A Comparison of System-Controlled and User-Controlled Personalization Approaches

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ABSTRACT

Personalizing interactive systems including games increases their effectiveness. This paper explores and compares two main approaches to personalization: *system-controlled* and *usercontrolled adaptation*. The results of large-scale exploratory studies of 1768 users show that both techniques to personalizing systems share seven common strengths of increasing users' perception of a system's *relevance, usefulness, interactivity, ease of use, credibility and trust,* and also increases users' *self-efficacy.* The results also reveal some unique strengths and weaknesses peculiar to each of the approaches that designers should take into consideration when deciding on a suitable adaptation technique to use in personalizing their systems. Users prefer system- over user-controlled adaptation.

CCS CONCEPTS

• Human-centered computing \rightarrow Personalization \rightarrow Human-computer Interaction \rightarrow HCI design and evaluation methods \rightarrow User models

KEYWORDS

User-control; system-control; personalization; tailoring; health; adaptation; persuasive technology; HCI; behaviour change

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1 INTRODUCTION

Personalizing interactive systems including games adapt the system's interface and/or functionalities to make them more appropriate for the target user(s). There is an increasing interest in how to personalize interactive systems to suit individuals of different capabilities and dispositions across several disciplines [1-3]. From the extant literature, *system-controlled adaptation* (also known as *personalization*) and *user-controlled adaption* (also known as *customization*) are the commonly employed approaches to system adaptation.

However, there is still a gap in knowledge regarding the mechanism through which each of these personalization approaches could influence interactive systems' (perceived) effectiveness. More specifically, as a research community, we do not have a good understanding of the comparative effectiveness of these approaches. There have been debates as to which of the personalization approaches is the best across several domains [4–6]. To fill this gap, we conducted two large-scale exploratory studies of 1108 and 660 (a total of 1768) participants to explore and compare the strengths and weaknesses of the two approaches to personalization in the context of interactive systems for motivating desirable health behaviours in various health domains represented in storyboards.

Our qualitative results show that both system- and usercontrolled approaches share seven common strengths. The results also reveal some unique strengths and weaknesses peculiar to each of the approaches that designers should take into consideration when deciding on the appropriate personalization approach. Some of these strengths are systemfocused such as *increased usefulness, ease of use, interactivity, and relevance,* while others are user-focused such as *increase selfefficacy* (with respect to their ability to use the system for the intended purposes), *trust, feeling of control,* and *freedom.* Finally, the participants preferred system- over user-controlled personalization. Our findings shed light on the mechanism through which both system- and user-controlled personalization approaches could affect the effectiveness of any systems.

2 RELATED WORK

In the two last decades, there has been an intense research activity in studying how to adapt interactive systems and games to increase their efficacy and the various dimensions for

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adaptation [7]. There are two main approaches to adaptation: *system-controlled adaptation* and *user-controlled adaptation*. System-controlled adaptation dynamically adjusts the system to better suit and support users. In contrast, user-controlled adaptation provides system customization mechanisms [1], but relies on the user to use those mechanisms to adapt the systems (as they desire) to suit their preferences [5]. The main difference between the two approaches is who is in control of the adaptation. In system-controlled, the system automatically adapts the interface and functionalities, whereas in user-control, the user is responsible.

Research has examined and compared the two approaches to adapting systems in various domains, including recommender systems [8], user interface menu [5], and educational systems [6]. The findings highlight the need to personalize systems; nevertheless, they also suggested a possibility of varying preferences for system- and user-controlled adaption approaches.

Existing studies on the two approaches to personalization are limited in two major ways: first, none of these studies has examined the mechanism through which personalizing systems using the two approaches may influence their effectiveness; and second, none of the studies has examined the effectiveness of the two approaches in the health domain. However, it is likely that the preference for one approach over the other is dependent on the application domain. This paper fills the gap by exploring and comparing the strengths and weaknesses of the two approaches to personalization in the context of persuasive games for motivating healthy behaviour change.

3 METHOD

For the purpose of this study, we focus on two common applications of Persuasive Games (PGs) for health to ensure uniformity and generalizability: PGs for encouraging healthy eating behaviour and PGs for motivating change of risky healthy behaviour (risky alcohol behaviour change).

To achieve this, we conducted two separate studies, the first focuses on PGs for motivating healthy eating behavior and the second focuses on PGs for motivating a change of risky alcohol behaviors. To collect data for our studies, we used prototype storyboard implementations illustrating system-controlled and user-controlled personalized persuasive systems that have been validated in other studies [1, 9]. Specifically, we represented each adaptation approach in a storyboard about persuasive games for encouraging healthy eating (study one) and persuasive systems for promoting change of risky alcohol behaviours (study two). The storyboards were drawn by an artist and were based on storyboard design guidelines by Truong et al. [10]. Implementing the system adaptation approaches in storyboards makes it easier to elicit responses from diverse populations because storyboards provide a common visual language that individuals from diverse backgrounds can read and understand [11]. In study one, the storyboards show a character and their interactions with PGs for motivating healthy eating behavior and in study two, the storyboards show a character and their interactions with PGs for promoting change of risky alcohol behavior personalized either

using the system- or user-controlled approach. We evaluated and iteratively refined the storyboards. Fig.1 shows an example of one of the storyboards illustrating the system-controlled personalization for PGs for motivating healthy eating behavior.

Table 1: Participants	' demographic	information
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Total Participants = 1,768			
Gender	Females (49%), Males (51%).		
Age	18-25 (32%), 26-35 (38%), 36-45 (18%), Over 45 (12%).		
Education	Less than high school (1%), High school (31%), College diploma (13%), Bachelor's degree (37%), Master's degree (15%), Doctorate degree (2%), Others (1%).		



Figure 1: Sample storyboard illustrating system-controlled personalization for motivating healthy eating behaviour



Figure 2: Sample storyboard illustrating user-controlled personalization in the context of alcohol drinking behavior

To elicit quantitative feedback on the effectiveness of the approaches, each storyboard was followed by a validated scale for assessing perceived persuasiveness. The scale was adapted from Orji et al. [1] and has been used in many studies [4, 9, 14]. Specifically, we asked participants the following questions:

"Imagine that you are using the system presented in the storyboard above to track your daily eating (or alcohol in study 2), on a scale of 1 to 7 (1-Strongly disagree to 7-Strongly agree), to what extent do you agree with the following statements: a) The system would influence me. b) The system would be convincing. c) The system would be personally relevant for me. d) The system would make me reconsider my eating (or alcohol drinking) habits."

To obtain qualitative feedback about the storyboards, each of the storyboards was followed with an open-ended question allowing participants to provide comments to describe the personalization approach represented in the system, how they would use the system, and to justify their ratings of each system's effectiveness in line with their strengths and weaknesses. We ensured that the participants understood the personalization approach depicted in each storyboard by asking them two comprehension questions – first, to identify the illustrated approach and second, to describe what is happening in the storyboard in their own words ("In your own words, please describe what is happening in this storyboard"). We also included questions for assessing the participants' demographic information, and eating and drinking behaviours.

We recruited participants from the Amazon's Mechanical Turk (AMT). A total of 1768 responses were included in our analysis (1108 and 660 responses from study one and two respectively), after filtering out incomplete responses and incorrect responses to comprehension and attention-determining questions. In the two studies, our participants were at least 18 years of age at the time of data collection, read and understood English well. In addition to this, for study two, participants were those who consumed or have ever consumed alcohol. The participants received a \$2 USD compensation in appreciation for their time. In general, we have a relatively diverse population in terms of gender, age, education level attained; see Table 1.

4 DATA ANALYSIS AND RESULT

To ensure that participants understood the strategy depicted in each of the storyboards, we ran chi-square tests on the participants' responses to the multiple-choice questions that required them to identify the personalization approach represented in each of the storyboards. The results for all the approaches were significant at p<.01, which indicates that the storyboards were understood by the participants and that the storyboards successfully depicted the intended personalization approach [1]. Secondly, we determined the consistency of the scale using Cronbach's alpha (α). The α for the two approaches was greater than 0.70, showing that the scales have good internal consistency. Next, to examine and compare the persuasiveness of the approaches, we conducted a paired-samples t-test. We also used notched boxplot to visualize the persuasiveness of the approaches.

4.1 Comparing the Persuasiveness of the Two Personalization Approaches

We conducted a paired-samples t-test to determine which of the personalization approaches our participants prefer. The results show that there is a significant difference between system-controlled and user-controlled personalization ($t_{1767} = 31.288$, p < 0.0001). On average, system-controlled personalization is 1.29 points higher (M = 4.83, SD = 1.71) than user-controlled personalization (M = 3.54, SD = 1.84). Hence, our participants prefer system- over user-controlled personalization.

Figure 2 shows the notch boxplots of the approaches. The notch represents the 95% confidence interval of the median. In general, our participants perceive both approaches as persuasive, with persuasiveness score significantly higher than the neutral median rating of 4 (p<.0001), indicated by the horizontal line in Figure 2.

4.2 Comparing the Strengths and Weaknesses of System-controlled and User-controlled Personalization Approaches

To tease out the strengths and weaknesses of the system- versus user-controlled personalization approaches, we conducted a thematic analysis [12, 13] of 163 pages of qualitative comments about the approaches from our participants. The comments were analysed in an iterative manner, identifying the central ideas within them and their relationship and classifying them into strengths and weaknesses until it seemed that no further ideas were emerging from them. The themes² reported in Table 2 are the major ones that transpire from the analysis.

Figure 2. A boxplot showing the overall persuasiveness (yaxis) of user-controlled (customization) and system-



controlled (personalization) on a scale ranging from 1 to 7. The horizontal line indicates a neutral rating of 4.

5 DISCUSSION AND LIMITATION

Tailoring and adapting systems to suit individuals of different capabilities and dispositions have been studied in Human-Computer Interaction (HCI). System-controlled and usercontrolled adaptations represent two different approaches to personalization. There have been debates within the HCI community as to which of the personalization approaches is better [4] across different domains. Our work shows that with respect to their overall effectiveness in the health domain, our participants perceive the two approaches as positive with persuasiveness score significantly higher than the median rating. However, comparatively, system-controlled personalization is preferred over user-controlled approach. A possible explanation for the preference can be found in the unique weaknesses of the user-controlled approach highlighted by our participants as shown in Table 3: (1) "Customization is difficult and time consuming to achieve" and (2) "Over customization could distract users and divert attention away from the main goals of the system".

² Quotes from participants are included verbatim throughout the paper, including spelling and grammatical mistakes.

Comments. "✓" Indicates Themes Belonging to Each Approach, "NA" Shows Themes that do not Apply to an Approach				
	Stı	rengths of the approaches with sample participants' comments	System-Controlled	User-controlled
			(personalization)	(customization)
	1.	It increases the perceived relevance and usefulness of a system:		
	-	"Customization is good to make the system relevant to me" [P25].		
	-	"The information is based on me, it's far more useful " [P61].		
	-	"Personalizing makes the system VERY useful and relevance " [P94].		
	-	"This system would be very useful and especially relevant to those of us who		
		are introverted, self-motivated" [P103].	1	1
	-	"I like when these sorts of systems offer advice and goals that are personalized		
		and therefore relevant to me " [P649].		
	2	It increases wears' confidence in their shility (calf office arr) to use the system		
	2.	to achieve the desired objective:		
	_	"It definitely helps to have a digital likeness when interacting with a self-		
		management software For example when I am able to create an avatar that		
		looks like me it helps to visualize the changes in the weight and increases		
		my confidence in my ability to use the system to manage my weight" [P758].		
	-	"I like this feature a lot. Assuming I'm already motivated, the personalized	✓	✓
		practicable information on the amount I could drink would be very helpful , and		
		increase my confidence that I could change my behavior" [P394].		
	-	"If I knew the feedback was given directly matching my physical		
		characteristics with a specific weight loss plan, I think it would be most		
		effective" [P1208].		
	3.	It increases system's credibility and users' trust in the system:		
	-	"Because I customized it, I have more confidence on its efficacy" [P255].		
	-	"Custom tailoring would make me believe that the recommendations were		
		more valid" [P15]. "If I knew it wasn't just a general suggestion, it would		
		make me trust the system and more willing to follow the program's advice"		
		[P213].	✓	✓
	-	"Personalization is favorable because it yields more accurate results " [P873].		
	-	"A personalized system would feel more realistic to me. I wouldn't feel as		
		though random advice is being thrown my way but more that the advice I		
		received would be directly beneficial to me ^{<i>m</i>} [P927]. "It feels safe because it's		
		tailored to me ^{<i>m</i>} [P193]. This is more trusting than having a random system		
		decide for you [P11]		
	-	A great way to convince me is to treat me as an individual [P7].		
	4.	"O standarting to the system:		
	-	Customization could help to make people leel more connected to the		
		system [P75]. I would reel closer to this system if it were personalized to fit		
	_	"The non-conscious bond a user develops through the emotional		
	-	investment in customization would probably boost the effects of a system		
		that is good in other ways" [P115] "Customization helps one identify with	✓	✓
		the system" [P29]		
	-	"This type of system since it was made just for me would be more		
		attractive and that would actually make me want to use it to lose weight"		
	-	"Like this approach. It is individualized and would help track eating, and		
		that inspires me to stick with plan " [P46]. "I really like this, it would keep		
		me interested" [P809]. "This would help to keep the user interested in the		
1		system. He may even develop a connection to it" [P1129].		
	-	"The application is more appealing when it is customizable" [P34].		
	5.	It increases the systems interactivity:		
1	-	"Personalizing the game to the player adds a more interactive feel to the		
1		game." [P2]. "It sounds interesting. It is quite interactive " [P926].	✓	✓
1	-	"I like this approach because it's more like having a virtual nutritionist."		
1		[P1526]		
	-	"It's engaging and interesting" [P59].		

Table 2: The Strengths of the System- Versus User-controlled Personalization Approaches with Sample Participants' Comments. "✓" Indicates Themes Belonging to Each Approach, "NA" Shows Themes that do not Apply to an Approach

(6.	It makes the user feel valued and important :		
	-	"Personalizing details about myself will make me feel like the system is all just about		
		me and for me only. It makes one feel valued and hence motivated" [P957].		
	-	"I feel this would yield successful results because it is personalized, therefore valuing	\checkmark	✓
		the user" [P910].		
	7.	It makes the system simple, user friendly and easy to use:		
	-	"Customization makes the app so easy to use " [P72].		
	-	"It makes the system very simple when the person built it to his personality" [P672].		
	-	"Customization makes application more user friendly" [P892].	✓	✓
	-	"The system would be easy to use because it's meant for me" [P601].		
1	8.	It gives sense of freedom and control :		
	-	"It gives me freedom and control ." [P29] "It's effective because it gives more		
		choices." [P849]. "Customization helps you idealize the system" [P1692].	NA	
	-	"I like how it is customizable because it makes the person think about how to adjust		✓
		it to meet their needs the most. This is more trusting than having a random		
		system decide for you" [P11].		
9	9.	It gives a sense of personal touch :		
	-	"It would be cool to have a personal touch to the system, so customization is a good		
		idea" [P18].		
•	-	"It would bring a more personal element to it and hence a personal experience "	NA	\checkmark
		[P94].		
	-	This system is more personal because I am able to control certain things within		
		the game more to my liking and suitability [P842].		
	10.	It reduces system complexity and makes the target behavioural outcome less		
		abstract:		
	-	The good thing is that it is less abstract (it tells you how much you can drink based	\checkmark	NA
		on your personal profile)" [P913].		
	-	"Personalization adds responsibility to the equation, prompting people to be more		
		truthful and work harder by adding some specifics to the behaviour" [P744].		
	-	"This system would be very influential and successful because it's less complex. It		
		tells you exactly what to do each day to improve your diet and exercise as a		
		person" [P597].		
-	-	"Knowing your goals and knowing they're not arbitrary , is a great influencer on		
		meeting those goals" [[P1702]		

Table 3: The Weaknesses of the System- versus User-controlled Personalization Approaches with Sample Participants' Comments. "✓" Indicates Themes Belonging to Each Approach, "NA" Shows Themes that do not Apply to an Approach

Weakn	esses of the approaches with sample participants' comments	System-controlled	User-controlled
		(personalization)	(customization)
1.	Personalization could be boring :		
-	"It's a great concept, pretty convincing, but could be boring if used alone" [P503].		
-	"It would be interesting to gain personally helpful information based on my body		
	parameters, but not as fun as some of the other strategies" [P1515].	\checkmark	NA
-	"Useful and relevant but not funny " [P298].	•	
-	"I tried a diet plan similar to this and without positive reinforcement it can		
	become boring" [P174].		
2.	Customization is difficult and time consuming to achieve:		
-	"I sometimes find customizing difficult to do or make just right for myself"		
	[P39].		
-	"I'm not very much into micromanaging, lots of work" [P615].		
-	"Customization is nice, but can take up time" [P927].	NA	1
-	"It would take way too long to customize." [P1196].		•
-	"I do not like to manipulate anything in life, it's complex" [P97].		
3.	Over customization could distract users and divert attention away from the		
	main goals of the system:		
-	"It's not a bad idea, but I feel that all the customizable features would take away	NA	✓ /
	or shift attention from the drinking habits aspect of the application." [P29]		

Our participants believed that it is difficult for users to customize the system by themselves to suit their own preferences as that may require a lot of work, reasonable technology skills, and may be time consuming. They also highlighted the tendency of user-controlled adaption to distract and divert users' attention away from the main task they wish to achieve with the system. Another possible explanation is that people often do not trust their own judgement and knowledge especially when it comes to making decisions about their health (behaviours) which is the main focus of these studies. Hence, they tend to prefer the system-controlled personalization and recommendations especially if they trust that the system is from a credible source.

Our qualitative results show that both system- and usercontrolled approaches share seven common strengths (as listed in Table 2) including their tendency to increase system's *relevance, usefulness, interactivity, ease of use, credibility and trust,* and also increase users' *self-efficacy* and *make them feel valued.* These strengths shed light on the mechanism through which various personalization approaches could positively impact the effectiveness of any interactive system employing them. On the other hand, the major difference between the user-controlled and the system-controlled personalization is the feeling of *control, freedom*, and *personal touch* that the user-controlled personalization imbues users with.

However, our results suggest that the need for users to control the personalization and feel some sense of freedom is more when they lack trust in the system as shown by the sample comment about user-control personalization: "...*This is more trusting than having a random system decide for you*" [P1129]. This suggests that, in order to make users accept system-controlled personalization and give up their need for freedom and control, the system needs to first gain users' trust and prove itself as credible, especially when it has to do with health.

The main limitation of this work is that the studies are based on storyboard implementations; the findings may differ when implemented in usable interactive systems and evaluated in realtime. Therefore, as part of our future work, we hope to compare the system-controlled and user-controlled adaption approaches in actual persuasive system and gamified persuasive system implementations.

6 CONCLUSION

In conclusion, we shed light on the mechanism through which both system- and user-controlled personalization can impact the effectiveness of interactive systems by revealing their strengths and weaknesses. Some of these strengths are system-focused such as *increase usefulness, ease of use, interactivity, and relevance*, while others are user-focused such as *increase selfefficacy, trust, feeling of control,* and *freedom.* More importantly, we show that system-controlled personalization is preferred over user-controlled personalization in the health domain. However, for the system-controlled personalization to be really effective, the system needs to be designed to gain users' trust and, hence, make them willingly give up their need for control, freedom, and feeling of personal touch. The distinguishing advantage of system- over user-controlled approach personalization that system-controlled is personalization reduces system complexity; however, user's may get bored and discouraged by the inability of the system to engage them and their lack of control. The major weaknesses of the user-controlled approach are that it is often difficult and time-consuming to effectively customize a system to suit users' preferences. Again, too many customizable features may distract attention from the main task that the user intends to perform using the system. A hybrid approach that employs some aspect of system-control to personalize complex features and some aspect of user-control to personalize less complex but more sensitive features (that are likely to threaten user's need for control) would likely overcome the weaknesses of both approaches and leverage their strengths.

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