Using Hexad User Types to Select Suitable Gamification Elements to Encourage Healthy Eating

Maximilian Altmeyer[1], **Marc Schubhan**[1], **Pascal Lessel**[1], **Linda Muller**[2], **Antonio Krüger**[1]
[1]DFKI GmbH, [2]Saarland University
Saarland Informatics Campus
[1]firstName.lastName@dfki.de, [2]linda_muller@hotmail.de

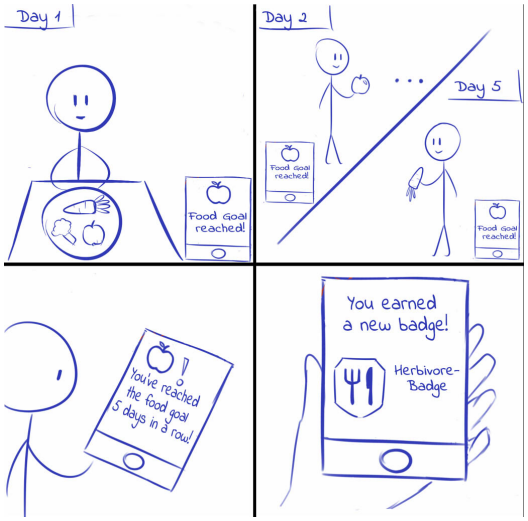

Figure 1: Storyboard of the gamification element "Badges"

CHI'20 Extended Abstracts, , April 25–30, 2020, Honolulu, HI, USA
ACM 978-1-4503-6819-3/20/04.
https://doi.org/10.1145/3334480.3383011

Abstract
Given that an increasing number of people cultivate poor eating habits, encouraging people to eat healthy is important. One way to motivate people eating healthy is using gamification, i.e. using game elements in a non-game context. Often, a static set of gamification elements is used. However, research suggests that the motivational impact of gamification elements differs substantially across users, demanding personalized approaches. In this paper, we contribute to this by investigating the perception of frequently used gamification elements in the healthy eating domain and correlations to Hexad user types in an online study (N=237). To do so, we created storyboards illustrating these gamification elements and show their comprehensibility in a lab study (N=8). Our results validate and extend previous research in the healthy eating domain, underline the need for personalization and could be used to inform the design of gamified systems for healthy eating.

Author Keywords
Personalization; Gamification; Hexad; Healthy Eating

CCS Concepts
•Human-centered computing → Empirical studies in HCI;

Virtual Character
The appearance of a virtual character is linked to the calorie intake of the user.
Exp. correlations: AC, PL

Custom Goal
The user sets themselves a custom calorie intake goal.
Exp. correlations: AC, FS

Personalized Goal
The system personalizes the users' calorie intake goal.
Exp. correlations: AC

Challenge
The user manages to reach a demanding goal.
Exp. correlations: AC

Badges
The user reaches their goal three times, unlocking a new badge.
Exp. correlations: AC, PL

Rewards
The user receives a coupon code for staying below the daily calorie intake limit.
Exp. correlations: PL

Sidebar 1: Gamification elements, storyboard descriptions and expected correlations (based on [11, 19])

Introduction and Related Work

Overweight and obesity because of poor eating habits are among the most important health issues today [5]. They have been shown to be a key factor for chronic diseases such as cancer, cardiovascular diseases or diabetes [5]. However, obesity is not only a health risk, but also has personal and social consequences, since it is associated with reduced quality of life, stigmatization and poor social integration [7]. Therefore, using technology to cultivate healthy eating habits is an important research topic and has been investigated in the past:

For instance, Schaefbauer et al. [16] investigated a mobile application called "Snack Buddy", which allows families to both track their snacking and receive feedback on its healthiness. The app allows to review the healthiness of snacks of other family members. There is also a gameful interface, showing an avatar progressing through life goals. The study revealed that the system successfully led to a decrease in the number of snacks, and that participants appreciated the social and gameful features of the system. Similarly, Chang et al. [4] investigated a combination of a public display and a mobile application to encourage healthy food choices in a company cafeteria. The public display was used to provide a daily challenge and normative feedback to users by visualizing the progress in the daily challenge of all users together with the reported real-time lunch food consumption. The app allowed users to track their lunch food intake, their progress in the daily challenge and to compare the nutritional content of their food to established guidelines as well as to the food other users ate. The evaluation of the system revealed that the public display was successful in attracting users and that the social and normative feedback elements were effective in encouraging app usage. Also, positive effects on self-awareness and self-reflection have been found. Since drinking enough water is an important part of a healthy diet, Lessel et al. [10] implemented a system called "WaterCoaster" to encourage people drinking a healthy amount of liquids throughout the day. The device measures the drinking amount of people by using a scale and transferring data via Bluetooth to a gamified mobile app. The app visualizes a virtual marine animal whose emotional state is connected to the drinking behavior of users. By drinking healthy, users receive upgrades for their virtual character such as sunglasses or hats. A user study revealed that the system subjectively leads to positive behavioral outcomes and that the gameful features that were used in the system were perceived particularly well.

While the aforementioned gamified systems have been shown to lead to various positive effects adopting a "one-size-fits-all" approach, research has also found negative results when using such an approach [3, 8, 17]. This is unsurprising, given that the motivational impact of gamification elements differs substantially across users [2, 18]. To account for and understand these differences, the Hexad user types model [11], has been developed. It is the only user types model that specifically targets gamified interventions and has been shown to be a useful factor for tailoring gamified, persuasive systems [1, 14, 19]. The Hexad user types model consists of six user types that differ in the degree to which they are driven by their needs for autonomy, relatedness, competence and purpose (as defined by the Self-Determination Theory (SDT) [15]). **Philanthropists ("PH")** are socially-minded, like to bear responsibility and share knowledge with others. The most important motivational factor is *purpose*. Similarly, **Socializers ("SO")** are socially-minded, but they are more interested in interacting with others. *Relatedness* is most important for them. **Free Spirits ("FS")** are satisfied when they have the opportunity to act without external control, with *autonomy* being most important for them. **Achievers ("AC")** are satisfied when

Points
The system rewards the user with points for eating healthy.
Exp. correlations: PL, AC

Knowledge Sharing
The user helps others in a forum by answering questions.
Exp. correlations: PH, SO

Unlockable Content
Staying below the daily calorie limit three times in a row unlocks a new feature.
Exp. correlations: FS

Cheating
The user decides to cheat by entering wrong data about the food intake into the app.
Exp. correlations: DI

Social Collaboration
A group of users have to collaborate, to stay below their shared calorie intake limit.
Exp. correlations: SO, PH

Social Competition
A group of users are shown on a leaderboard, competing for the top position.
Exp. correlations: PL, SO

Sidebar 2: Gamification elements, storyboard descriptions and expected correlations (based on [11, 19]) cont'd

overcoming difficult challenges. The most important motivational factor is *competence*. **Players ("PL")** are out for their own benefits, driven by the will to win and will do their best to earn rewards. *Extrinsic rewards* are most important for them. Lastly, **Disruptors ("DI")** are driven by disrupting systems and by testing its boundaries. The most important motivational factor is triggering *change*.

In this paper, we contribute to the ongoing tailoring efforts by investigating the perceived persuasiveness of twelve frequently used gamification elements to encourage healthy eating. Besides reporting general preferences for gamification elements in this domain, we report correlations between Hexad user types and preferences for gamification elements, allowing to personalize and inform the design of gamified systems encouraging healthy eating. We also provide a set of twelve storyboards for gamification elements, which have been shown to be comprehensible and may be used freely by fellow researchers and practitioners.

Storyboards and Gamification Elements

We decided to use storyboards to explain the gamification elements in order to give participants a better idea of how those elements work. For the storyboards, we ensured to have at least one gamification element for each user type (based on [11, 19]), resulting in twelve different storyboards. A list of gamification elements and expected correlations can be found in Sidebar 1 and Sidebar 2. Figures 1 and 2 show two exemplary storyboards. All storyboards are licensed under a CC BY 4.0 license and can be found in full resolution on figshare[1].

Storyboard Validation

We conducted a study to make sure that the storyboards are comprehensible (similar to our previous work, in which we created storyboards for the physical activity domain [1]). In this study, a semi-structured interview was conducted, in which participants were shown each printed storyboard in random order. First, participants were asked to describe the storyboard in their own words. When necessary, the interviewer asked questions to prompt participants to identify which activities are depicted by the storyboard. Next, participants were given a short textual summary of each gamification element. They were asked to assign each of the storyboards its respective gamification element by using the short textual summary. This was done to get an additional indication of whether participants understood the storyboards. Finally, interviews were transcribed and analyzed by two independent raters ("R1", "R2"). They received the transcriptions for each storyboard, without revealing which gamification element was described by the participants. Their tasks were to evaluate which element was being described and to rate how well the element was understood on a 5-point scale (1-very poor to 5-very well).

8 German participants took part (4 female, 4 male, average age 21.75). They claimed to be gaming-affine (M=5.75, SD=1.40, Mdn=6), to frequently play video games (M=6.00, SD=1.41, Mdn=7) and to have a passion for video games (M=5.63, SD=1.85, Mdn=6.5). To ensure that the ratings can be interpreted objectively, we calculated the inter-rater agreement and found it to be Kappa=0.63, which is considered as substantial [12]. Analyzing the ratings of the two independent raters, we found that the participants understood the storyboards very well (M_{R1} = 4.89, Min_{R1} = 4; M_{R2} = 4.92, Min_{R2} = 4). This was supported by the fact that both raters successfully assigned all gamification elements correctly based on participants' storyboard descriptions.

[1] https://doi.org/10.6084/m9.figshare.11475012.v1

Evaluation

We conducted an online survey, which was available in English and German. Participants were recruited via social media and Academic Prolific (participants were paid 1.50 pounds). The study took 10-15 minutes to complete and was approved by our Ethical Review Board[2]. After collecting demographic data, participants were asked to rate their gaming affinity on a 5-point scale. Next, participants' Hexad user type was determined using the 24 item Hexad User Types scale developed by Tondello et al. [19]. Finally, as the main part of the questionnaire, participants were shown the 12 storyboards in a randomized order. To measure the persuasiveness of each gamification element depicted in the storyboards, we adapted the perceived persuasiveness scale by Drozd et al. [6] in the same way as was done by Orji et al. [13]. The scale consists of four items to be answered on 7-point Likert scales. A Shapiro-Wilk test revealed that the persuasiveness items were not normally distributed, which is why we used non-parametric tests for our analysis. For correlation analysis, Kendall's τ was used, as it is well-suited for non-parametric data [9]. It should be noted that Kendall's τ is usually lower than Pearson's r for the same effect sizes. Therefore, we transformed interpretation thresholds for Pearson's r to Kendall's τ, according to Kendall's formula [20]:

- small effect: τ = 0.20 (r = 0.30)
- medium effect: τ = 0.34 (r = 0.50)
- large effect: τ = 0.50 (r = 0.70)

Demographics

237 participants completed the online survey. 38.4% were male, 60.8% female and 0.8% identified themselves as

[2] https://erb.cs.uni-saarland.de/, last accessed February 10, 2020

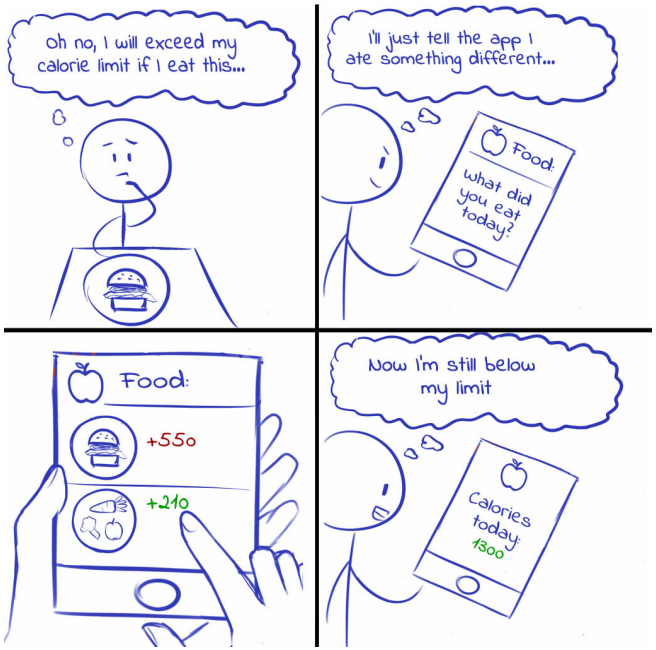

Figure 2: Storyboard of the gamification element "Cheating"

"non-binary" or "genderqueer". Most participants (35%) were aged 18-24 years, followed by 25-31 (31.6%), 32-38 (14.3%), 39-45 (8%), 46-52 (4.2%) and younger than 18 (4.2%). The remaining participants were aged 53 and older (2.5%). They considered themselves as gaming-affine (M=3.58, SD=1.11, Mdn=4.00), claimed to have a passion for video games (M=3.58, SD=1.03, Mdn=4.00) and to frequently play video games (M=3.44, SD=1.16, Mdn=4.00).

Perceived Persuasiveness of Gamification Elements

The median scores of perceived persuasiveness can be found in Table 3. It can be seen that all but the "Cheating" gamification element scored higher than the neutral choice

Figure 3: Distribution of participants' Hexad scores

	Mdn. PP	AC	DI	FS	PH	PL	SO
Virtual Character	4.25	**.146****	-	.152**	.134**	**.147****	.186**
Custom Goal	**5.00**	-	-	-	.102*	.036*	.112*
Personalized Goal	**5.25**	**.095***	-	-	.097*	-	.095*
Challenge	**5.00**	**.114***	-	.139**	.191**	.125**	.180**
Badges	**4.50**	-	-	-	.164**	**.113***	.200**
Points	**4.50**	**.120****	-	-	.106*	**.152****	.124**
Rewards	**5.75**	.135**	-	.100*	.142**	**.248****	.143**
Knowledge Sharing	**4.25**	-	-	.132**	**.260****	.121*	**.248****
Unlockable Content	**5.00**	.097*	-	**.115***	.196**	.109*	.234**
Cheating	**3.00**	-	-	-	-	-	-
Social Collaboration	**4.75**	-	-	-	**.255****	-	**.268****
Social Competition	4.50	-	-	-	-	**.223****	**.143****

Table 3: Median perceived persuasiveness of all gamification elements ("Mdn. PP", colored cells indicate a significant ($p<.05$) deviation from the neutral choice (red=less, green=more persuasive)) and bivariate correlation coefficients (Kendall's τ) between the Hexad user types and the gamification elements (bold entries represent correlations that we expected (see Sidebar 1 and Sidebar 2). *p<.05, **p<.01)

of 4 on the 7-point scale. To analyze whether the median scores significantly differ from the neutral choice, we calculated one-sample Wilcoxon signed rank tests for each gamification element. All gamification elements but "Virtual Character" and "Social Competition" differed significantly ($p<.05$) from the neutral choice. Of those elements, "Cheating" is the only one where the perceived persuasiveness is significantly lower than 4, whereas the rest scores significantly higher. These results suggest that most gamification elements should have positive effects on user behavior when being implemented and may help to select gamification elements to encourage healthy eating, when no information about the target audience or their user type distribution is known.

Hexad User Types and Gamification Elements

The distribution of participants' scores across all Hexad subscales is shown in Figure 3. Regarding the correlations between Hexad user types and the perceived persuasiveness of gamification elements depicted in the storyboards, we found 15 correlations between user types and gamification elements out of 19 expected ones (see Sidebar 1 and Sidebar 2). Besides replicating previous research in the context of healthy eating [14, 19], we contribute correlations between gamification elements and the Philanthropist, which have been hypothesized, but not yet shown. These results may help to further personalize the set of gamification elements when implementing or designing behavior change applications to encourage healthy eating.

Discussion

We investigated the perceived persuasiveness of twelve commonly used gamification elements by creating storyboards explaining each element, ensuring their comprehensibility (N=8) and presenting them to users in an online study (N=237). Our results show that most gamification elements scored significantly higher than the neutral choice on the perceived persuasiveness scale. Thus, these results may help researchers and practitioners to inform the design of gamified behavior change support systems encouraging healthy eating.

Confirming previous findings [14, 19], we also found that the Hexad user type is a useful factor for personalization of gamified systems. Besides replicating previously found correlations between gamification elements and Hexad user types in the context of healthy eating, we contribute a set of new correlations, which were expected in previous works [11, 19], but have not been shown before. This might be due to using storyboards rather than textual descriptions as in [19] and because of using a concrete context rather than a general context, also as in [19], potentially leading to a more concrete idea of how the elements work. Taking our results together, we show that certain gamification elements seem promising to encourage healthy eating and that Hexad user types are worthwhile to consider as a factor for personalization of such systems, extending previous work using the Hexad model.

Conclusion, Limitations and Future Work

In this paper, we investigated the perception of commonly used gamification elements and the effectiveness of Hexad user types as a factor for personalizing gamified, persuasive systems in the Healthy Eating context (N=237). To ensure that participants understand the gamification elements in this context, we make use of storyboards explaining each gamification element. In a qualitative pre-study, we showed the comprehensibility of these storyboards. In general, our results suggest that most gamification elements might lead to positive behavioural outcomes and thus have great potential to help people eating healthy. Our results also show that the Hexad model can be used for personalization, as we found several expected correlations between user types and gamification elements. This shows the validity of previous results found in other domains [14] or in a general context [19], but also provides additional insights, which are reasonable given the motivational factors of each user type as explained in [11], but had not yet been shown.

However, our work has several limitations that should be considered. First, we used storyboards to assess the perceived persuasiveness of each gamification element; we did not implement them, i.e. we investigated perceived persuasiveness, not actual persuasiveness. Therefore, validating our findings using real implementations is an important next step that should be followed. Second, even though we investigated atomic gamification elements using storyboards, some aspects of the realization of these gamification elements are inherently a matter of interpretation, affecting the external validity of our results when implementing gamification elements differently. Additionally, it should be noted that combining gamification elements may create different experiences for the user, which has not been investigated and should be analyzed in future work. Also, we cannot say whether our findings generalize to different contexts besides Healthy Eating. Therefore, further research should be conducted about the Hexad user model as a factor for personalization in different contexts. Last, we would like to acknowledge that calorie intake is not the only factor of a healthy diet and that the use of this metric should be seen as a design decision to conceptualize and simplify healthy eating for the purpose of the study.

REFERENCES

[1] Maximilian Altmeyer, Pascal Lessel, Linda Muller, and Antonio Krüger. 2019. Combining Behavior Change Intentions and User Types to Select Suitable Gamification Elements for Persuasive Fitness Systems. In *International Conference on Persuasive Technology*. Springer.

[2] Martin Böckle, Isabel Micheel, and Markus Bick. 2018. A Design Framework for Adaptive Gamification Applications. *Proceedings of the 51st Hawaii International Conference on System Sciences (HICSS '18)* (2018), 1227–1236.

[3] Martin Böckle, Jasminko Novak, and Markus Bick. 2017. Towards Adaptive Gamification: A Synthesis of Current Developments. *Proceedings of the 25th European Conference on Information Systems (ECIS '17)* (2017). http://aisel.aisnet.org/ecis2017

[4] Kerry Shih Ping Chang, Catalina M. Danis, and Robert G. Farrell. 2014. Lunch Line: Using Public Displays and Mobile Devices to Encourage Healthy Eating in an Organization. *UbiComp 2014 - Proceedings of the 2014 ACM International Joint Conference on Pervasive and Ubiquitous Computing* (2014), 823–834. DOI: http://dx.doi.org/10.1145/2632048.2636086

[5] Sameer Deshpande, Michael D. Basil, and Debra Z. Basil. 2009. Factors Influencing Healthy Eating Habits Among College Students: An Application of the Health Belief Model. *Health Marketing Quarterly* 26, 2 (2009), 145–164. DOI: http://dx.doi.org/10.1080/07359680802619834

[6] Filip Drozd, Tuomas Lehto, and Harri Oinas-Kukkonen. 2012. Exploring Perceived Persuasiveness of a Behavior Change Support System: A Structural Model. *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)* 7284 LNCS (2012), 157–168. DOI: http://dx.doi.org/10.1007/978-3-642-31037-9_14

[7] Steven Gortmaker, Aviva Must, James Perrin, Arthur Sobol, and William Dietz. 1993. Social and Economic Consequences of Overweight in Adolescence and Young Adulthood. *New England Journal of Medicine* (1993).

[8] Juho Hamari and Harri Sarsa. 2014. Does Gamification Work? - A Literature Review of Empirical Studies on Gamification. *Hawaii International Conference on System Sciences*. (2014), 3025–3034. DOI:http://dx.doi.org/10.1109/HICSS.2014.377

[9] David Howell. 2002. *Statistical Methods For Psychology*. Duxbury. DOI: http://dx.doi.org/10.2307/2348956

[10] Pascal Lessel, Maximilian Altmeyer, Frederic Kerber, Michael Barz, Cornelius. Leidinger, and Antonio Krüger. 2016. WaterCoaster: A Device to Encourage People in a Playful Fashion to Reach Their Daily Water Intake Level. *Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems. ACM* (2016), 1813–1820. DOI: http://dx.doi.org/10.1145/2851581.2892498

[11] Andrzej Marczewski. 2015. *Even Ninja Monkeys Like to Play: Gamification, Game Thinking and Motivational Design*. CreateSpace Independent Publishing Platform.

[12] Mary L Mchugh. 2012. Interrater Reliability: The Kappa Statistic. *Biochemia Medica* (2012), 276–282.

[13] Rita Orji, Lennart E. Nacke, and Chrysanne Di Marco. 2017. Towards Personality-driven Persuasive Health Games and Gamified Systems. *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems - CHI '17* (2017), 1015–1027. DOI: http://dx.doi.org/10.1145/3025453.3025577

[14] Rita Orji, Gustavo F Tondello, and Lennart E Nacke. 2018. Personalizing Persuasive Strategies in Gameful Systems to Gamification User Types. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems - CHI '18* (2018). DOI:http://dx.doi.org/doi.org/10.1145/3173574.3174009

[15] Richard M Ryan and Edward L Deci. 2000. Self-Determination Theory and the Facilitation of Intrinsic Motivation, Social Development, and Well-Being. *American Psychologist* 55, 1 (2000), 68–78. DOI: http://dx.doi.org/10.1037/0003-066X.55.1.68

[16] Chris Schaefbauer, Danish Kahn, Amy Le, Garrett Sczechowski, and Katie Siek. 2015. Snack Buddy: Supporting Healthy Snacking in Low Socioeconomic Status Families. *Computer Supported Cooperative Work and Social Computing (CSCW)* (2015), 1045–1057.

[17] Katie Seaborn and Deborah Fels. 2015. Gamification in Theory and Action: A Survey. *International Journal of Human-Computer Studies* 74 (2015), 14–31. DOI: http://dx.doi.org/10.1016/j.ijhcs.2014.09.006

[18] Gustavo F. Tondello, Alberto Mora, and Lennart E. Nacke. 2017. Elements of Gameful Design Emerging from User Preferences. *Proceedings of the Annual Symposium on Computer-Human Interaction in Play - CHI PLAY '17* (2017), 129–142. DOI: http://dx.doi.org/10.1145/3116595.3116627

[19] Gustavo F Tondello, Rina R Wehbe, Lisa Diamond, Marc Busch, Andrzej Marczewski, and Lennart E Nacke. 2016. The Gamification User Types Hexad Scale. *The ACM SIGCHI Annual Symposium on Computer-Human Interaction in Play* (2016). DOI: http://dx.doi.org/10.1145/2967934.2968082

[20] David Walker. 2003. JMASM9 : Converting Kendall's Tau For Correlational Or Meta-Analytic Analyses. *Journal of Modern Applied Statistical Methods* 2, 2 (2003), 525–530. DOI: http://dx.doi.org/10.22237/jmasm/1067646360