exact wording of the 16 items can be found in the Annex.

Finally, to address our two research questions, we tested two complementary structural equation models of MIM uses on MIM stress. The first one regresses MIM stress (as a second-level construct that integrates four MIM techno-stressors: *overload*, *invasion*, *urgency*, and *ambiguity*) on the five uses of MIM (first order constructs, with observed indicators declared categorical). The overall WLSMV-based model showed acceptable fit to the data (χ^2/df = 4.02; CFI = .96; TLI = .96; RMSEA = .05; SRMR = .04), and suggests that all MIM uses, except for *relatedness and intimacy*, are associated with MIM stress (RQ1): *work-related uses* ($\beta = .302$, $p < .001$), *news* ($\beta = .156$, $p < .001$), *coordination of social activity* ($\beta = .327$, $p < .001$), and *pastime* ($\beta = .120$, $p < .001$). The sign of the association between *relatedness and intimacy* and *MIM stress* was negative but statistically non-significant ($\beta = -.069$, $p = .176$, *ns*).

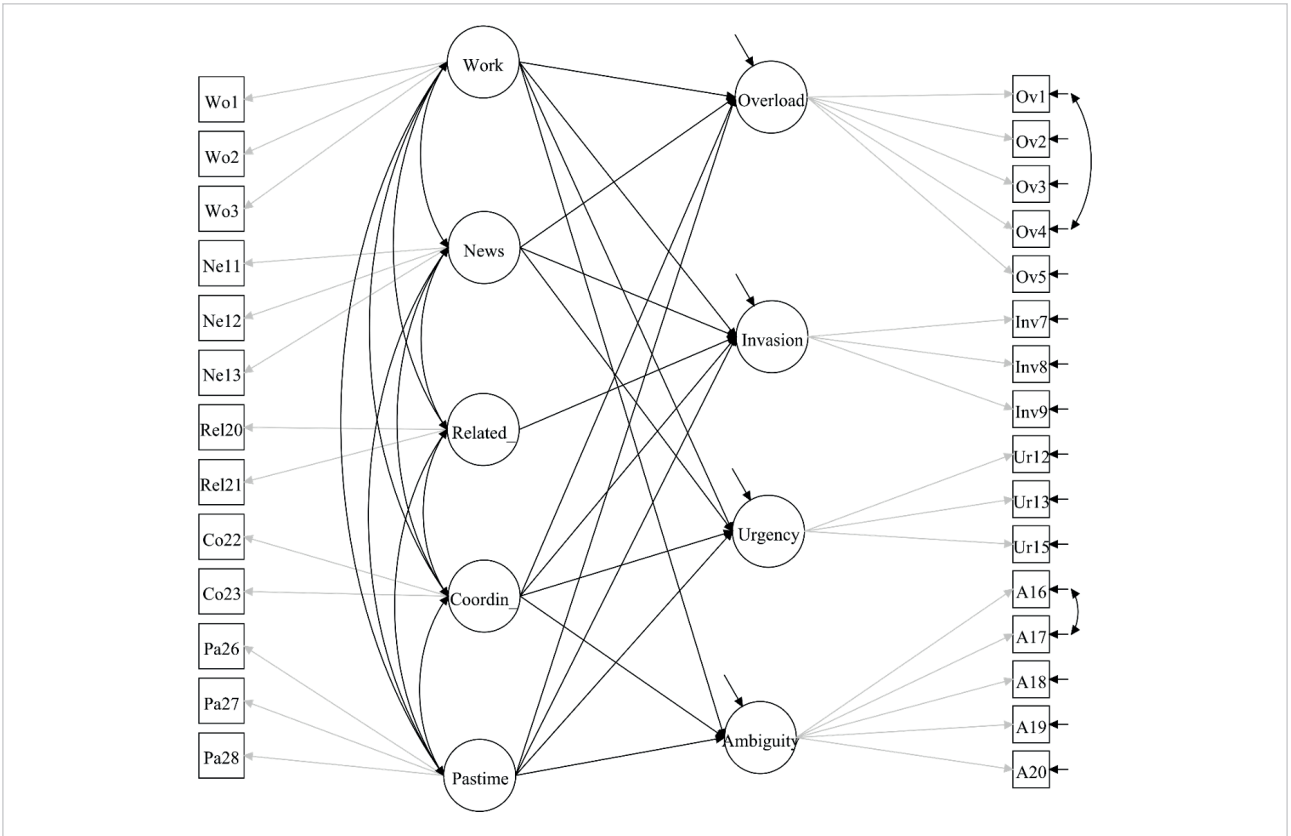

Figure 2. Structural equation model of MIM uses on MIM techno-stressors.
Note: $n = 1{,}257$. The model uses WLSMV as estimator, with MIM use variables declared as categorical. Goodness of fit: χ^2/df = 3.58; CFI = .97; TLI = .96; RMSEA = .05; SRMR = .03. Long, straight black arrows represent significant regression paths (ON paths). Non-significant regression paths are not represented. Straight grey arrows represent paths for the latent variables (BY paths). Long curved arrows represent correlations between the latent independent variables, while short curved ones refer to residual covariances. Short, straight arrows are residual arrows. Residual variables and residual covariances of the latent dimensions of MIM stress are not represented for simplicity.

The second overall SEM regresses each dimension of MIM stress on the five uses of MIM (RQ2). The model (Fig. 2) showed good fit indices: χ^2/df = 3.58; CFI = .97; TLI = .96; RMSEA = .05; SRMR = .03. Regression paths indicated that *work uses* of MIM are associated with MIM *overload* (β = .250, *p* < .001), *invasion* (β = .342, *p* < .001), *urgency* (β = .247, *p* < .001), and *ambiguity* (β = .200, *p* < .001). *News uses* are not associated with *ambiguity* (β = .057, *p* = .071, *ns*), but they are with *overload* (β = .233, *p* < .001), *invasion* (β = .080, *p* < .01), and *urgency* (β = .166, *p* < .001). For its part, *relatedness uses* are not associated with *overload* (β = -.067, *p* = .206, *ns*), *urgency* (β = -.025, *p* = .663, *ns*), or *ambiguity* (β = -.031, *p* = .544, *ns*), but they are negatively related to feelings of *invasion* (β = -.119, *p* < .05). *Coordination of social activity* is however related to all dimensions of stress: *overload* (β = .266, *p* < .001), *invasion* (β = .345, *p* < .001), *urgency* (β = .160, *p* < .01), and *ambiguity* (β = .294, *p* < .001). The same applies for *pastime*, that in our sample is also associated with feelings of *overload* (β = .103, *p* < .01), *invasion* (β = .074, *p* < .05), *urgency* (β = .132, *p* < .001), and *ambiguity* (β = .096, *p* < .01).

> We propose four MIM-specific techno-stressors: *overload*, *invasion*, *urgency of response*, and *ambiguity*

7. Discussion and conclusions

Based on earlier qualitative and quantitative research on technostress, this study first developed and evaluated a measure of MIM stress comprised of several techno-stressors. After deciding on a four-factor model and optimizing the scale length using EFA on subsample 1, we assessed its validity and reliability. CFA on subsample 2 confirmed that the data fitted well to the four-factor solution, which is in line with previous qualitative studies (**Ardèvol-Abreu** *et al*., 2022).

Following our theoretical and empirical framework, MIM stress is a higher-order construct that includes four techno-stressors as first-order dimensions: *Overload* refers to situations where MIM users receive too may messages from too many people, which leads them to spend too much time filtering information or dealing with unread messages. *Invasion* is associated with contexts where MIM gets in the way of the users' daily routines or distracts them from other activities. This includes (but is not limited to) work-related issues spilling over into users' personal life. *Urgency* accounts for situations involving social pressures to reply quickly to one's chat partners and expectations for them to do the same. Finally, *ambiguity* defines MIM-based exchanges where users need to make extra efforts to determine the meaning, tone, and intent of messages, which often results in misunderstandings.

The instrument developed in the present study for measuring MIM techno-stressors will be useful for further investigation of the broader MIM stress process. For example, future studies are needed to better understand how, if at all, these MIM techno-stressors set into motion coping responses. These may include affect-related responses (e.g., anger, frustration), MIM use-related responses (e.g., turning on the mobile flight mode at a certain point, leaving or silencing MIM groups, having separate work and personal phones), interpersonal-related (e.g., asking coworkers not to communicate via MIM), etc. (see **Tarafdar**; **Cooper**; **Stich**, 2019). Further research should also explore outcome variables of the MIM stress process and examine immediate (e.g., physiological changes, emotions) and long-term effects (e.g., psychological and somatic well-being, satisfaction with the MIM technology) (see **Lazarus**; **Folkman**, 1987; **Tarafdar**; **Cooper**; **Stich**, 2019).

Second, we followed an equivalent approach to the above to develop a wide-ranging, empirically validated measure of MIM uses. We began exploring the factor structure of a list of items built from earlier work on social media and MIM uses and gratifications (**Ardèvol-Abreu** *et al*., 2022; see also **Costa-Sánchez**; **Guerrero-Pico**, 2020; **Gil de Zúñiga**; **Ardèvol-Abreu**; **Casero-Ripollés**, 2021; **Gil de Zúñiga**; **Jung**; **Valenzuela**, 2012; *Pew Research Center*, 2015; **Quan-Haase**; **Young**, 2010). After finding good support for a five-factor, 13-item solution using subsample 1, we submitted the structure to CFA using subsample 2. Fit indices provided support for a five-factor structure including the following uses of MIM: *work-related* (e.g., performing work-related tasks and staying up to date on work issues), *news* (e.g., stay informed about current events and public affairs), *relatedness and intimacy* (e.g., staying in touch with family, friends, or people one wouldn't meet otherwise), *coordination of social activity* (e.g., coordinating face-to-face meetings with friends and family), and *pastime* (e.g., having fun and entertaining oneself).

Finally, this investigation also showed how various uses of MIM associate differently with MIM stress and its four first-level techno-stressors. Perhaps most relevant for the development of future strategies or guidelines for healthier use of MIM, we found that the only use that is not associated with MIM stress (overall measure) is *relatedness and intimacy.* Quite to the contrary, *relatedness and intimacy uses* are negatively and significantly related to "feelings of invasion." This means that, in our sample, using MIM for relatedness and intimacy purposes may have helped reduce feelings that MIM gets in the way of one's daily routines or distracts one's attention from other activities (*invasion* techno-stressor). We speculate that emotionally close conversations through MIM may cultivate perceptions of social and emotional support, which have been found to provide a buffer against stress and other mental health issues (**Gilmour** *et al*., 2020). This is why warm, close MIM interactions with people we love, even when they are very frequent, do not associate with increased technostress. This reasoning is also in line with previous findings of social media's (e.g., Facebook) potential to increase perceived social and emotional support and, indirectly, minimize perceived stress and even some of its long-term outcomes, such as physical illness (**Nabi**; **Prestin**; **So**, 2013; see also **Wright**'s, 2012, study among college students).

> *Relatedness and intimacy* uses of MIM were not positively related to MIM stress

> Other uses (e.g., *work*, *coordinating social activity*, and even *pastime*) were related to MIM stress

Using MIM with any other purpose seems more problematic with respect to MIM stress levels—at least when the frequency of usage is high. Thus, *work-related uses*, *coordination of social activity*, *news*, and even *pastime* are positively associated with the overall measure of MIM stress. This means that a higher frequency of usage is related to increased evaluations of MIM as damaging or taxing on one's resources. When we explore the specific techno-stressors behind these associations, we find that *work-related uses*, *coordination of social activity*, and even *pastime* are positively associated with all four MIM techno-stressors. In simpler words, using MIM for any of these purposes is associated with situations where users feel they are overloaded with messages and information; invaded in their personal, face-to-face lives; pressured to reply and anxious to be replied quickly; and confused about the meaning, tone, or intent of the messages. *News uses*, for their part, relate to all MIM techno-stressors except for ambiguity.

It is somehow striking that even more recreational uses of MIM (to kill time, have fun, and entertain oneself) associate with higher levels of MIM stress and all its first-level dimensions—at least among our respondents. Although we do not have any empirical basis to provide additional interpretation for this finding, we can offer some conjectures. We know that jokes, memes, and other humorous content are frequently shared through MIM groups, whether they were originally intended for these purposes or not (**Costa-Sánchez**; **Guerrero-Pico**, 2020; **Huang**; **Zhang**, 2019). In this regard, different expectations regarding the purposes or the level of formality of the groups can lead to misunderstandings and ambiguities. As one WeChat user put it in a previous qualitative study (**Huang**; **Zhang**, 2019):

> I found a very funny joke about lawyers and shared it in our law firm's group. Some of my colleagues replied like "haha" or "this is very funny," but our executive asked why it was funny. He didn't get the point. I felt awkward and rarely shared interesting stuff in the group later (p. 1929).

Furthermore, when MIM group chats are large, humorous content can trigger a cascade of comments, emoticons, additional jokes, etc. In these situations, it seems likely that some users may feel that they receive more content that they can read or reply to, that it is difficult to focus on their daily activities, that they should quickly write their feedback in the chat in order not to be excluded from the group, etc. Another possibility is that the entertaining content is pushed to the user at the wrong time–e.g., while they are at work or chatting with someone else in another window. Although they may be eager to interact with the content to have fun, they may also appraise the situation as invasive and overloading.

Although the current study offers important theoretical and empirical contributions to the literature on technostress, it is not without limitations. First, the study design is correlational, and we therefore cannot infer cause and effect relations. This refers to the role of certain uses as actual causes of MIM stress or some of its first-level components. Future designs may find ways to manipulate MIM uses in an experimental setting and also test possible mediating mechanisms linking MIM uses with techno-stressors–for example, through perceived social and emotional support, as suggested above. Second, while our sample is large and demographically diverse, it was drawn from an online panel of respondents and therefore may not be fully representative of the Spanish population. For example, it is likely that our sample under-represents people with low digital competences and internet usage. Finally, our pool of items was produced based on previous qualitative and quantitative work, but we cannot guarantee that it exhaustively covers all possible dimensions of MIM stress and all possible MIM uses.

In spite of these limitations the present study provides important insights into the MIM-specific stress process, its main techno-stressors, and possible usage-related antecedents. From a practical perspective, MIM techno-stressors and their measurement may serve to design tailored recommendations for a healthier use of MIM. It seems important to know what specific demands and MIM techno-stressors are triggering the stress process for a given individual. Also, by knowing how specific uses relate to specific techno-stressors, user may decide to control certain usages (e.g., reduce *MIM use for work*) and take advantage of the beneficial or neutral impact of others (e.g., *relatedness and intimacy*).

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9. Annex. Item wording of the MIM uses and MIM stress constructs

(*The questionnaire was in Spanish and translated for this Annex*).

"The following questions relate to your frequency of use of mobile instant messaging (MIM) apps such as *WhatsApp*, *Telegram*, or *Snapchat*. Generally speaking, how often would you say you use MIM apps to… (1 = *never* to 5 = *all the time*)

Wo1. ask or answer work-related questions?

Wo2. perform work-related tasks?

Wo3. stay up to date on work-related issues?

Ne11. stay informed about current events and public affairs?

Ne12. get additional information about what's going on in your community or residence area?

Ne13. get news about current events and public affairs?

Rel20. stay in touch with family and friends?

Rel21. contact people you wouldn't meet otherwise?

Co22. coordinate social activities (for example, eating out or hanging out with someone)?

Co23. organize face-to-face meetings with friends and family?

Pa26. kill time?

Pa27. have fun?

Pa28. entertain yourself?"

"Below are different statements regarding your use of mobile instant messaging, which will be referred to by its acronym (MIM) for brevity. Indicate how often, in general, you tend to experience the following situations (1 = *never* to 5 = *all the time*). When you use MIM…

Ov1. You are forced to interact (through text, voice, etc.) with too many people at the same time.

Ov2. You receive more messages (text, voice, etc.) than you can read or reply to.

Ov3. You need a long time to filter the information that comes to you.

Ov4. You need to spend a long time dealing with unread messages in the application.

Ov5. You have to deal with too many issues through the application.

Inv7. MIM forces you to stay in touch with your work or studies, even in your free time.

Inv8. You feel that MIM gets in the way of your daily routines.

Inv9. You feel that MIM distracts your attention from other activities.

Ur12. You need your contacts to reply to your messages urgently.

Ur13. When you receive a message, you feel compelled to reply quickly.

Ur15. The features of MIM apps force you to reply to messages too quickly.

A16. You feel there are misunderstandings in your MIM conversations.

A17. MIM creates ambiguities about the meaning of the messages you exchange.

A18. MIM makes it difficult to understand the intent of the messages you exchange.

A19. MIM makes it difficult to interpret the tone of the messages you exchange.

A20. One has to give a lot of thought to the messages one exchanges so as not to misinterpret them."