Original Article

Is SMS APPropriate?

Comparative Properties of SMS and Apps for Repeated Measures Data Collection

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Abstract: The ubiquity of mobile telephones worldwide offers a unique opportunity for bidirectional communication between researchers and participants. There are two ways mobile phones could be used to collect self-report data: via Short Message Service (SMS) or app (mobile telephone software applications). This study examined the comparative data quality offered by SMS and app, when mobile phone type, self-report instrument, and sampling schedule are controlled. One hundred ten undergraduate students used their own iPhones to complete the same repeated measures instrument on 20 occasions, responding either by SMS or by app. There were no differences between SMS and app respondents in terms of response rates or response delay. However, data from those responding via SMS was significantly less complete than from app respondents. App respondents rated their respondent experience as more convenient than SMS respondents. Though findings are only generalizable to an undergraduate sample, this suggests that researchers should consider using apps rather than SMS for repeated measures self-report data collection.

Keywords: Short Message Service, app, mobile telephone, methodology

Over three quarters of the global population own a mobile telephone (The World Bank, 2012). As either a supplement or a replacement to traditional research modes such as telephone or postal surveys, mobile telephones offer an unprecedented opportunity for researchers to communicate with participants in self-report research. Though uptake of mobile technology in self-report research is gaining momentum, there remains little structured investigation into the optimal way to use mobile phones in self-report research (Haller, Sanci, Sawyer, Coffey, & Patton, 2006). Two of the ways mobile telephones can support self-report data collection are Short Message Service (SMS) and mobile telephone applications (apps).

SMS is a text-only messaging system available on even the most basic mobile telephone handset and a very common communication method in people's daily lives (Anhoj & Moldrup, 2009). Despite the rise of other text-based mobile communication technologies (such as Multimedia Messaging Service, platform-specific services like iMessage, or services like WhatsApp), SMS remains a dominant communication medium worldwide, and in Australia (ACMA, 2013; Mackay & Weidlich, 2009). Its widespread nature may provide an important opportunity for researchers to communicate with their participants (Haller et al., 2006; Lehman, 2011). Some research using SMS involves sending messages through a mobile handset, but a more common approach is to manage scheduling, sending, and receiving of SMS through online databases. Some do this through preexisting SMS aggregation services (as in Walsh & Brinker, 2012), and others write a computer program of their own to manage the SMS (as in Reimers & Stewart, 2009).

Apps are downloadable software programs that are common to all smart mobile telephones or smartphones (Miller, 2012). They are typically tied to a particular mobile operating system, such as Android or iOS, though there has been a move toward cross-system app compatibility (Ribeiro & da Silva, 2012). There are millions of apps used for different purposes, from communication to games, and many are designed specifically for self-report data collection. With over a thousand self-report survey apps and at least six thousand different health-related apps, use of apps for health and medical research and intervention is gaining attraction (Rosser & Eccleston, 2011). Self-report apps can be designed to mimic the web browsing experience (and thus involve a user experience similar to online surveys) or can have their own aesthetic more in line with mobile telephone interfaces (Kojo, Heiskala, & Virtanen, 2014). Researchers using apps may choose to use preexisting software, such as iSurvey, or design their own apps to meet their specific research goals (e.g., Fukuoka & Kamitani, 2011; Morris et al., 2010). Others have combined SMS

DOI: 10.1027/1015-5759/a000376

with apps, by routing everyday SMS usage through apps for the purposes of data collection (e.g., Montag et al., 2014).

Recognizing the global saturation of mobile phones, and the potential use of both apps and SMS as platforms for self-report data collection, it is important to establish how SMS and app compare as a data collection method. Complete and timely responses are important for building a high-quality dataset, and so response completeness and response delay are a useful metric for comparing how SMS and app perform as data collection tools. Two sources of data incompleteness are complete nonresponses, and item skipping resulting in an only partially complete instrument (Sax, Gilmartin, & Bryant, 2003). Nonresponses threaten the total sample size available for analyses (Fox, Crask, & Kim, 1988) and can lead to an unrepresentative portion of a given population being sampled, threatening the validity of research (Flick, 1988). Skipping items can result in small levels of incompleteness. This is problematic because score totals cannot be calculated (Mogensen, 1963), and item missingness causes difficulties for many methods of statistical analysis (Van Buuren, 2010).

Meta-analyses suggest that the average response rate in academic research is roughly 50% (Baruch & Holtom, 2008). This can depend on the specific mode used for data collection, with comparative studies indicating mail surveys obtain a higher response rate than voice calls (Dillman et al., 2009a), and online surveys a higher response rate than mail surveys (Cook, Heath, & Thompson, 2000). A comparison of participants responding via app and via paper diary has found a higher response rate in app respondents (Tsai et al., 2007).

Repeated measures research using apps has reported roughly 80% response rates (Fukuoka & Kamitani, 2011), suggesting that a relatively high response rate may be expected from apps. Many apps follow the lead of online surveys by prompting participants to complete skipped items, and only allowing them to submit their response when every item in the survey has been satisfactorily completed. For online data collection, some studies have found this has led to significantly less item skipping in online surveys in comparison to paper surveys where no such prompts are possible (Van de Vijver & Harsveldt, 1994), though others have found the opposite (Richardson & Johnson, 2009).

Response rates to research using SMS to communicate with participants vary from 20% (Chib, Wilkin, Ling, Hoefman, & Van Biejma, 2012) to 100% (Donaldson, Fallows, & Morris, 2014). SMS has no provision for automatically detecting and prompting participants to complete skipped items in a larger questionnaire, so it provides no barrier to incomplete submission. In a comparison of completeness of SMS, paper, and online diaries, Lim, Sacks-Davis, Aitken, Hocking, and Hellard (2010) found that participants responding via SMS were more likely to return diaries, but provided more incomplete data, than those responding using paper or online diaries. Together, this literature suggests that data collected via SMS may offer higher response rates, but lower response completeness, than data collected via app.

As the time between an event or experience increases, so does the likelihood of recall bias distorting self-report (Raphael, 1987). Minimizing the delay between when a response is required, and provision of that response would likely improve the accuracy of the data. Mode can impact on both how quickly people begin their response and how long it takes to complete it. For example, web surveys are quicker to complete than paper surveys with the same content (Richardson & Johnson, 2009). Participants tend to respond more promptly when using SMS, in comparison to paper (Asiimwe et al., 2011; Broderick et al., 2012). Response delays in SMS research range from 2 min (Conner & Reid, 2012) up to an hour (De Lepper, Eijkemans, Van Beijma, Loggers, & Tuijn, 2013). Response delays in app research have been around 8 min (Hofmann & Patel, 2014). Although range and median are informative for forming response delay expectations, they have limited usefulness for direct comparison of the response delays that may be expected when collecting self-report data via SMS and app. To date, no research has directly compared the response delays associated with SMS and app self-report responses.

The way participants perceive a particular research mode can impact upon how they engage with it (Dillman et al., 2009b). Positive perceptions of convenience can lessen the perceived burden of responding (Sharp & Frankel, 1983), and lead to deeper engagement with research, and thus more honest and thoughtful responses (Naughton, Jamison, & Sutton, 2013). Negative perceptions regarding data privacy can be a barrier to using mobile phones for research purposes (Déglise, Suggs, & Odermatt, 2012; Ranney et al., 2014). Reflecting on their participation experience, across a number of studies participants have reported that they felt responding via SMS (Akamatsu, Mayer, & Farrelly, 2006; Lim et al., 2010; Matthews, Doherty, Sharry, & Fitzpatrick, 2008) and app (Fernandez, Johnson, & Rodebaugh, 2013; Marshall, Medvedev, & Antonov, 2008) were convenient and private. To date, there has been no research directly contrasting perceived privacy and convenience of SMS and apps being used for self-report research.

The aim of the current paper is to directly contrast SMS and app in terms of response rate, response pleteness, response delay, and participant evaluation of privacy and convenience. Findings will be used to discuss the potentially different utility of apps and SMS for researchers.

Method

Participants

Sample

This study was only open to individuals who owned an iPhone, because the end-user experience can be markedly different even with very similar mobile phones due to different screen sizes and user interface layouts (Keijzers, Ouden, & Lu, 2008). One hundred fifteen undergraduate students in Australia participated in return for course credit. Aged 17–52 years (M = 22), 84% of participants were female. The ethical aspects of this research were approved by the Australian National University Human Research Ethics Committee, and all participants provided written informed consent prior to participation.

Materials

Entry Questionnaire

This was a computer-administered questionnaire consisting of demographic and mobile ownership questions.

Ongoing Questionnaire

This short questionnaire formed part of a larger project on the topic of mental time travel. All questions were self-report, on the topic of the respondent's current state of mind and surroundings. It consisted primarily of categorical question choices, with one Likert scale and one open-ended response. Five of the questions were mandatory, and one was optional. Specifically, Question 1 was a categorical choice between six categories, Question 2 was an optional open-ended request for elaboration on the response to Question 1. Question 3 was a bipolar Likert rating scale. Questions 4 through 6 were categorical choices, with Question 4 being a binary choice, Question 5 a choice from six categories, and Question 6 a choice from three categories. For those responding via app, this questionnaire was preloaded into the iPhone survey app, *iSurvey*. For those responding via SMS, the questionnaire was sent in full via SMS.

Exit Questionnaire

This was a computer-administered questionnaire regarding the participation experience. Participants rated the privacy and convenience of their response experience on a 3-point scale of poor, neutral, or good.

Procedure

Study Groups

This study manipulated whether participants responded via an app or SMS. This was between-subjects, as participants could only undertake this study once, responding via app or SMS, but not both. Due to a limited licensing time frame associated with the survey app, assignment to responding via app or SMS was not random. Instead, participants recruited prior to the end of license time frame provided responses via app, and those recruited afterwards responded via SMS. To minimize the potential for this nonrandom assignment to bias participant behavior, participants were not aware of the two different response conditions. Recruitment materials indicated that mobile telephones would be used to collect survey data, but did not specify how that data was to be collected. Fifty-four participants responded via app, while 61 responded via SMS.

Study Procedure

Participants attended a physical meeting with the researcher and completed the computer-administered entry questionnaire. A test SMS prompt was sent during this meeting to confirm the researcher had the appropriate contact details. The mental time travel questionnaire was then provided to participants. Those recruited first, thus assigned to responding via app, were guided through the app installation process. Those recruited later, thus assigned to responding via SMS, were sent the questionnaire via SMS. To ensure the task was clear and the mobile systems were functioning correctly, a test run of the ongoing questionnaire was completed during this physical meeting. In the two days following the physical meeting with the researcher, all participants received a total of 20 SMS prompts (10 per day) to complete the exit questionnaire. Those responding via app opened iSurvey and entered their answers, while those responding via SMS replied to the prompt SMS with their answers. Participants then attended a follow-up appointment, where they completed the computer-administered exit survey. Those responding via app were guided through the process of submitting their responses and then deleting the iSurvey app. Those responding via SMS, where applicable, were reimbursed for the cost of sending SMS for the purposes of participation.

Results

Participants in the app group (n = 54) were aged 17–52 years (M = 22), and 70% were female. Participants in the SMS group (n = 61) were aged 18–46 years (M = 21), and 75% were female. T-tests and chi-square tests did not indicate the two samples differed significantly in terms of age (t = 1.2, p = .90), gender (χ^2 = 0.15, p = .69), or number of SMS sent in daily life (t = 1.4, p = .13).

SMS and app responses were compared in terms of response completeness and response delay. Response completeness consisted of increasingly stringent criterion. A *partially* complete response consisted of one to four questions answered. A *complete* response was the five required questions answered, but not the optional sixth question. An *overcomplete* response is an attempt of all six questions (where the sixth was specified as optional). These categories are mutually exclusive. The outcome variable is therefore the count of partial, basic, and full responses each participant provided, with a maximum of 20 possible responses.

In both response conditions, participants provided an average of 15 responses. *T*-tests revealed that this did not significantly differ between SMS and app respondents. However, compared with SMS respondents, app respondents provided significantly fewer partial responses, $t(144) = 8.47$, $p < .01$ (per person, app mean = 1, SMS mean = 8), and significantly fewer complete responses, $t(144) = 2.21$, $p = .02$ (per person, app mean = 3, SMS mean = 1). Conversely, app respondents provided significantly more overcomplete responses, $t(114) = 5.14$, $p < .01$ (per person, app mean = 12, SMS mean = 6). This pattern of results suggests that response mode did not affect whether responses were attempted, but that people using an app were significantly more likely to provide complete responses.

Response completeness can also be examined in terms of the number of questions answered within responses, removing complete nonresponses (where none of the six questions were attempted) from analysis. Viewed in this way, those responding via app completed an average of six questions per sampling occasion ($SD = 0.58$), while those responding via SMS completed an average of five questions per sampling occasion, but this was more variable ($SD = 0.86$). A multilevel model was fit, with responses nested by participant and response mode specified as a predictor of number of questions answered. Response mode significantly predicted the number of questions answered $b = 0.64$, 95% CI [0.42, 0.85]. The slope suggests that, for every three answered via SMS, an app respondent is likely to answer four. This supports the assertion that mode is significantly associated with response completeness.

While coding the data, it was clear that SMS respondents were not completing one question in particular as required. When asked to rate their mood on a Likert scale, many SMS respondents instead provided a qualitative mood descriptor such as "frustrated" or "bored." Though some manner of response had been provided, this was coded as a missing response as it did not conform to the required response format.

Table 1. Ratings of convenience and privacy by mode

	Counts (percentages)		Model properties		
	App	SMS	χ^2	χ^2 Power	Fisher's *p*
Convenience					
Poor	1 (2%)	4 (7%)	5.956	.58	.05
Neutral	8 (15%)	18 (31%)	*p* = .05		
Good	43 (83%)	36 (62%)			
Privacy					
Poor	0 (0%)	2 (4%)	2.909	.31	.24
Neutral	7 (13%)	11 (19%)	*p* = .203		
Good	46 (87%)	43 (77%)			

Notes. Counts reflect what was included in the model, percentages are included to give context due to differing sample sizes of app and SMS respondents. *N* is slightly smaller than total sample in either group due to some missing data in the exit survey.

Response delay was evaluated by way of number of minutes between a prompt, and response in minutes, with the shortest delay possible set at 1 min. As can be expected given this was a response time variable, this response delay was strongly bounded and skewed. Given that this data shape is theoretically expected, rather than transform the data to meet model assumptions, models were fitted using a Poisson distribution. The median response delay for responses completed via app was three min, while those completed via SMS was 4 min. A logistic multilevel model was fit, with mode as a predictor of receipt of response delay (in minutes), nested by participant. This model did not reveal a significant association between response mode and response delay ($b = 0.15$, 95% CI [−0.19, 0.51], suggesting that response delay was unaffected by mode.

Summarized in Table 1, two chi-square tests were completed to explore differences in participant perceptions of convenience and privacy, based on whether they participated by way of SMS or app. While the two groups did not significantly differ in their perceptions of privacy, those using apps were significantly more likely to rate their data collection mode as having "good" convenience than those using SMS.

Discussion

This study examined whether app or SMS provided superior data completeness, response delay, and participant evaluation of privacy and convenience. Collecting data by app or SMS did not impact upon whether or not a response was attempted, whether the response was extraneous or a duplicate, or how promptly participants responded. The response rate for SMS and app respondents was equivalent, promisingly exceeding the average response rate in academic research estimated by Baruch and Holtom (2008). However, mode did significantly impact on response completion. Following the same pattern as in Lim et al. (2010), SMS data was significantly less complete than app data. This may be due to two factors caused by the uncontrolled response format of SMS. Firstly, while app respondents had fixed forms in which to provide their answers, the free-text nature of SMS responses allowed participants to respond in a nonstandard format (i.e., providing qualitative mood descriptors such as "fine" rather than requested Likert ratings). Though participants technically answered the question, this data must be considered missing as it cannot be confidently reconciled with the required numeric format. Secondly, apps offer item skipping prevention akin to online surveys, while SMS does not. This allows more accidental response omissions to occur in SMS. Given the almost identical overall response rates, this indicates that data collection via app provides superior data completeness, particularly when the usability of the data is contingent on participants following specific response format instructions.

Minimizing response delays minimizes potential data distortion due to retrospective recall bias (Raphael, 1987). The median response delay of under four min for both modes was consistent with the literature using SMS (Conner & Reid, 2012; De Lepper et al., 2013), and was better than what may be expected from the literature using apps. This may be because the current study had a more compressed sampling schedule (10 times in a day) than those reviewed in Hofmann and Patel (2014, three to seven times in a day), thus engendering a greater sense of rush to respond, lest a late response become a missed response. Another possibility is that the current study sampled only from university undergraduates, a population particularly likely to have their mobile telephones nearby at all times, while the studies in Hofmann and Patel (2014) were a mixture of undergraduates and members of the general population. These short response delays are particularly promising for ecological momentary assessment, where researchers seek to tap transient, current thoughts and feelings, as problems of recall bias are minimized when responses are prompt. These results suggest that either app or SMS may be a viable method of data collection where prompt responses are particularly important.

As in previous research using SMS and apps as a means for communicating with participants, perceptions of the privacy and convenience of both modes were generally positive (Akamatsu, Mayer, & Farrelly, 2006; Lim et al., 2010; Matthews et al., 2008). Here, participants who responded via apps were significantly more likely to rate their data collection mode as having "good" convenience than those using SMS. This difference cannot be due to the response platform (as all participants were using iPhones), or the response schedule (which was randomized), suggesting that something may be more convenient about responding via app than SMS. One possibility is that respondents participating via SMS received the questions in an initial SMS, and only prompts when it came time to respond. This resulted in the questions and the input space for answers being separated, thus necessitating scrolling. Conversely, those responding via app were presented with the questions directly next to answer input. This could be clarified in future research, by sending the full SMS questionnaire on each response occasion, rather than just a prompt referring participants to an earlier SMS containing the questionnaire.

This was the first study to directly compare SMS and app response behavior for self-report psychological research. The difference between the two response modes was made clear by controlling the demographic to only undergraduate students, and the response platform to only iPhones. However, this limits the generalizability of findings. Further investigation is warranted to see how SMS and apps compare in a wider population sample, likely to own different types of mobile telephones, and importantly, across a wider range of ages. Engagement with mobile telephone differs on the basis of age (Devitt & Roker, 2009; Ling, 2010; Mante & Piris, 2010), which may in turn impact on the viability of using SMS or apps for data collection with a particular age group. For example, teenagers and young adults use SMS heavily in their daily lives (Charlton, Panting, & Hannan, 2002; Pain et al., 2005), and have experience with apps – only a tenth of individuals aged 18–35 years have never downloaded an app (Deloitte, 2013). Conversely, older adults use SMS more sparingly (Lobet-Maris & Henin, 2002; Mallenius, Rossi, & Tuunainen, 2007), and almost a third of those aged 65 and over have never downloaded an app (Deloitte, 2013). It would be educative to establish whether the relative efficacy of apps and SMS reflects these differing levels of preexisting mastery.

A particularly useful set of tools for pursuing these questions is Psychoinformatics. In brief, psychoinformatics applies computer science tools to psychological data collection, often via data mining and collection from multiple digital and behavioral sources (for a more detailed explanation, see Yarkoni, 2012). Here, simultaneous behavioral and software monitoring of the interaction between participant and mobile telephone during everyday life, and self-report data collection could clarify behavioral differences in communication via app and SMS. This could be achieved using a similar technique to Montag et al. (2014), who collected data on smartphone usage behavior via a bespoke monitoring app.

This paper directly contrasted SMS and app in terms of response rate, response completeness, response delay, and participant evaluation of privacy and convenience. In a self-report, repeated measures paradigm, apps outperformed SMS in terms of data completeness, and positive participant perceptions of the research experience. All else being equal, this suggests that researchers should consider using apps rather than SMS for repeated measures self-report data collection.

Acknowledgments

The authors would like to acknowledge the support and access to participants provided by Janie Busby-Grant.

References

ACMA. (2013). *ACMA Communications report 2012–2013*. Australia: The Australian Media Communications Authority.

Akamatsu, C. T., Mayer, C., & Farrelly, S. (2006). An investigation of two-way text messaging use with deaf students at the secondary level. *Journal of Deaf Studies and Deaf Education, 11*, 120–131. doi: 10.1093/deafed/enj013

Anhoj, J., & Moldrup, C. (2009). Feasibility of collecting diary data from asthma patients through mobile phones and SMS (short message service): Response rate analysis and focus group evaluation from a pilot study. *Journal of Medical Internet Research, 6*, e42. doi: 10.2196/jmir.6.4.e42

Asiimwe, C., Gelvin, D., Lee, E., Ben Amor, Y., Quinto, E., Katureebe, C., ... Berg, M. (2011). Use of an innovative, affordable, and open-source short message service-based tool to monitor malaria in remote areas of Uganda. *The American Journal of Tropical Medicine and Hygiene, 85*, 26–33. doi: 10.4269/ajtmh.2011.10-0528

Baruch, Y., & Holtom, B. C. (2008). Survey response rate levels and trends in organizational research. *Human Relations, 61*, 1139–1160. doi: 10.1177/0018726708094863

Broderick, C. R., Herbert, R. D., Latimer, J., Mathieu, E., van Doorn, N., & Curtin, J. A. (2012). Feasibility of short message service to document bleeding episodes in children with haemophilia. *Haemophilia: The Official Journal of the World Federation of Hemophilia, 18*, 906–910. doi: 10.1111/j.1365-2516.2012.02869.x

Charlton, T., Panting, C., & Hannan, A. (2002). Mobile telephone ownership and usage among 10- and 11-year-olds. *Emotional and Behavioural Difficulties, 7*, 37–41.

Chib, A., Wilkin, H., Ling, L. X., Hoefman, B., & Van Biejma, H. (2012). You have an important message! Evaluating the effectiveness of a text message HIV/AIDS campaign in Northwest Uganda. *Journal of Health Communication, 17*(Suppl 1(April 2014)), 146–157. doi: 10.1080/10810730.2011.649104

Conner, T. S., & Reid, K. A. (2012). Effects of intensive mobile happiness reporting in daily life. *Social Psychological and Personality Science, 3*, 315–323.

Cook, C., Heath, F., & Thompson, R. L. (2000). A meta-analysis of response rates in Web- or Internet-based surveys. *Educational and Psychological Measurement, 60*, 821–836. doi: 10.1177/00131640021970934

Déglise, C., Suggs, L. S., & Odermatt, P. (2012). Short message service (SMS) applications for disease prevention in developing countries. *Journal of Medical Internet Research, 14*, e3. doi: 10.2196/jmir.1823

De Lepper, A. M., Eijkemans, M. J. C., Van Beijma, H., Loggers, J. W., & Tuijn, C. J. (2013). Response patterns to interactive SMS health education quizzes at two sites in Uganda: A cohort study. *Tropical Medicine and International Health, 18*, 516–521. doi: 10.1111/tmi.12059

Deloitte Global Media Consumer Survey, Developed Countries. (2013). United Kingdom: Deloitte Touche Tohmatsu Ltd.

Devitt, K., & Roker, D. (2009). The role of mobile phones in family communication. *Children & Society, 23*, 189–202. doi: 10.1111/j.1099-0860.2008.00166.x

Dillman, D., Phelps, G., Tortora, R., Swift, K., Kohrell, J., Berck, J., & Messer, B. L. (2009a). Response rate and measurement differences in mixed-mode surveys using mail, telephone, interactive voice response (IVR) and the Internet. *Social Science Research, 38*, 1–18. doi: 10.1016/j.ssresearch.2008.03.007

Dillman, D. A., Smyth, J. D., & Christian, L. M. (2009b). *Internet, Mail, and Mixed-Mode Surveys* (3rd ed.). Hoboken, NJ: Wiley.

Donaldson, E. L., Fallows, S., & Morris, M. (2014). A text message based weight management intervention for overweight adults. *Journal of Human Nutrition and Dietetics: The Official Journal of the British Dietetic Association, 27*(Suppl 2), 90–97. doi: 10.1111/jhn.12096

Fernandez, K. C., Johnson, M. R., & Rodebaugh, T. L. (2013). TelEMA: A low-cost and user-friendly telephone assessment platform. *Behavior Research Methods, 45*, 1279–1291. doi: 10.3758/s13428-012-0287-9

Flick, S. N. (1988). Managing attrition in clinical research. *Clinical Psychology Review, 8*, 499–515. doi: 10.1016/0272-7358(88)90076-1

Fox, R., Crask, M., & Kim, J. (1988). Mail survey response rate a meta-analysis of selected techniques for inducing response. *Public Opinion Quarterly, 52*, 467–491.

Fukuoka, Y., & Kamitani, E. (2011). New insights into compliance with a mobile phone diary and pedometer use in sedentary women. *Journal of Physical Activity and Health, 8*, 398–403.

Haller, D., Sanci, L., Sawyer, S., Coffey, C., & Patton, G. (2006). R U OK 2 TXT 4 RESEARCH? – Feasibility of text message communication in primary care research. *Australian Family Physician, 35*, 175–176.

Hofmann, W., & Patel, P. V. (2014). SurveySignal: A convenient solution for experience sampling research using participants' own smartphones. *Social Science Computer Review, 33*, 235–253. doi: 10.1177/0894439314525117

Keijzers, J., Ouden, E. D., & Lu, Y. (2008). Usability benchmark study of commercially available smart phones: Cell phone type platform, PDA type platform and PC type platform. *Proceedings of the 10th International Conference on Human Computer Interaction with Mobile Devices and Services* (pp. 265–272). ACM. Retrieved from http://dl.acm.org/citation.cfm?id=1409269

Kojo, I., Heiskala, M., & Virtanen, J. (2014). Customer journey mapping of an experience-centric service by mobile self-reporting: Testing the Qualiwall Tool. In A. Marcus (Ed.), *Design, user experience, and usability. Theories, methods, and tools for designing the user experience* (pp. 261–272). Bern, Switzerland: Springer International. Retrieved from http://link.springer.com/chapter/10.1007/978-3-319-07668-3_26

Lehman, B. J. (2011). Getting started: Launching a study in daily life. In M. R. Mehl & T. S. Conner (Eds.), *Handbook of research methods for studying daily life* (pp. 89–107). New York, NY: The Guilford Press.

Lim, M. S. C., Sacks-Davis, R., Aitken, C. K., Hocking, J. S., & Hellard, M. E. (2010). Randomised controlled trial of paper, online and SMS diaries for collecting sexual behavior information from young people. *Journal of Epidemiology and*

Community Health, 64, 885–889. doi: 10.1136/jech.2008.085316

Ling, R. (2010). Texting as a life phase medium. *Journal of Computer-Mediated Communication, 15*, 277–292. doi: 10.1111/j.1083-6101.2010.01520.x

Lobet-Maris, C., & Henin, L. (2002). Talking without communicating or communicating without talking: From the GSM to the SMS. *Estudios de Juventud, 57*, 101–114.

Mackay, M. M., & Weidlich, O. (2009). Austrailan Mobile Phone lifestyle index. *Specialist*. Australian Interactive Media Industry Association Mobile Industry Group. Retrieved from http://www.aimia.com.au/enews/mobile/090929AIMIA_Report_FINAL.pdf

Mallenius, S., Rossi, M., & Tuunainen, V. (2007). Factors affecting the adoption and use of mobile devices and services by elderly people – Results from a pilot study. *6th Annual Global Mobility Roundtable, 31.* Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.130.2463&rep=rep1&type=pdf

Mante, E. A., & Piris, D. (2010). SMS use by young people in the Netherlands. *Revista de Estudios de Juventud, 52*, 47–58.

Marshall, A., Medvedev, O., & Antonov, A. (2008). Use of a smartphone for improved self-management of pulmonary rehabilitation. *International Journal of Telemedicine and Applications*,1–5. doi: 10.1155/2008/753064

Matthews, M., Doherty, G., Sharry, J., & Fitzpatrick, C. (2008). Mobile phone mood charting for adolescents. *British Journal of Guidance & Counselling, 36*, 113–129. doi: 10.1080/03069880801926400

Miller, G. (2012). The smartphone psychology manifesto. *Perspectives on Psychological Science, 7*, 221–237. doi: 10.1177/1745691612441215

Mogensen, A. (1963). Item-skipping and right and wrong solutions in a preliminary version of a multiple-choice vocabulary test. *Acta Psychologica, 21*, 49–54.

Montag, C., Błaszkiewicz, K., Lachmann, B., Andone, I., Sariyska, R., Trendafilov, B., . . . Markowetz, A. (2014). Correlating personality and actual phone usage: Evidence from psychoinformatics. *Journal of Individual Differences, 35*, 158–165.

Morris, M. E., Kathawala, Q., Leen, T. K., Gorenstein, E. E., Guilak, F., Labhard, M., & Deleeuw, W. (2010). Mobile therapy: Case study evaluations of a cell phone application for emotional self-awareness. *Journal of Medical Internet Research, 12*, e10. doi: 10.2196/jmir.1371

Naughton, F., Jamison, J., & Sutton, S. (2013). Attitudes towards SMS text message smoking cessation support: A qualitative study of pregnant smokers. *Health Education Research, 28*, 911–922. doi: 10.1093/her/cyt057

Pain, R., Grundy, S. U. E., Gill, S., Towner, E., Sparks, G., & Hughes, K. (2005). "So long as i take my mobile": Mobile phones, urban life and geographies of young people's safety. *International Journal of Urban and Regional Research, 29*, 814–830.

Ranney, M. L., Choo, E. K., Cunningham, R. M., Spirito, A., Thorsen, M., Mello, M. J., & Morrow, K. (2014). Acceptability, language, and structure of text message-based behavioral interventions for high-risk adolescent females: A qualitative study. *Journal of Adolescent Health, 55*, 1–8. doi: 10.1016/j.jadohealth.2013.12.017

Raphael, K. (1987). Recall bias: A proposal for assessment and control. *International Journal of Epidemiology, 16*, 167–170.

Reimers, S., & Stewart, N. (2009). Using SMS text messaging for teaching and data collection in the behavioral sciences. *Behavior Research Methods, 41*, 675–681. doi: 10.3758/BRM.41.3.675

Ribeiro, A., & da Silva, A. R. (2012). Survey on cross-platforms and languages for mobile apps. In *2012 Eighth International Conference on the Quality of Information and Communications Technology* (pp. 255–260). Washington, DC: IEEE. doi: 10.1109/QUATIC.2012.56

Richardson, C., & Johnson, J. (2009). The influence of web- versus paper-based formats on the assessment of tobacco dependence: Evaluating the measurement invariance of the Dimensions of Tobacco Dependence Scale. *Substance Abuse: Research and Treatment, 3*, 1–14.

Rosser, B. A., & Eccleston, C. (2011). Smartphone applications for pain management. *Journal of Telemedicine and Telecare, 17*, 308–312. doi: 10.1258/jtt.2011.101102

Sax, L., Gilmartin, S., & Bryant, A. (2003). Assessing response rates and nonresponse bias in web and paper surveys. *Research in Higher Education, 44*, 409–432. doi: 10.1023/A:1024232915870

Sharp, L. M., & Frankel, J. (1983). Respondent burden: A test of some common assumptions. *Public Opinion Quarterly, 47*, 36–53.

The World Bank. (2012). *2012 Information and Communications for Development: Maximizing Mobile*. Washington, DC: World Bank.

Tsai, C. C., Lee, G., Raab, F., Norman, G. J., Sohn, T., Griswold, W. G., & Patrick, K. (2007). Usability and feasibility of PmEB: A mobile phone application for monitoring real time caloric balance. *Mobile Networks and Applications, 12*, 173–184. doi: 10.1007/s11036-007-0014-4

Van Buuren, S. (2010). Item imputation without specifying scale structure. *Methodology: European Journal of Research Methods for the Behavioral and Social Sciences, 6*, 31–36. doi: 10.1027/1614-2241/a000004

Van de Vijver, F., & Harsveldt, M. (1994). The incomplete equivalence of the paper-and-pencil and computerized versions of the General Aptitude Test Battery. *Journal of Applied Psychology, 79*, 852–859.

Walsh, E. I., & Brinker, J. K. (2012). Evaluation of a Short Message Service diary methodology in a nonclinical, naturalistic setting. *Cyberpsychology, Behavior and Social Networking, 15*, 615–618. doi: 10.1089/cyber.2012.0189

Yarkoni, T. (2012). Psychoinformatics new horizons at the interface of the psychological and computing sciences. *Current Directions in Psychological Science, 21*, 391–397.

Received June 24, 2015
Revision received February 23, 2016
Accepted March 14, 2016
Published online December 29, 2016

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