Investigation of the Persuasiveness of Social Influence in Persuasive Technology and the Effect of Age and Gender

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Abstract. Research has shown that social influence is a strong motivator of behavior change. However, in persuasive technology research, limited studies exist showing the influence of age and gender on its effectiveness. To bridge this gap, we conducted a study among 323 participants on the level of susceptibility to four social influence strategies: Social Learning, Social Comparison, Competition and Reward. Our results reveal that 1) males and females vary in their level of susceptibility to Reward and Competition, with males being more susceptible than females; and 2) younger and older individuals vary also, with younger individuals being more susceptible to Competition, Social Comparison and Social Learning. Specifically, our results reveal that Competition, a powerful driver of intrinsic motivation, is most effective in bringing about behavior change in younger males, but least effective in older females. These findings provide designers with insight into effective ways of tailoring persuasive applications (using commonly applied gamification mechanics) based on age and gender.

Keywords: persuasive strategies, gamification, social influence, social comparison, social learning, reward, competition, intrinsic motivation.

1   Introduction

In recent years, persuasive applications, aimed at changing attitudes and behaviors, have become widespread, cutting across different domains, such as commerce and health [1]. However, most of the persuasive applications in the marketplace have been designed mainly based on general user requirements and designers' judgments and experiences [2]. In most cases, established behavior change theories and/or empirical evidence have not been used to inform their design, thereby making it difficult to evaluate persuasive technologies as to which persuasive strategy works or does not [3]. Whereas, research has shown that applications developed based on user models are likely to be more effective than those that are not [4]. Moreover, social influence has been found to be a powerful means to change human behaviors [5]. According to Cialdini and Trost [6], social influence "*can be employed to foster growth and move people away from*

negative habits and in more positive directions, thereby creating the conditions for new change opportunities" (p. 151).

However, in persuasive technology research, limited empirical evidence exists showing which social influence strategies users are likely to be more susceptible to and how demographic variables, such as age and gender, moderate their susceptibility. In this paper, as part of our ongoing research [7], aimed at investigating possible effective social influence strategies to motivate people to change their behavior in the physical activity domain, we carried out a study among 323 participants to uncover the most effective persuasive strategies participants are most susceptible to and the role gender and age play. We used Busch et al.'s [8] Persuadability Inventory, which include Reward, Competition, Social Learning and Social Comparison, to uncover how susceptible individuals are to social influence.

The results of our analysis reveal that all four social influence strategies are potentially effective in bringing about behavioral change using persuasive technology, as participants, irrespective of gender and age, rated them as persuasive, i.e., above the neutral score of 3.5. Overall, Reward is the most persuasive strategy, followed by Competition, while Social Learning and Social Comparison are the least persuasive. Moreover, with respect to gender, our results reveal that males are more motivated by Reward and Competition than females. Similarly, with respect to age, the results show that younger people are more motivated by Competition, Social Learning and Social Comparison than older people. More importantly, younger males are more motivated by Competition, while older females are least motivated by Competition. This suggests that while Competition may be a very effective strategy for younger males, it may be less effective for older females. This underscores the need for personalization of persuasive technologies based on age and gender. Consequently, these findings will help designers of persuasive technologies to design more effective persuasive applications by tailoring based on age and gender.

2   Background

In this section, we provide a brief overview of the four social influence strategies for which Busch et al. [8] developed measurement instruments, called Persuadability Inventory (PI). We also provide an overview of the socio-psychology theories on which these four strategies are based.

Reward. Reward is a persuasive strategy, which derives from the Incentive Theory of Motivation [9]. According to the theory, human behavior is primarily motivated by extrinsic factors, such as incentive, praise or reward [9, 10]. Reward is something which is offered to "*an individual as a result of the accomplishment of a specific task or the achievement of a target behavior*" [11]. In persuasive technology research, Reward is modeled as a construct for measuring how well Reward as a persuasive strategy can persuade people to perform a target behavior. In empirical research, it is operationalized as a set of questions. A typical question from the PI [8] is "*I put more ambition into*

something if I know I am going to be rewarded for it." In persuasive applications, Reward can be implemented as virtual points, badges, etc. [11].

Competition. Competition is a persuasive strategy, which derives from the Theory of Competition [12]. According to Mead [13], Competition is "*the act of seeking or endeavoring to gain what another is endeavoring to gain at the same time*" (p. 8). Unlike rivalry, it is oriented towards a primary goal, with other competitors for the goal being secondary [14]. In persuasive technology research, Competition is modeled as a construct for measuring how well it can be used as a persuasive strategy to motivate users intrinsically to perform the target behavior. In empirical research, it is operationalized as a set of questions. An example question from the PI [8] is "*It is important to me to be better than other people*" [11]. In persuasive applications, it can be implemented as a leaderboard on which users' performance are displayed [15] . The leaderboard allows users to know their relative position in the performance of the target behavior. Basically, it allows users to view and compare their performance of a target behavior with the performance of other users of the persuasive application [16].

Social Comparison. Social Comparison is a persuasive strategy, which has been adapted from the Social Comparison Theory postulated by Festinger [17]. The theory states that people compare their opinions and abilities with the opinions and abilities of others, with the intention of improving themselves [18]. According to Festinger [17], if people intend to improve themselves, they compare themselves with people who are superior to them. This type of interpersonal comparison is known as *upward comparison*. On the other hand, if they intend to enhance their self-esteem, they compare themselves with people who are inferior. This type of comparison is known as *downward comparison*. In persuasive technology empirical research, Social Comparison is modeled as a construct for measuring how well Social Comparison as a persuasive strategy can persuade people to perform a target behavior [11]. In empirical studies, it is operationalized as a set of questions, one of which, from the PI [8], is "*I like to compare myself with other people.*" Further, Social Comparison can be implemented in persuasive applications by providing users with the ability to view and compare their performance with that of others [19, 20], e.g., step count, distance walked or cycled, calories burnt, time spent exercising, etc.

Social Learning. Social Learning is a persuasive strategy, which is derived from the Social Learning Theory developed by Bandura [21]. The theory holds that the learning of an individual is a social cognitive process, which involves observing the behaviors of other people and their consequences. In persuasive technology research, Social Learning, also known as Social Proof or Consensus [12], is modeled as a construct for measuring how well Social Learning as a persuasive strategy can persuade people to engage in a target behavior [11]. It is operationalized as a set of questions in empirical research. A typical question from the PI [8] is "*I take other people as role models for new behaviors.*" In persuasive applications, it is implemented in a number of ways, e.g., informing users about the behaviors of other users of the application with the intention

of persuading them to act in a similar way. For example, the persuasive message "*People who bought item A also bought item B*" (as seen in Amazon's website) is intended to persuade online shoppers to purchase item B after purchasing item A [22].

3 Related Work

Though social influence is considered a powerful means to motivate beneficial behaviors in persuasive technology [5], limited research has been carried out on the responsiveness of individuals to social influence strategies. Busch et al. [8] carried out a study to develop measurement instruments (which they called Persuadability Inventory) for five social influence strategies, which they adapted from the Persuasive System Design (PSD) model proposed by Kaptein et al. [23]. Furthermore, Oyibo and Julita [11] carried out a study in which they investigated how four of the inventory's instruments (Reward, Competition, Social Learning and Social Comparison) influence one another in a path model analysis, with Competition as the target (predicted) construct. They found that the susceptibility of individuals to Reward and Social Comparison are good predictors of their persuadability by Competition. However, both groups of authors did not investigate the level of susceptibility of individuals to each of the five persuasive strategies. Moreover, in validating the instruments in Busch et al.'s [8] original study, over 95% of the items did not meet the internal consistency reliability requirement (i.e., Cronbach alpha >= 0.7). One possible reason for the poor reliability is the limited sample size (n = 167). Consequently, in our study, in addition to our main objective of determining the social influence strategies individuals are more susceptible to and the role gender and age play, we set out to validate the Persuadability Inventory by testing the internal consistency reliability of its scales using a larger sample size (n = 323), which approximately doubles Busch et al.'s [8] sample size (n = 167).

4 Method

In this section, we present our research hypotheses, the instruments used to measure the social influence constructs of interest and the demographics of participants.

4.1 Research Hypotheses

Research has shown that social influence can be leveraged as a persuasive strategy to effect behavior change that benefits both the individual and society. In this paper, we attempt to address the research questions: 1) "*Which of the social influence strategies in Busch et al.'s* [8] *Persuadability Inventory (PI) are individuals more susceptible to?*" 2) "*How do gender and age affect the effectiveness of these strategies?*" Based on the PI (adapted from the PSD model [12]) and existing theories and findings in the literature, we formulated the following eight hypotheses:

H1: Males are more persuadable by Competition than females.
H2: Males are more persuadable by Reward than females.
H3: Females are more persuadable by Social Comparison than males.
H4: Females are more persuadable by Social Learning than males.
H5: Younger people are more persuadable by Competition than older people.
H6: Younger people are more persuadable by Reward than older people.
H7: Younger people are more persuadable by Social Comparison than older people.
H8: Younger people are more persuadable by Social Learning than older people.

The first hypothesis (H1: *males are more persuadable by Competition than females*) was informed by the work of Niederle and Lise [24] on gender difference in competitiveness. They found that males were more competitive than females. Thus, we hypothesize that males will be more susceptible to Competition as a social influence strategy than females. The second hypothesis (H2: *males are more persuadable by Reward than females*) is informed by the work of Li et al. [25], which was based on the Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ). They found that males were more sensitive to Reward than females. Thus, we hypothesize that males will be more responsive to Reward as a persuasive strategy than females. The third hypothesis (H3: *females are more persuadable by Social Comparison than males*) is informed by the notion that males focus on their personal uniqueness and hardly define themselves in the context of relationships [26]. Thus, they are viewed by society as more independent. However, females tend to define themselves in the context of their interpersonal relationships. Thus, they are viewed by society as more interdependent [26]. Moreover, in a study on body comparison tendencies, Franzoi et al. [27] found that women were more likely to compare their face and bodies to similar others' than men. Based on these findings, we hypothesize that females will be more susceptible to Social Comparison than males. Furthermore, the fourth hypothesis (H4: *females are more persuadable by Social Learning than males*) is informed by Orji et al.'s [28] work on Cialdini's principles of persuasion. Specifically, they found that females are more persuadable by Consensus (i.e., Social Learning) than males.

With respect to age, the fifth hypothesis (H5: *younger people are more persuadable by Competition than older people*) is based on Yee's [29] study on the effect of age on competition. He found that the appeal of competition to gamers drops with age. Consequently, we hypothesize that younger adult will be more persuadable by Competition than younger adults. The sixth hypothesis (H6: *younger people are more persuadable by Reward than older people*) is based on Sproten and Schwieren [30] study on age difference in the reaction to incentives. They found that social incentives motivate men to improve their performance more than women. Based on this finding, we hypothesize that younger adults will be more persuadable by Reward than older adults. The seventh hypothesis (H7: *younger people are more persuadable by Social Comparison than older people*) is based on Callan et al.'s [3] study on the individual tendency to engage in social comparison. They found that older adults are less likely to engage in social comparison than younger adults. Based on this finding, we hypothesize that younger adults will be more persuadable by Social comparison than older adults. Finally, the eight hypothesis (H8: *younger people are more persuadable by Social Learning than older people*) is based on prior research findings on the influence of peer pressure on adolescents. As cited by Steinberg and Monahan [31], adolescents tend to alter their behaviors because they want to fit in: they care more about what their friends think of them and, as a result, prefer to go along with the crowd in order to avoid being rejected. Based on this finding, we hypothesize that younger individuals will be more persuadable by Social Learning than older individuals.

4.2 Measurement Instruments

We used four of the five validated scales in Busch et al.'s [8] PI to measure the constructs of interest: Reward (6 items), Social Comparison (6 items), Social Learning (5) and Competition (5 items). We dropped the fifth construct in the PI (Trustworthiness) because it has limited (three) validated items, which might likely affect its content validity and reliability. Each of the four constructs comprises a nine-point Likert scale, ranging from "Completely Disagree (1)" to "Completely Agree (9)". In order to prevent participants from knowing which specific construct was being measured at any given time in the online survey, we selected approximately equal number of items from all four scales, combined and randomized them in each webpage of the survey.

4.3 Participants

Our study was approved by the University of Saskatchewan Research Ethics Board. Respondents were invited to participate in the online survey via email, the university's website, Facebook and Amazon Mechanical Turk (AMT). The AMT participants were compensated with $0.8 each, while the others were given a chance to win a C$50 gift card. A total of 323 subjects completed the survey. Among them, 42.1% were males, 56.0% were females. Age-wise, 39.9% were between 18 and 24, 42.7% were between 25 and 34, and 17.3% were above 34. Education-wise, 28.2% had high school education, 40.6% had bachelor degrees and 19.8% had postgraduate degrees. Lastly, 61.0% were from North America, 21.4% were from Africa and 9.3% were from Asia.

Table 1. Demographics of participants

N = 323	
Gender	Male (42.1%) Female(56.0%); Unknown (1.9%)
Age	18-24 (39.9%); 25-34 (42.7%); > 34 (17.3%)
Education	Technical/Trade School (8.7%); High School (28.2%); Bachelor Degree (40.6%); Postgraduate Degree (19.8%); Others (2.7%)
Continent	North America (61.0%); Africa (21.4%); Asia (9.3%); Others (8.4%)

5 Results

In this section, we present the construct reliability test, the aggregated means of each construct and our between-group and within-group parametric analyses.

5.1 Reliability of Measures

Using the *scaleReliability* function in the *userfriendlyscience* package in R, we carried out the internal consistency reliability test for the four social influence constructs based on McDonald's omega (ω) and Cronbach's alpha (α) coefficients. However, given that our data did not meet the normal-distribution criterion, the former metric is considered

appropriate as a measure of the reliability of the constructs [32]. As shown in Table 2, based on both metrics, our data met the reliability requirement of $\omega >= 0.7$ [33].

Table 2. Internal consistency reliability for the social influence constructs

Construct	McDonald's Coefficient		Cronbach's Coefficient	
	Omega (ω)	Confidence Interval	Alpha (α)	Confidence Interval
Competition	0.76	[0.71, 0.80]	0.75	[0.71, 0.79]
Reward	0.82	[0.79, 0.85]	0.82	[0.72, 0.85]
Social Comparison	0.79	[0.75, 0.82]	0.78	[0.75, 0.82]
Social Learning	0.83	[0.80, 0.86]	0.82	[0.79, 0.85]

5.2   Mean Ratings of Strategies

Fig. 1 shows the overall (aggregated) mean score of each strategy, with error bars represent 95% confidence interval. Overall, all of the four social influence strategies were perceived as persuasive as the respective scores are above the neutral score of 3.5. Moreover, participants perceived Reward as the most persuasive socially influential strategy, followed by Competition. However, Social Learning and Social Comparison were perceived as least persuasive. Our non-parametric pairwise comparisons using Nemenyi post-hoc test shows that each pair of the strategies significantly differs at $p < 0.0001$, except for the Social Comparison/Social Learning pair, which p-value = 0.06.
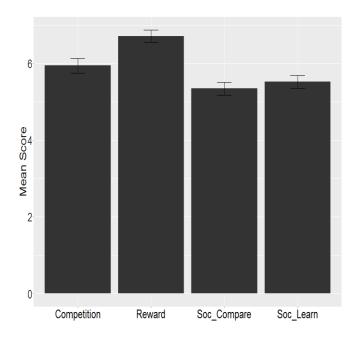

Fig. 1. Overall aggregated mean scores of social influence strategies

5.3   Between Group Analysis and Interaction Effect

We carried out between-group analysis based on gender and age. Specifically, based on age, we split the data into two categories: younger participants (18-24 years old) and older participants (above 24 years old). We used the age 24 for the split because it resulted in the best almost-equal halves, with the younger and older groups comprising approximately 40% and 60% of the participants respectively. Fig. 2 shows the plot of the mean scores based on gender and age. Based on gender, we found some differences between males and females with respect to Competition and Reward. Similarly, based on age, we found some differences between the two groups with respect to Competition, Social Comparison and Social Learning. To investigate whether these differences were statistically significant, we carried out non-parametric between-group analysis (Kruskal-Wallis rank sum test) as shown in Table 2. The result reveals that 1) based on gender, males perceived Competition and Reward more persuasive than females; and 2) based on age, younger participants perceived Competition, Social Comparison and Social Learning more persuasive than older participants. Lastly, we carried out an interaction effect analysis. The result shows no interaction effect between age and gender.
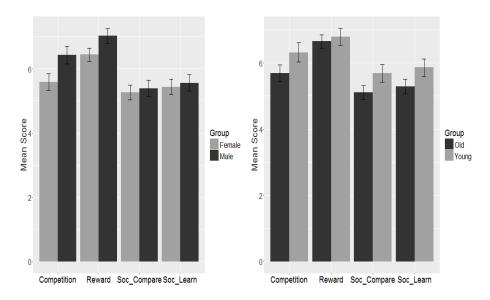

Fig. 2. Aggregated mean scores of social influence strategies based on gender and age

Table 2. Mean scores of social influence strategies and group difference significance test (the bold values indicate significant difference between two groups)

Construct	Overall	Male	Female	Sig.	Young	Old	Sig.
Competition	5.94	**6.43**	**5.59**	**0.001**	**6.32**	**5.69**	**0.01**
Reward	6.71	**7.03**	**6.44**	**0.001**	6.79	6.65	n.s
Social Compare	5.34	5.39	5.27	n.s	**5.69**	**5.11**	**0.01**
Social Learning	5.52	5.56	5.44	n.s	**5.86**	**5.29**	**0.001**

Table 3. Summary of supported and unsupported hypotheses

No.	Description of Hypothesis	Supported
H1	Males are more persuadable by Competition than females	✓
H2	Males are more persuadable by Reward than females	✓
H3	Females are more persuadable by Social Comparison than males.	X
H4	Females are more persuadable by Social Learning than males.	X
H5	Younger people are more persuadable by Competition than older people.	✓
H6	Younger people are more persuadable by Reward than older people.	X
H7	Younger people are more persuadable by Social Comparison than older people.	✓
H8	Younger people are more persuadable by Social Learning than older people.	✓

6   Discussion

The paper presents the results from investigating the gender and age differences in the persuasiveness of four social influence strategies (Competition, Reward, Social Comparison, and Social Learning) that have been widely employed in the design of persuasive technological interventions. In addition, we investigated the overall and the comparative persuasiveness of the strategies. As a secondary objective, we investigated the internal consistency reliability of the operationalized constructs. Our reliability test reveals that all of the four social influence constructs we investigated are reliable, thereby providing evidence of stronger reliability than Busch et al. [8] was able to achieve in their original study on the development of the measurement instruments for the constructs, perhaps, due to a relatively small sample size.

6.1   Overall and Comparative Persuasiveness

Our results show that participants perceive all the four strategies as persuasive as the average rating of each strategy is higher than the neutral rating of 3.5. Comparatively, Reward emerged as the most persuasive overall, followed by competition. This implies that in a one-size-fits-all design approach, designers should choose the Reward and Competition strategies over the Social Comparison and Social Learning to increase the efficacy of their persuasive systems. The results also suggest that although Reward has been a controversial strategy because of its tendency to redirect the intention of behavior from intrinsic to extrinsic [20], it appeals to many people. This is probably because Reward has the tendency to provide an immediate reinforcement and present users something to work for since it is often difficult to visualize the short-term benefit of most behavior. These findings are in line with existing literature, Reward and Competition are among the most frequently and widely employed strategies in persuasive and gamified system design [34].

6.2   Tailoring Persuasive Technology Based on Gender

Our results show that males are more responsive to the Reward and Competition strategies than females. This result is in line with Orji et al. [35] and Busch et al. [36] who found that males are more responsive to the Competition strategy than females in the context of healthy eating and physical activity respectively. One explanation for this finding is that males who are often more confident and domineering than females are more inclined to the competition because it provides an opportunity for them to overpower or outperform others and show their superiority. Males are even more motivated when they are rewarded as a way of confirming their superiority and ingenuity than females. The findings imply that males can be more easily persuaded using Reward and Competition strategies. Thus, applications tailored for males should employ the Reward and Competition strategy (above the comparison and social learning) to motivate behavior change. On the other hand, females are more motivated by Social comparison and Social Learning (although the difference is not significant). Again, this is not surprising considering that females tend to be more interdependent and influenced by group opinions than males. This finding contradicts that of Busch et al. [36], who found that males are more responsive to the comparison strategy than females in the context of persuasive technology for motivating physical activity. One possible explanation for this difference is that individual's susceptibility to a persuasive strategy may be context-dependent [4]. A persuasive strategy that works well in one domain may fail in another domain. Busch et al. [36] focused on physical activity while the current study investigated persuasiveness in a more general context. The results suggest that the persuasiveness of some strategies such as Social Comparison may be domain-dependent; hence, more research is needed to establish this.

6.3   Tailoring Persuasive Technology Based on Age

Our findings show that younger individuals are more responsive to all of the four social influence strategies (Competition, Reward, Social Comparison, and Social Learning) than older individuals, though there was no statistically significant difference between both groups with respect to Reward. This is in line with Orji et al. [28] who found that younger adults are more persuadable than older adults. This suggests that younger people are more likely to evaluate persuasive appeals via the peripheral route (without thoughtfully considering the arguments) compared to the older individuals. The implication is that an emotional persuasive approach may work better for younger adults than older adults [28]. Most social influence persuasive strategies motivate by appealing to an individual's emotional thinking rather than logical thinking; therefore, they are more appropriate for motivating younger people. Hence, further research is needed to identify older-adult-oriented strategies that can persuade via the central route and appeal to an individual's sense of reasoning.

7   Conclusion

This paper presents the results of an empirical study among 323 participants, which investigated gender and age differences in the persuasiveness of four social influence strategies: Competition, Reward, Social Comparison, and Social Learning. The results from the data analysis reveal that, in general, participants perceived all of the four strategies as persuasive, as they were rated above the neutral value of 3.5. This implies that each of the strategies has the potential of motivating behavioral change when implemented in persuasive applications. Overall, regardless of gender and age, Reward, followed by Competition, emerged as the most persuasive strategies, while Social Comparison and Social Learning emerged as the least persuasive strategies. Moreover, with respect to gender, we found that males are more motivated by Reward and Competition than females. Similarly, with respect to age, we found that younger people are more motivated by Competition, Social Learning, and Social Comparison. Specifically, younger males are more motivated by Competition, while older females are least motivated by Competition. This indicates that while Competition may be a very effective strategy for younger males, it is less effective for older females, thereby highlighting the need to tailor persuasive strategies to increase their effectiveness. In conclusion, in order to increase the effectiveness of persuasive technology, our findings can guide designers in deciding the best strategies to employ when designing persuasive applications for various user groups based on age and gender.

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