Frontiers Commentary: The HEART Mobile Phone Trial: The Partial Mediating Effects of Self-Efficacy on Physical Activity among Cardiac Patients

Dan J. Graham*

Department of Psychology, Colorado School of Public Health, Colorado State University, Fort Collins, CO, USA

Keywords: mHealth, mobile phone, smartphone, physical activity, self-efficacy

A commentary on

The HEART Mobile Phone Trial: The Partial Mediating Effects of Self-Efficacy on Physical Activity among Cardiac Patients
by Maddison R, Pfaeffli L, Stewart R, Kerr A, Jiang Y, Rawstorn J, et al. Front Public Health (2014) 2:56. doi: 10.3389/fpubh.2014.00056

Maddison and colleagues’ HEART mobile phone trial (1) presents dual insights that will be useful and important to those promoting physical activity (PA) and other health behaviors in the twenty-first century. First, interventions delivered by smartphone can increase PA among a clinically important population (individuals with heart disease). Second, increasing self-efficacy is an important mechanism for mobile health (mHealth) interventions to target.

As has been demonstrated previously, self-efficacy is among PA’s most reliable correlates and even determinants (2, 3). This robust relationship between self-efficacy and PA exists for children and adolescents (4–6) as well as younger and older adults (7–9). Furthermore, much intervention research has shown that successfully increasing PA self-efficacy leads to increased PA in both healthy and obese populations (10–12). Self-efficacy’s enhancement of PA has been demonstrated via interventions delivered in-person (13), by print-based materials (14), by telephone (15), by mass media (16), by postal mail (14), and by combinations of these (17, 18). Email has also been used to deliver PA intervention content with some success (19), and with smartphones representing one of the most rapidly adopted technologies ever documented (20), there is reason to believe that email and other smartphone-mediated delivery will be at least as successful in years to come. Although the HEART trial reveals the importance of increasing self-efficacy in the context of promoting PA (1), the principle is likely more broadly applicable. This evidence that self-efficacy can be effectively increased in mHealth interventions should be encouraging to public health practitioners aiming to improve not only PA but also other health behaviors that have been positively impacted by self-efficacy change in other intervention contexts. Reducing smoking and drinking, increasing contraceptive use, and healthy eating all have long established (21) as well as consistently and recently reaffirmed ties to increased self-efficacy (22–25).

Maddison and coauthors indicate that future mHealth research promoting PA would benefit from incorporating objective activity assessment (1); this is an increasingly feasible goal, even with large-scale interventions. Smartphone-mediated interventions can permit accelerometers already present in smartphones, and already capable of assessing PA (26), to be linked with intervention apps, so that content could be tailored based on users’ activity. For example, if a phone’s accelerometer has...
not recorded some designated level of movement over the past two daytime hours, the user could receive a text message suggesting a brief walk. Such an alerting feature is available in some commercial activity monitors (e.g., Garmin vivofit, Jawbone UP) and could comprise a useful element of mHealth PA interventions. Additionally, interventions could incorporate persuasive technologies (27) like those used in home energy meters that glow one color when energy use is low and a different color when energy use is high. Similarly, smartphone users can benefit from simple visible cues to modify their own energy expenditure (28). Smartphones are already being used to assess PA speed and location (29), and as technology continues to advance, current obstacles to data quality such as sensor disruptions due to competing power demands or the phone being worn/carried in different positions (30) will likely diminish.

Maddison and colleagues provide encouraging evidence of mHealth success even in the absence of substantial tailoring of intervention content (1). The ability to tailor content, a strategy previously shown to be successful in increasing self-efficacy and PA (31) is enhanced substantially in mHealth interventions. It is reasonable to assume that tailored intervention content delivered to smartphones would improve intervention outcomes as tailoring has done through print delivery channels (32). Indeed, meta-analytic results identify tailoring based on self-efficacy as a particularly promising strategy (32). Moving forward, mHealth interventions may be even more successful if they employ active assistance technology (33) that is not only tailored, but adaptive (i.e., interacting with the user in an ongoing way, not merely utilizing one-time, a priori tailoring).

Online and smartphone-based games are also very popular, being played by nearly half of all Internet users (34). Gaming represents another excellent electronic venue through which interventionists can promote health behavior change [e.g., Ref. (35, 36)]. Some health-promotion video games have produced beneficial effects by increasing self-efficacy for important health behaviors [e.g., Ref. (37, 38)]. As video game technology provides increasingly immersive experiences, interventions incorporating gaming may well be even more effective in increasing player self-efficacy and health behaviors (39). Virtual reality technology could further enhance self-efficacy (e.g., by seeing one’s virtual self engaging in efficacious health-promotion acts) (40).

The greatest potential barrier to mHealth interventions, the inability to access individuals who lack necessary electronic devices, is rapidly reducing. With over 50% of the populations of nearly 20 countries owning smartphones as of 2013 (41), and projections that over half of the world’s 4+ billion mobile phone users will have smartphones by 2016 (42), many more individuals will soon be able to access smartphone-mediated interventions. In several countries (e.g., South Korea, Australia, Israel, United States, Spain), smartphone ownership currently exceeds 70% (41). In the US, 64% of all Americans, and 85% of young adults, currently own smartphones, and these rates are rapidly increasing (e.g., only 35% of US adults owned smartphones 4 years ago) (43).

In addition, mHealth interventions may not necessarily exclude those most in need of targeted efforts. Public health practitioners previously hampered by the inability to access those living in rural areas, low-income areas, and minority communities (44) may actually find mHealth programs well-suited to reaching racial and ethnic minority groups that have traditionally faced greater health inequities (45). For example, rates of smartphone ownership are higher among Hispanic and Black Americans than among White Americans (43).

The success of the HEART mobile phone trial provides promising strategies for researchers and public health practitioners to adopt and expand upon. Future mHealth interventions may benefit from incorporating location- and/or movement-based content delivery, message tailoring, persuasive and active assistance technologies, video games, and dissemination to a variety of groups including at-risk populations. Such strategies have great potential to enhance public health in an affordable and far-reaching manner.

**AUTHOR CONTRIBUTIONS**

The author confirms being the sole contributor of this work and approved it for publication.

**REFERENCES**

1. Maddison R, Pfaeffli L, Stewart R, Kerr A, Jiang Y, Rawstorn J, et al. The HEART mobile phone trial: the partial mediating effects of self-efficacy on physical activity among cardiac patients. *Front Public Health* (2014) 2:56. doi:10.3389/fpubh.2014.00056
2. Bauman AE, Reis RS, Sallis JF, Wells JC, Loos RJ, Martin BW, et al. Correlates of physical activity: why are some people physically active and others not? *Lancet* (2012) 380(9838):238–71. doi:10.1016/S0140-6736(12)60735-1
3. McAuley E, Blissmer B. Self-efficacy determinants and consequences of physical activity. *Exerc Sport Sci Rev* (2000) 28(2):85–8.
4. Biddle SJ, Whitehead SH, O’Donovan TM, Nevill ME. Correlates of participation in physical activity for adolescent girls: a systematic review of recent literature. *J Phys Act Health* (2005) 2(4):423–34.
5. Cragg C, Corder K, van Sluijs EM, Griffin SJ. Determinants of change in physical activity in children and adolescents: a systematic review. *Am J Prev Med* (2011) 40(6):645–58. doi:10.1016/j.amepre.2011.02.025
6. Van der Horst K, Paw M, Twisk JW, Van Mechelen W. A brief review on correlates of physical activity and sedentariness in youth. *Med Sci Sports Exerc* (2007) 39(8):1241. doi:10.1249/mss.0b013e318059b35
7. Ploczynski DJ. Physical activity determinants of older women: what influences activity? *Med Surg Nurs* (2003) 12(4):213–21.
8. Rhodes RE, Martin AD, Taunton JE, Rhodes EC, Donnelly M, Elliott J. Factors associated with exercise adherence among older adults. *Sports Med* (1999) 28(6):397–411. doi:10.2165/00007256-199928060-00003
9. Trost SG, Owen N, Bauman AE, Sallis JF, Brown W. Correlates of adults’ participation in physical activity: review and update. *Med Sci Sports Exerc* (2002) 34(12):1996–2001. doi:10.1097/01.mss.0000057683-200212200-00020
10. Ashford S, Edmunds J, French DP. What is the best way to change self-efficacy to promote lifestyle and recreational physical activity? A systematic review with meta-analysis. *Br J Health Psychol* (2010) 15(2):265–88. doi:10.1348/135910709X461752
11. Olander EK, Fletcher H, Williams S, Atkinson L, Turner A, French DP. What are the most effective techniques in changing obese individuals’ physical...
activity self-efficacy and behaviour: a systematic review and meta-analysis. *Int J Behav Nutr Phys Act* (2013) 10(29):1–15. doi:10.1186/1479-5868-10-29
12. Williams S, French D. What are the most effective intervention techniques for changing physical activity self-efficacy and physical activity behaviour – and are they the same? *Health Educ Res* (2011) 26(2):308–22. doi:10.1093/her/cyt005
13. Darker C, French D, Eves F, Sniehotta F. An intervention to promote walking amongst the general population based on an ‘extended’ theory of planned behaviour: a waiting list randomised controlled trial. *Psychol Health* (2010) 25(1):71–88. doi:10.1080/08870440902893716
14. Marcus BH, Napolitano MA, King AC, Lewis BA, Whiteley JA, Albrecht A, et al. Telephone versus print delivery of an individualized motivationally-tailored physical activity intervention: project STRIDE. *Health Psychol* (2007) 26(4):401. doi:10.1037/0278-6136.26.4.401
15. Eakin EG, Lawler SP, Vandelanotte C, Owen N. Telephone interventions for physical activity and dietary behavior change: a systematic review. *Am J Prev Med* (2007) 32(5):419–34. doi:10.1016/j.amepre.2007.01.004
16. Baume AN, Bello, Owen N, Vita P. Impact of an Australian mass media campaign targeting physical activity in 1998. *Am J Prev Med* (2001) 21(1):41–7. doi:10.1016/S0749-3797(01)00313-0
17. Blanchard CM, Fortier M, Sweet S, O’Sullivan T, Hogg W, Reid RD, et al. Explaining physical activity levels from a self-efficacy perspective: the physical activity counseling trial. *Ann Behav Med* (2007) 34(3):323–8. doi:10.1007/BF02874557
18. Cafsà KJ, Sallis JF, Oldenburg B, Frenich M. Mediators of change in physical activity following an intervention in primary care: PACE. *Prev Med* (1997) 26(3):297–304. doi:10.1016/pmed.1997.0141
19. Plotnikoff RC, McCargar LJ, Wilson PM, Loucaides CA. Efficacy of an E-mail intervention for the promotion of physical activity and nutrition behavior in the workplace context. *Am J Health Promot* (2005) 19(6):422–39. doi:10.4278/0981-1119-17.6.422
20. Stewart J. Reaching 70% Penetration, Smart Phones Cement Place As Rapidly Adopted Technology. *Digital Transactions*. (2014). Available from: http://www.digitaltransactions.net/news/story/Reaching-70_-Penetration_-Smart-Phones-Cement-Place-As-Rapidly-Adopted-Technology
21. Strecher VJ, DeVellis BM, Becker MH, Staudenmayer J, Kerr J, Ellis K, Godbole S, Marshall S, Lanckriet G, Staudenmayer J, Kerr J. Identifying active travel behaviors in challenging environments using GPS, accelerometers, and machine learning algorithms. *Front Public Health* (2014) 2:36. doi:10.3389/fpubh.2014.00036
22. Marcus BH, Bock BC, Pinto BM, Forsyth LAH, Roberts MB, Traicante RM. Efficacy of an individualized, motivationally-tailored physical activity intervention. *Ann Behav Med* (1998) 20(3):174–80. doi:10.1007/BF02884958
23. Noar SM, Benac CN, Harris MS. Does tailoring matter? Meta-analytic review of tailored print health behavior change interventions. *Psychol Bull* (2007) 133(4):673. doi:10.1037/0033-2909.133.4.673
24. Kennedy CM, Powell J, Payne TH, Ainsworth J, Boyd A, Buchan I. Active assistance technology for health-related behavior change: an interdisciplinary review. *J Med Internet Res* (2012) 14(3):e80. doi:10.2196/jmir.1893
25. Takahashi D. More Than 1.2 Billion People Are Playing Games. (2013). Available from: http://venturebeat.com/2013/11/25/more-than-1-2-billion-people-are-playing-games/
26. Giner-Bartolomé C, Fagundo AB, Sánchez J, Jiménez-Murcia S, Santamaría J, Ladouceur R, et al. Can an intervention based on a serious videogame prior to cognitive behavioral therapy be helpful in bulimia nervosa? A clinical case study. *Front Psychol* (2015) 6:982. doi:10.3389/fpsyg.2015.00982
27. Merry SN, Stasiak K, Shepherd M, Frampton T, Lucassen MF. The effectiveness of SPARX, a computerised self help intervention for adolescents seeking help for depression: randomised controlled non-inferiority trial. *BMJ* (2012) 344:e2598. doi:10.1136/bmj.e2598
28. Brown SJ, Lieberman DA, Gemeny B, Fan YC, Wilson D, Pasta D. Educational video game for juvenile diabetes: results of a controlled trial. *Med Inform (Lond)* (1997) 22(1):77–89. doi:10.1136/medinfo.9790989835
29. Khazaal Y, Chatton A, Prezzemolo R, Zebouni F, Edel Y, Jacquet J, et al. Impact of a board-game approach on current smokers: a randomised controlled trial. *Subst Abuse Treat Prev Policy* (2013) 8(1):3. doi:10.1186/1747-597X-8-3
30. Behm Morawitz E, Lewallen J, Choi G. A second chance at health: how a 3D virtual world can improve self-efficacy for weight loss management among adults. *Cyberpsychol Behav Soc Netw* (2016) 19(2):74–9. doi:10.1089/cyber.2015.0317
31. Reid DT. Benefits of a virtual play rehabilitation environment for children with cerebral palsy on perceptions of self-efficacy: a pilot study. *Pediatr Rehabil* (2002) 5(3):141–8. doi:10.1080/109692902000039344
32. Poushter J. Smartphone Ownership and Internet Usage Continues to Climb in Emerging Economies. Pew Research Center (2016). Available from: http://www.pewglobal.org/2016/02/22/smartphone-ownership-and-internet-use-continues-to-climb-in-emerging-economies/ eMarketer.2 Billion Consumers Worldwide to Get Smart(Phones) by 2016.(2014). Available from: http://www.emarketer.com/Article/2-Billion-Consumers-Worldwide-Smart-Phones-by-2016/1011694
33. Smith A. U.S. Smartphone Use in 2015. Pew Research Center. (2015). Available from: http://www.pewinternet.org/2015/04/01/us-smartphone-use-in-2015/
34. Griffiths F, Lindemeyer A, Powell J, Lowe P, Thorogood M. Why are health care interventions delivered over the Internet? A systematic review of the published literature. *J Med Internet Res* (2006) 8(2):e10. doi:10.2196/jmir.8.2.e10
35. Fiscella K, Franks P, Gold MR, Clancy CM. Inequality in quality: addressing the digital divide. *Health Serv Res* (2009) 44:1312–37. doi:10.1111/j.1475-6773.2008.01042.x
36. Khazaal Y, Chatton A, Prezzemolo R, Zebouni F, Edel Y, Jacquet J, et al. Impact of a board-game approach on current smokers: a randomised controlled trial. *Subst Abuse Treat Prev Policy* (2013) 8(1):3. doi:10.1186/1747-597X-8-3
37. Fiscella K, Franks P, Gold MR, Clancy CM. Inequality in quality: addressing the digital divide. *Health Serv Res* (2009) 44:1312–37. doi:10.1111/j.1475-6773.2008.01042.x
38. Griffiths F, Lindemeyer A, Powell J, Lowe P, Thorogood M. Why are health care interventions delivered over the Internet? A systematic review of the published literature. *J Med Internet Res* (2006) 8(2):e10. doi:10.2196/jmir.8.2.e10
39. Fiscella K, Franks P, Gold MR, Clancy CM. Inequality in quality: addressing socioeconomic, racial, and ethnic disparities in health care. *JAMA* (2000) 283(19):2579–84. doi:10.1001/jama.283.19.2579

Conflict of Interest Statement: The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest. Copyright © 2016 Graham. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.