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**Article**

## Gamification 2.0 - How Activity Tracking Apps Provide Long-Term Motivation

Marketing Review St.Gallen

**Provided in Cooperation with:**

Universität St. Gallen, Institut für Marketing und Customer Insight

*Suggested Citation:* Mönninghoff, Annette (2021) : Gamification 2.0 - How Activity Tracking Apps Provide Long-Term Motivation, Marketing Review St.Gallen, ISSN 1865-7516, Thexis Verlag, St.Gallen, Vol. 38, Iss. 4, pp. 48-57

This Version is available at:

<https://hdl.handle.net/10419/276152>

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## Conversational Commerce



# Gamification 2.0

## How Activity Tracking Apps Provide Long-Term Motivation

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One in four consumers is insufficiently physically active, resulting in substantial health risks. Conventional activity tracking apps motivate consumers but can promote motivational crowding-out. Gamification can help overcome these challenges. This paper presents two case studies and introduces a new motivational framework for gamification.

**Annette Mönninghoff, M.A.**

**T**oday, one in four consumers is insufficiently physically active (World Health Organization, 2018), resulting in substantial health risks. Insufficient physical activity (PA) increases the risk of chronic illnesses such as diabetes, cardiovascular diseases, and cancer (Lee et al., 2012).

Activity tracking apps might help motivate consumers. Wearables and tracking apps have trended in recent years, with over 850 million sold to date (Statista, 2020). However, recent evidence has raised the question whether tracking apps can motivate consumers in the long term. A meta-analysis found no statistically significant effect of tracking apps on PA (Romeo et al., 2019). Surprisingly, when tracking apps were used for less than three months, they increased PA. However, in trials running for more than three months, no statistically significant increases were found (Romeo et al., 2019). In a series of experiments, Etkin (2016) found that wearable trackers promote motivational crowding-out and theorized that activity trackers serve as an extrinsic incentive: They increase activity performance but decrease intrinsic walking motivation. This crowding-out effect has also been documented in other fields (Deci et al., 1999). Finally, a 2014 survey showed that one in three consumers already stops using their activity tracker six months after purchase (Endeavour Partners, 2014).

Could gamifying activity tracking apps help prevent motivational crowding-out? This paper investigates how gamification promotes long-term motivation. Building on two case studies, it presents a *motivational framework for gamification* and makes various practical recommendations.

## Gamification and Motivation

Gamification has been defined as “the use of game design elements in non-game

contexts” (Deterding et al., 2011, p. 9). Central to gamification are game elements. While common in many games, such elements are not part of every game. No single game element creates gameful experiences. Only integrating multiple game elements establishes intrinsically motivating environments in non-game contexts (Deterding et al., 2011). Game elements have been manifoldly modelled, leading scholars to criticize the lack of conceptual consensus (Johnson et al., 2016). Reeves and Read (2009) laid the foundations for a gamification framework by publishing ten “ingredients” of great games that can be used in non-game contexts to create consumer engagement. Building on this publication, scholars have developed various concepts ranging from 7 to 19 game elements (Hamari et al., 2014; Johnson et al., 2016; Lister et al., 2014). Some research has proposed classifying game elements into subgroups (Schlager et al., 2017). Figure 1 summarizes existing conceptualizations.

### Impact of Gamification on Motivation

Understanding whether gamification might drive long-term behavior change toward a more active lifestyle requires exploring its impact on consumer motivation. Using game elements in non-game contexts (e.g., fitness tracking) potentially makes these products more enjoyable and engaging (Flatla et al., 2011). Playing games is fun and absorbing. It may create flow, i.e., being fully involved in and adequately challenged by an activity (Csikszentmihalyi, 2000; Mathwick & Rigdon, 2004).

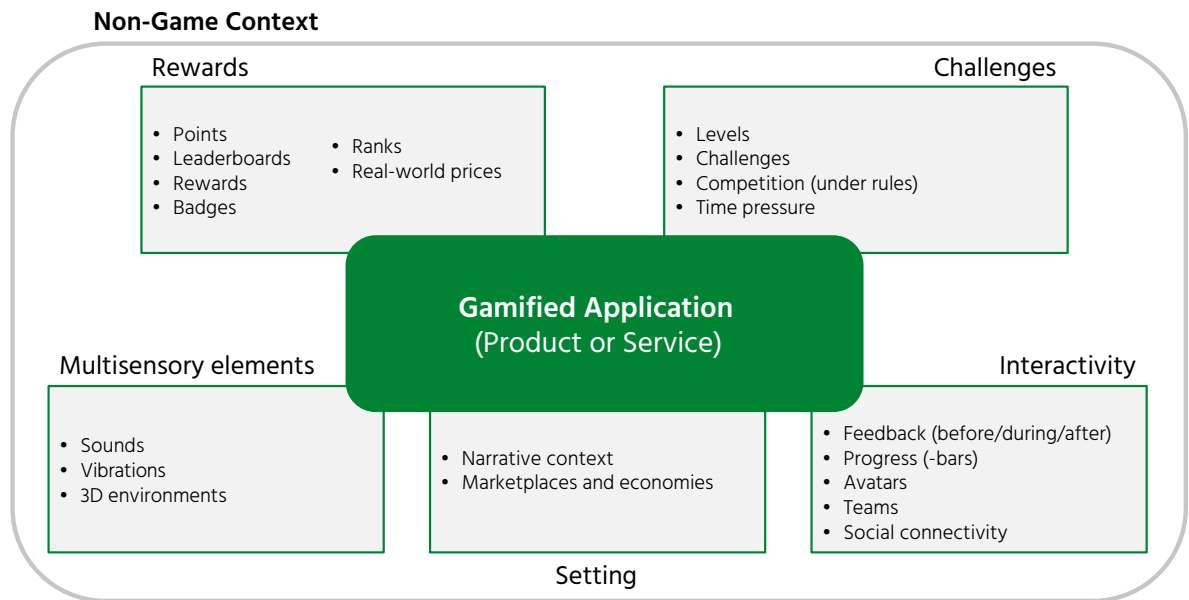
Scholars differentiate two types of activity motivation: Consumers may be motivated to perform an activity either for its own sake (i.e., intrinsic motivation) or for an ulterior end (i.e., extrinsic motivation; cf. goal system theory, Krug-

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**Fig. 1: Existing Conceptual Framework for Gamification**



Source: Own illustration based on Hamari et al. (2014); Johnson et al. (2016); Lister et al. (2014); Reeves & Read (2009); Schlager et al. (2017).

lanski et al., 2018). Gamification per se is associated with intrinsic motivation (Hamari et al., 2014). However, this approach falls short when multiple, very different game elements are employed in non-game contexts. Not all game elements promote intrinsic motivation. Some elements (e.g., rewards, points, and leaderboards) are extrinsic incentives and thus motivate users by providing ulterior consumption motives. Extrinsically motivating game elements do not gamify PA itself, instead, they gamify the means used to motivate PA and thus often occur after the activity has been performed. Other elements, however, have the potential to motivate intrinsically, by making the activity itself more enjoyable. Intrinsic activity motivation leads to more sustainable behavior change than extrinsically motivated behavior and is thus crucial in establishing long-term moti-

vation (Teixeira et al., 2012). Building on self-determination theory, the satisfaction of three basic psychological needs can help explain how gamification promotes intrinsic motivation (Ryan & Deci, 2017): first, *challenges* support users' striving for *competence*, which positively impacts intrinsic motivation. *Levels* within gamified applications help ensure that users are optimally challenged. Second, *avatars* enable customizing a virtual counterpart, while *3D environments* promote exploration, with both elements satisfying users' need for *autonomy* (Peng et al., 2012). Third, *social connectivity* may satisfy users' need for *relatedness* and, thus, their intrinsic motivation.

#### Motivational Crowding-out

Motivational crowding-out occurs when extrinsic incentives diminish in-

trinsic motivation over time (Etkin, 2016; Kruglanski et al., 1975). Extrinsically motivating game elements (e.g., points, leaderboards) may be perceived as controlling, thus diminishing users' sense of autonomy. Also, competition may negatively impact intrinsic motivation by reducing users' sense of competence if their performance is inferior to that of others (Ryan & Deci, 2017).

The context in which extrinsic incentives are employed moderates their impact on intrinsic motivation (Kruglanski et al., 1975). If incentives are perceived as integral (i.e., blend with the activity itself), they do not evoke motivational crowding-out. Within gamified activity tracking apps, points, leaderboards, and competition may be integral and hence prevent motivational crowding-out (Kruglanski et al., 1975; Schlager et al., 2017).

## Gamification in Activity Tracking Apps

Existing research shows that over half of all health and fitness apps are gamified (Lister et al., 2014). A review of 132 health and fitness apps revealed that social or peer pressure was the game element used most (45.2%), followed by digital rewards (24.1%), competition (18.4%), and leaderboards (14.2%; Lister et al., 2014). A more recent review of 19 digital interventions in the health and wellness domain identified rewards (84.2%), leaderboards (31.6%), and avatars (31.6%) as the most common game elements (Johnson et al., 2016).

These reviews reveal the broad variety of gamified tracking apps. There is no single way of gamifying trackers, merely countless possible combinations of game elements. The reviewers criticize the lack of theoretical grounding in how game elements are selected. They also highlight that the most commonly used elements tend to be extrinsic motivators. This is surprising given the original goal of gamification to harness the motivational power of games to intrinsically encourage long-term behavior change (Deterding et al., 2011).

Many studies have proven the short-term effectiveness of gamified applications in increasing PA (Hamari et al., 2014; Johnson et al., 2016; Thorsteinsen et al., 2014). However, the longer-term motivational impact of applications remains under-researched (Johnson et al., 2016; Schlager et al., 2017; Zuckerman & Gal-Oz, 2014). Some authors have questioned that gamification is motivating per se, claiming there is only “anecdotal evidence” for this effect (Schlager et al., 2017, p. 31). Others have found that gamified health applications often have

no or even negative effects on cognitive constructs such as motivation (Johnson et al., 2016). Scholars consider the mismatch between the most common game elements (i.e., rewards, leaderboards, avatars) and their motivational power the main reason why some studies report negative user reactions to gamified apps.

## Research Objectives and Methodology

The literature review revealed that most apps gamify post-activity feedback by employing extrinsically motivating game elements. However, existing research has evaluated apps as a single product without considering the various game elements used. Moreover, few studies have reviewed the

long-term motivational impact of gamified tracking apps. Addressing these research gaps, this study presents two cases and seeks to answer two research questions:

- (1) How can gamifying activity tracking apps motivate consumers in the long term?
- (2) Which game elements should be used to promote long-term behavior change toward more active lifestyles?

*Zombies, Run!* and *Jump Jump Froggy 2* were selected for case studies. Both apps use intrinsically motivating game elements, were created by developers with a scientific background in motivation theory, and received positive media coverage (Howard, 2016). The walkthrough method (Light et al., 2018) was used to develop the case studies. Telephone interviews with the app developers were conducted and relevant public documents (e.g., press releases, newspaper articles, websites) and consumer reviews (e.g., YouTube, App stores) were analyzed.

## Findings

### Case Study 1: *Zombies, Run!*

Launched in 2012, *Zombies, Run!* has become the world’s most popular gamified activity tracking app with more than 5 million downloads and 200,000 active users (Six to Start & Alderman, 2020). The app leverages several game elements and aims to motivate users to run or walk more. Unlike conventional gamified trackers, *Zombies, Run!* gamifies the run itself by leveraging intrinsically motivating game elements instead of focusing solely on post-run rewards. Its most important game ele-

## Management Summary

This article reviews gamification literature and presents two case studies on activity tracking apps to evaluate the motivational impact of gamification. It finds that most tracking apps gamify post-activity feedback with extrinsically motivating game elements (e.g., leaderboards, points, and rewards). The article presents a new motivational framework for gamification and concludes that the activity tracking process itself should be gamified (e.g., with narrative context, sound, levels and challenges) to motivate intrinsically and promote long-term motivation within inactive consumer groups.



ment is *narrative context*: Users assume the role of *Runner 5*, who has survived the zombie apocalypse. By running, users complete missions and receive important supplies which they can use after the run to build Abel Township, the last surviving town populated by humans. The storytelling uses audio (i.e., game element *sound*), so users need not look at the screen while running.

CEO Adrian Hon describes *Zombies, Run!* as a combination of game, tracking app, and audio storytelling that transforms the experience of running. Long-term motivation is created by a captivating narrative context that makes consumers immediately want to take up the next mission. The more users run, the more missions (i.e., game element *levels*) they get to complete, thus creating the optimal challenge. In the storytelling context, users randomly encounter zombies and are asked to speed up (i.e., game elements *time pressure* and *challenge*). The app supports users' sense of autonomy by offering various options: First, users can self-select how long their mission should be. The audio storytelling is then spaced across the run. Second, users can choose their music playlist or connect to music streaming services. The app also includes post-run *rewards*; these, however, are deeply integrated into the narrative, preventing motivational crowding-out. The rewards consist of supplies collected while running. After the run, users can use these supplies to develop Abel Township, a 3D environment on a separate tab of the tracking app (see figure 2). The app automatically tells consumers their average running pace and summarizes core statistics (pace, kilometers, steps). The app deliberately includes no competitive elements as the devel-

opers believe that leaderboards, direct competition, and ranks demotivate many users, particularly if they are not proficient runners. The app is designed to appeal to a broad audience: CEO Adrian Hon describes users as non-runners or occasional runners who would like to run more often than they currently do.

*If you are like me and you don't really care much for running or exercising in general, then Zombies, Run! is definitely for you. You come for the great story, stay for the endorphins!*  
(Mack, app user)

*I enjoy running, but it gets boring. Having the motivation to go on longer runs, to get out every day and run is hard. With Zombies, Run! I want to get out there and run. The story is so compelling that I need to get out there and find out what happens next.*  
(C587, app user)

*After a few months of bouncing around different workout styles I found this app and let me tell you it works wonders. As soon as I start to space out and get bored, the story comes on again and I'm able to focus on that and get excited for the next piece of the story.*  
(Dogs\_Luvr, app user)

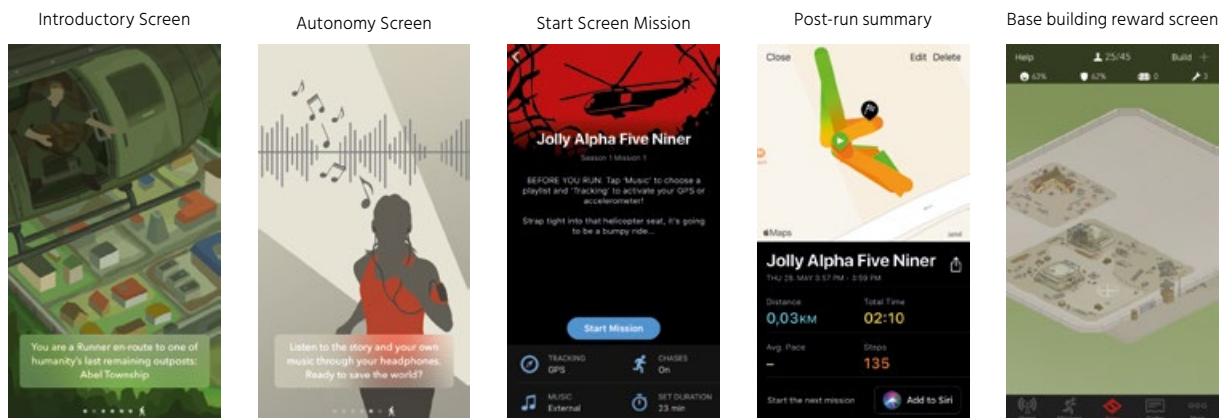
*This running app has gotten me through more tough runs and long weeks than I can tell you. I wanted a fun way to start back to running – and now I am fully hooked. [...] I am about a year in and still completely loving the app.*  
(Yogi 2.0, app user)

Evidence of the long-term motivational power of *Zombies, Run!* is manifold. A comparison of churn rates supports the long-term motivational power of *Zombies, Run!*: Over 50% of paying users stay with *Zombies, Run!* for more than a year, while research shows that regular activity tracking apps have a retention rate of just 6% 30 days after installment (Haslam, 2019). Also, over 200 missions have been taped since the launch, speaking to the need for ever new content for long-term users. Further, a randomized controlled trial confirmed that *Zombies, Run!* increases intrinsic motivation (Cowdery et al., 2015), consequently favoring long-term motivation.

## Case Study 2: *Jump Jump Froggy 2*

Launched in 2014, *Jump Jump Froggy 2* has been downloaded over 40,000 times. This app leverages multiple game elements and aims to motivate primary schoolchildren to be physically active. It was created by Timothy Charoenying, a cognitive scientist and software developer. A former teacher, he noticed that young children lacked opportunities to be active at school. His observation reflects the fact that, globally, 80% of kids do not meet the WHO's physical activity recommendations. Like *Zombies, Run!*, *Jump Jump Froggy 2* also gamifies the activity instead of using post-activity game elements. Kids choose from different activity options (sit-ups or jumping). Next, they select their virtual avatar (among different types of frogs). Then tracking begins, and the children are asked to jump up and down to catch flies, to do sit-ups to move a snake around the phone screen, or to jump up and turn their body to collect fruits

**Fig. 2: Zombies, Run! Overview**



Source: Six to Start & Alderman (2020), Zombies, Run! Version 8.72.

faster than an evil bee can catch them (i.e., game element *narrative context*). Fun music (i.e., game element *sound*) and an engaging comic-like 2D environment (figure 3) motivate the kids to perform the respective activity. To keep the app challenging, there are multiple game levels within each tracking option and task pace increases (i.e., game element *time pressure*). The app automatically recognizes movements through accelerometer data. Progress bars and points at the bottom of the screen inform the kids about their performance.

*I love that it gets my kids off the couch while still appealing to their love for video games*  
(Sorrento76, app user)

*Love watching my 7- and 10-year-old son and daughter choosing to do actual sit-ups and push-ups! So much better than just exercising their thumbs!"*  
(HTC2011, app user)

Positive consumer reviews, highlighting how much fun and how engaging *Jump Jump Froggy 2* is, attest to its intrinsic (long-term) activity motivation. Using the app in school contexts, Timothy Charoenying has observed high sustained student engagement. An analysis of consumer reviews also provides initial evidence for the long-term motivational power of the app. However, further quantita-

tive evidence is needed to confirm the app's lasting positive motivational impact.

### A Motivational Framework for Gamification

The case studies revealed the need for a more granular assessment of gamification. As the motivational impact of game elements varies, gamifica-

### Main Propositions

1. Gamifying activity tracking apps potentially motivates consumers to adopt more active lifestyles.
2. Conventional gamified activity tracking apps mostly leverage extrinsically motivating game elements and focus on already active target groups.
3. To create long-term motivation and to reach moderately active consumer groups, fitness apps should gamify the tracking experience itself.
4. Assessing the various game elements employed and their motivational impact leads to a more differentiated evaluation of gamification.



tion should not be evaluated as a single, unified phenomenon but broken down into individual game elements. Some game elements, especially those that gamify an integral component of a service or product, motivate intrinsically by enhancing consumers' sense of competence, autonomy, or relatedness; other elements motivate extrinsically, by providing a gamified ulterior end that motivates consumption. Building on the existing conceptual framework of gamification (figure 1), this paper proposes a new *motivational framework for gamification* (figure 4).

The proposed framework distinguishes two types of game elements: those gamifying a core component of a product or service, and those that gamify an ulterior consumption motive. To promote long-term motivation, this novel framework suggests that tracking app developers should focus on gamifying the activity itself. In contrast, gamifying post-tracking feedback (i.e., ulterior motive to be active) provides only short-term performance increases and potential motivational crowding-out.

The two case studies powerfully illustrate how extrinsically motivating game elements can be employed with-

out diminishing intrinsic motivation. *Zombies, Run!* enables users to collect rewards while running. Instead of traditional rewards (e.g., points or badges), runners gather construction materials or food items to build Abel Township after the run. Rewards, then, are not just an extrinsic incentive, but are meaningful within the game context and integral to the game. Thus, the framework suggests using extrinsically motivating game elements only if they are employed for gamifying the consumption experience and are meaningful within the game context.

## Lessons Learned

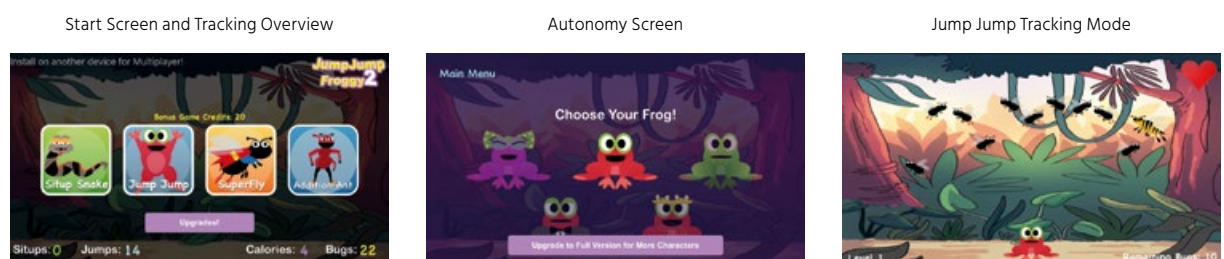
1. Leading fitness apps should tap into the underserved but promising target group of insufficiently active consumers (>25% of the total population) by expanding their product offerings to include intrinsically motivating game elements such as narrative context, sound, and time pressure.
2. Future research should take a more granular perspective when evaluating gamified applications and quantitatively validate the proposed motivational framework for gamification.
3. Policymakers should leverage gamified fitness apps to address the growing physical activity crisis as such devices can potentially motivate long-term behavior change and reach large population groups.

## Discussion

Prevalence of insufficient PA is high and involves substantial health risks. Recent evidence has called into question whether conventional activity tracking apps can motivate long-term behavior change and suggests that they may cause motivational crowding-out. Although gamification is believed to help overcome these challenges, evidence of its motivational long-term impact is limited.

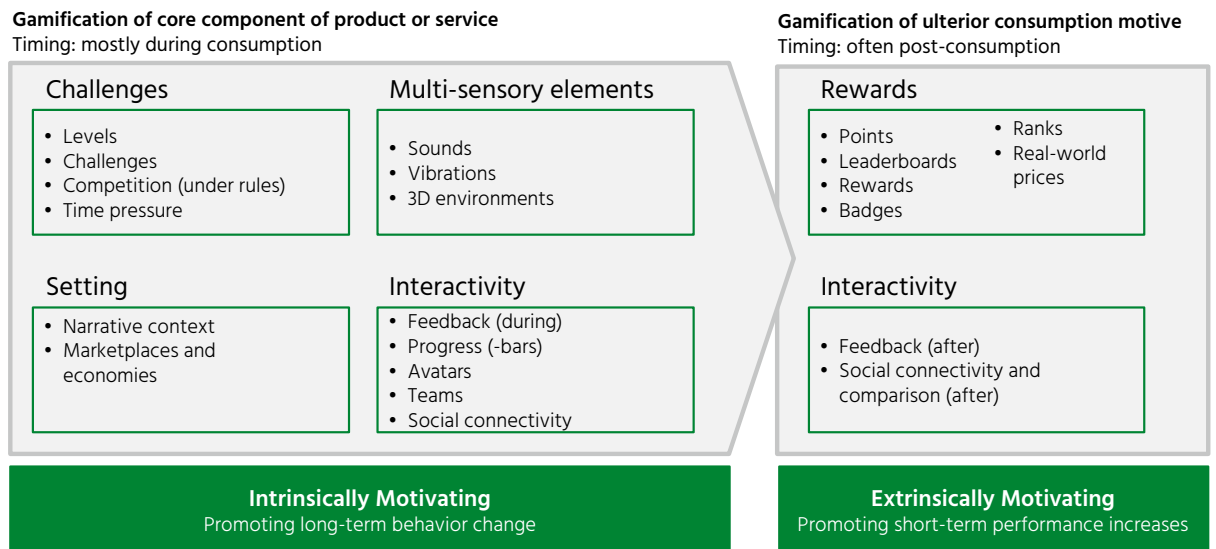
Based on a literature review and two case studies, this paper proposes a

**Fig. 3: *Jump, Jump Froggy 2* Overview**



Source: Human Factored Design LLC, *Jump Jump Froggy 2* Version 2.12.

**Fig. 4: Motivational Framework for Gamification**



Source: Own illustration based on case study analyses (Zombies, Run! and Jump Jump Froggy) and on Hamari et al., 2014; Johnson et al., 2016; Lister et al., 2014; Reeves & Read, 2009; Schlager et al., 2017.

*new motivational framework for gamification.* The framework provides guidance to app developers and public health officials on how best to gamify activity tracking apps to promote long-term motivation and behavior change. The framework suggests developers should focus on gamifying core components of the activity tracking process with intrinsically motivating game elements (e.g., sound, narrative context, and avatars). This marks a fundamental shift for leading tracking apps (e.g., Strava, Runtastic), which currently mostly rely on gamifying post-activity feedback with leaderboards, badges, and rewards.

However, consumers might react differently to gamified activity tracking apps. The case studies show that moderately active consumers require intrinsically motivating game elements to drive behavior change. In contrast, highly active consumers – as currently

targeted by Strava or Runtastic – possess high intrinsic motivation and thus might not require intrinsically motivating game elements. Thus, the findings provide initial evidence that companies might increase their consumer base by

Further research is needed to test the new conceptual framework given the limitations of this study. The framework was developed based on a literature review and the limited evidence of two case studies on innovative activity

Future research should focus on validating the framework with quantitative evidence to further evaluate the long-term motivational power of gamified activity tracking apps.

marketing intrinsically motivating gamified tracking solutions to moderately active consumers. The innovative fitness equipment company *Peloton* is an example of a firm which successfully markets to moderately active consumers by offering an intrinsically motivating, gamified bike.

tracking apps. The latter were developed for English-speaking, high-income countries, limiting the generalizability of the findings. Future research should focus on validating the framework with quantitative evidence to further evaluate the long-term motivational power of gamified activity tracking apps. 🚴

## Literature

- Cowdery, J., Majeske, P., Frank, R., & Brown, D. (2015). Exergame apps and physical activity: The results of the ZOMBIE trial. *American Journal of Health Education*, 46(4), 216–222. <https://doi.org/10.1080/19325037.2015.1043063>
- Csikszentmihalyi, M. (2000). *Beyond Boredom and Anxiety*. Jossey-Bass.
- Deci, E. L., Koestner, R., & Ryan, R. M. (1999). A meta-analytic review of experiments examining the effects of extrinsic rewards on intrinsic motivation. *Psychological Bulletin*, 125(6), 627–668. <https://doi.org/10.1037/0033-2909.125.6.627>
- Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). From game design elements to gamefulness: Defining 'gamification'. *Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments*, MindTrek 2011, 9–15. <https://doi.org/10.1145/2181037.2181040>
- Endeavour Partners (2017, April 27). *Inside Wearables Part 2: Key developments for adoption and engagement*. Medium. <https://medium.com/@endeavourprtnrs/inside-wearables-part-2-july-2014-ef-301d425cdd>
- Etkin, J. (2016). The hidden cost of personal quantification. *Journal of Consumer Research*, 42(6), 967–984. <https://doi.org/10.1093/jcr/ucv095>
- Flatla, D. R., Gutwin, C., Nacke, L. E., Bateman, S., & Mandryk, R. L. (2011). Calibration games: Making calibration tasks enjoyable by adding motivating game elements. *UIST'11 - Proceedings of the 24th Annual ACM Symposium on User Interface Software and Technology*, 403–412. <https://doi.org/10.1145/2047196.2047248>
- Hamari, J., Koivisto, J., & Sarsa, H. (2014). Does gamification work? - A literature review of empirical studies on gamification. *Proceedings of the Annual Hawaii International Conference on System Sciences*, 3025–3034. <https://doi.org/10.1109/HICSS.2014.377>
- Haslam, J. (2019, November 1). Fitness trackers see a boost in January — but do users keep their resolutions? Adjust, Blog. <https://www.adjust.com/blog/health-tracker-installs-and-retention-data/>
- Howard, J. (2016, July 14). *Pokemon 'no': 7 other games to get you moving instead of Pokemon Go*. CNN Health. <https://edition.cnn.com/2016/07/14/health/pokemon-go-exercise-games-apps/index.html>
- Johnson, D., Deterding, S., Kuhn, K. A., Staneva, A., Stoyanov, S., & Hides, L. (2016). Gamification for health and wellbeing: A systematic review of the literature. *Internet Interventions*, 6, 89–106. <https://doi.org/10.1016/j.invent.2016.10.002>
- Kruglanski, A. W., Fishbach, A., Woolley, K., Bélanger, J. J., Chernikova, M., Molinario, E., & Pierro, A. (2018). A structural model of intrinsic motivation: On the psychology of means-ends fusion. *Psychological Review*, 125(2), 165–182. <https://doi.org/10.1037/rev0000095>
- Kruglanski, A. W., Riter, A., Amitai, A., Margolin, Bath-Sheva Shabtai, L., & Zaksh, D. (1975). Can money enhance intrinsic motivation? A test of the content-consequence hypothesis. *Journal of Personality and Social Psychology*, 31(4), 744–750. <https://doi.org/10.1037/0022-3514.31.4.744>
- Lee, I.-M., Shiroma, E. J., Lobelo, F., Puska, P., Blair, S. N., & Katzmarzyk, P. T. (2012). Impact of physical inactivity on the world's major non-communicable diseases. *The Lancet*, 380(9838), 219–229. [https://doi.org/10.1016/S0140-6736\(12\)61031-9](https://doi.org/10.1016/S0140-6736(12)61031-9)
- Light, B., Burgess, J., & Duguay, S. (2018). The walkthrough method: An approach to the study of apps. *New Media and Society*, 20(3), 881–900. <https://doi.org/10.1177/1461444816675438>
- Lister, C., West, J. H., Cannon, B., Sax, T., & Brodegard, D. (2014). Just a fad? Gamification in health and fitness apps. *Journal of Medical Internet Research*, 16(8), e9. <https://doi.org/10.2196/games.3413>
- Mathwick, C., & Rigdon, E. (2004). Play, flow, and the online search experience. *Journal of Consumer Research*, 31(2), 324–332.
- Peng, W., Lin, J., Pfeiffer, K. A., & Winn, B. (2012). Need satisfaction supportive game features as motivational determinants: An experimental study of a self-determination theory guided exergame. *Media Psychology*, 15(2), 175–196. <https://doi.org/10.1080/15213269.2012.673850>
- Reeves, B., & Read, J. L. (2009). *Total Engagement: Using Games and Virtual Worlds to Change the Way People Work and Businesses Compete*. Harvard Business Review Press
- Romeo, A., Edney, S., Plotnikoff, R., Curtis, R., Ryan, J., Sanders, I., Crozier, A., & Maher, C. (2019). Can smartphone apps increase physical activity? Systematic review and meta-analysis. *Journal of Medical Internet Research*, 21(3), e12053. <https://doi.org/10.2196/12053>
- Ryan, R. M., & Deci, E. L. (2017). *Self-Determination Theory: Basic Psychological Needs in Motivation, Development, and Wellness*. Guilford Press.
- Schlager, T., Müller-Stewens, J., Sprott, D., Häubl, G., & Herrmann, A. (2017). *Gamification Paradigm*. Working paper, Université de Lausanne. <https://www.unil.ch/dmk/en/home/menuinst/research-1/working-papers.html>
- Six to Start & Alderman, N. (2020). *Zombies, Run! Presskit Factsheet*. <https://zombiesrungame.com/presskit/>
- Statista. (2020, November 23). *Wearables unit shipments worldwide by vendor from 2014 to 2019*. Statista. <https://www.statista.com/statistics/515634/wearables-shipments-worldwide-by-vendor/>
- Teixeira, P. J., Silva, M. N., Mata, J., Palmeira, A. L., & Markland, D. (2012). Motivation, self-determination, and long-term weight control. *International Journal of Behavioral Nutrition and Physical Activity*, 9(21). <https://doi.org/10.1186/1479-5868-9-22>
- Thorsteinsen, K., Vittersø, J., & Svendsen, G. B. (2014). Increasing physical activity efficiently: An experimental pilot study of a website and mobile phone intervention. *International Journal of Telemedicine and Applications*, 2014, 746232. <https://doi.org/10.1155/2014/746232>
- World Health Organization (2018). *Global action plan on physical activity 2018–2030: more active people for a healthier world*. <https://doi.org/10.1016/j.jpolmod.2006.06.007>
- Zuckerman, O., & Gal-Oz, A. (2014). Deconstructing gamification: evaluating the effectiveness of continuous measurement, virtual rewards, and social comparison for promoting physical activity. *Personal and Ubiquitous Computing*, 18(7), 1705–1719. <https://doi.org/10.1007/s00779-014-0783-2>