The Influence of Cognitive Ability on the Susceptibility to Persuasive Strategies

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Abstract. The realization that individuals may differ in their susceptibility to various persuasive strategies has motivated a shift of Persuasive Technology (PT) design from the traditional one-size-fits-all approach to a personalized approach that adapts to individuals' preferences. In Persuasive Educational Technologies (PETs) design, learners' cognitive level is an important dimension for personalization given that it can affect learners' response to and processing of various instructional contents. However, the relationship between students' cognitive level and their level of susceptibility to persuasive strategies has not been explored quantitatively in the extant literature. As a result, we conducted an empirical study among 117 participants to investigate whether learners' cognitive ability is an important trait to be considered in learner's PETs design. Specifically, we assessed participants' levels of Intelligent Quotient (IQ) and their responsiveness to three commonly used persuasive strategies in PT design: Social Comparison, Reward and Trustworthiness. Our results show that: (1) people with high cognitive level are more susceptible to Social Learning than people with low cognitive level; (2) people with low cognitive level are more susceptible to Trustworthiness than people with high cognitive level. Our results also show that there is no significant difference between people with high cognitive level and those with low cognitive level in their susceptibility to Reward strategy. Our findings provide insight into possible effective persuasive strategies which designers can employ to personalize PTs to individual users based on their cognitive level.

Keywords: Personalized Persuasive Technologies, Cognitive ability, Persuasive Strategies, Reward, Social Learning, Trustworthiness, Education.

1 Introduction

Today, nearly every individual interacts daily with a technological device [1]. Studies show that what we do and how we interact with technological devices influence our lives in various ways [2]. In recent years, persuasive technology (PT) has been—and continues to be—used to deliberately change behaviors in various domains of human

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endeavors such as health, education, commerce, etc. PT is an interactive application that is designed primarily to bring about desirable changes by reinforcing behavior, attitude, and thoughts about an issue, action, or object without using deception or coercion [3]. Generally, PT uses a one-size-fits all approach to change behaviors. However, research has shown that individuals may differ in their responsiveness to various PT strategies. This realization has motivated a shift of PT design from the traditional one-size-fits-all approach to a personalized approach that adapts to the preferences of individuals. Specifically, the main problem with the traditional blanket approach is that it treats all users as the same. It assumes that a persuasive strategy that works for one user will work for another. In the contrary, a persuasive strategy that motivates one type of person to change his or her behavior may deter another [4]. As a result, the personalized approach that adapts persuasive strategies to user types is being advocated in PT interventions [5] [6].

In the education domain, research has shown that learners have different comprehension abilities and learn at different paces [7]. Teaching methods over the years have evolved to accommodate these different learner types. However, in PET research, there is a lack of knowledge on how cognitive level influences the responsiveness of individuals to various persuasive strategies the context of learning. To bridge this gap, we investigated how cognitive level influences the susceptibility of individuals to three persuasive strategies (Reward, Social Learning and Trustworthiness) using Nigeria as a case study. The results of our study show that learners with high cognitive level (HCL) and learners with low cognitive level (LCL) significantly differ in their susceptibility to Social Learning and Trustworthiness but do not differ with respect to Reward. Specifically, our results show that: (1) HCL learners are more susceptible to Social Learning than LCL learners; and (2) LCL learners are more susceptible to Trustworthiness than HCL learners. These findings will help designers in future interventions to tailor PETs to these two groups of learners to make them more effective.

2 Background

In this section, we present an overview of persuasive strategies, personalization and cognitive ability.

2.1 Persuasive Strategies

The concept of PT is based on the idea that through technology the behavior or attitude of people can be changed using various persuasive strategies. These persuasive strategies are based on the persuasive theories of social influence in the field of psychology. In general, Cialdini [5] proposed six persuasive strategies, which are recognized as universal principles of persuasion and are mainly applied in the field of marketing and advertising. They include Reciprocity, Scarcity, Authority, Commitment and Consistency, Liking, and Consensus. In PT research, Fogg [2] proposed seven persuasive strategies for changing behaviors: Reduction, Tunneling, Tailoring, Suggestion, Self-Monitoring, Surveillance and Conditioning. Oinas-Kukkonen and Harjumaa [8] extended the Fogg's set of seven persuasive strategies to 28 strategies, which are categorized into three categories: Primary Task Support (e.g., Reduction,

Personalization, Simulation, etc.), Dialogue Support (Praise, Reward, Reminders, etc.), System Credibility Support (e.g., Trustworthiness, Expertise, Surface Credibility, etc.) and Social Support (e.g., Social Learning, Social Comparison, Cooperation, etc.). Other persuasive strategies proposed in the literature include the over 400 strategies described by Rhoads et al. [9] and 69 persuasive strategies by Kellerman and Cole [10]. For this study, in particular, we used three of the 28 persuasive strategies proposed by Oinas-Kukkonen and Harjumaa [8]. They include Reward, Social Learning and Trustworthiness. We chose these three PT strategies because we believe that these strategies are relevant in the context of learning. For example, one of the learning outcomes, which may motivate students to learn and work hard, include reward, which can be in the form of grades, social recognition or monetary prizes (Reward). Moreover, we believe that learning from others, such as peers, is an integral part of the learning process (Social Learning). Finally, we believe that learners will only use persuasive systems to learn if and only if they have trust in them and the content they offer. Moreover, we chose these three persuasive strategies because we believe the items used to measure them will be easily understood by our respondents, which will foster a reliable interpretation of their responses.

Reward. Reward is a persuasive strategy that involves offering incentives to individuals as they make progress towards performing the desired behavior [8]. Generally, humans find it motivating when they receive incentives for their performance. The Reward strategy is mostly implemented in gamified systems, where users' status, badges, points, and ranks are increased as players advance in behavior related tasks.

Social Learning. Social learning is a persuasive strategy that involves informing people about the behaviors of others with the intention of making them behave in a similar way [5]. It is derived from the Social Learning theory [11], which holds that "learning is a cognitive process in which people learn by observing the behaviors of others and their consequences in a social context" (p. 281) [12]. In persuasive systems, the Social Learning strategy can be implemented in various ways. For example, in PETs [5], sharing scores, decisions or methods used by some users to solve problems may inspire other users to perform better.

Trustworthiness. Trustworthiness is a persuasive strategy that involves providing a way to make the individual trust the mechanisms implemented in a persuasive system to achieve behavior change [5]. The persuasive system needs to be relied on as honest and truthful for it to achieve a desired behavior change.

2.2 Personalizing Persuasive Technologies

According to Cialdini et al. [5] and Orji et al [13], adapting persuasive applications to the personal preferences, ability and style of the user increases their effectiveness. Kaptein [6] identified two key personalization methods: *explicit* and *implicit* profiling. Explicit profiling is a meta-judgmental measure of the responsiveness of individuals to certain persuasive strategies. It is based on the standardized questionnaire scores of users. Usually, in user studies, individuals are asked to report, subjectively, judgments about their preferences and behaviors prior to using the actual persuasive system. On the other hand, implicit profiling is an operative measure of the traits of the user. It is

based on the actual user-system interactions and user responses to persuasive attempts, which are used to personalize future interactions through adaptation. This operative measure is directly linked to the cognitive processes that underlie persuasive responses. The influence principles are adapted as the user interacts with the persuasive system [6].

Over the years, with respect to explicit profiling, several measurement scales have been developed to elicit individuals' susceptibility to distinct persuasive strategies before they can be implemented in an actual persuasive system. Among the widely used scales is the Susceptibility to Persuasive Strategies (STPS) developed by Kaptein et al. [14] to measure individuals' susceptibility to Cialdini's persuasive strategies. Another scale is the Persuadability Inventory (PI) developed by Busch et al. [15] to measure individuals' susceptibility to five social influence strategies. Aside from these scales, other researchers have developed their own measurement scales to suit their studies, for example, in a certain domain. Through these scales, these researchers are able to investigate the susceptibility of their potential users to various persuasive strategies before implementing them in an actual persuasive system. This explicit approach allows persuasive system designers tailor persuasive strategies to user types.

2.3 Cognitive Ability

Michelson [16] defines Cognitive ability as the brain-based skills we need to carry out any task from the simplest to the most complex. Studies have shown that cognitive skills appear to promote or constrain learning [16]. We discuss four broad cognitive abilities in this subsection.

Short-Term Memory. Short-term memory skill is the ability to recall knowledge from memory without necessarily understanding what it means [17]. Examples include reciting facts or list of previously learned information such as terminologies, dates or events. There are mental actions that relate to short-term memory, e.g., naming, repeating, stating, outlining, etc.

Verbal Comprehension. Verbal Comprehension refers to the learner's ability to understand, analyze and interpret written information [17]. It involves using knowledge acquired through experience. It is measured with a test of vocabulary, comprehension and general information. To demonstrate an understanding of facts and ideas, one must be able to organize, translate, interpret and state the main ideas.

Quantitative Reasoning. Quantitative Reasoning skill is the ability to use numerical skills to solve problems [17]. Quantitative Reasoning is often assumed to be synonymous with mathematics; however, there is a difference. While mathematics is a discipline, quantitative reasoning is a skill [16]. According to [18], Quantitative Reasoning is "the application of basic mathematics skills, to the analysis and interpretation of real-world quantitative information in the context of a discipline or an interdisciplinary problem to draw conclusions that are relevant to students in their daily lives."

Fluid Reasoning. Fluid reasoning is the ability to solve novel problems independent of knowledge from the past [19]. Mental actions related to this function are developing, restructuring, demonstrating, implementing, solving and employing.

3 Related Works

Research into tailoring PTs to user types and preferences is receiving greater attention in PT research. So far, a substantial amount of work has been done in in the context of explicit profiling based on groups. Orji et al. [20] explored how users' responsiveness to Authority, Reciprocity, Scarcity, Consensus and Liking strategies varied based on gender and age group and found that females are more responsive to most of the strategies than males overall and some strategies are more suitable for persuading one gender than the other. Similarly, Oyibo et al. [21] [22] carried out a study with respect to users' susceptibilities to four PT strategies in the PI: Reward, Social Learning, Social Comparison and Competition. They found that individuals are most susceptible to Reward, followed by Competition. More specifically, they found that males are more susceptible to both strategies than females [21], while younger people, irrespective of culture, are more susceptible to Competition than older people [22]. Similarly, Orji [23] investigated the susceptibility of individuals to ten commonly used PT strategies, which include Reward and Social Comparison. The author found that, irrespective of gender, individuals are susceptible to Reward, including Social Comparison and other investigated strategies. Moreover, Oyibo et al. [12, 24] investigated the interrelationships among four PT strategies in the PI. They found that, irrespective of gender and culture, Reward, followed by Social Comparison, has the strongest influence on Competition. They also found a significant relationship between Reward and Social Comparison and between Social Comparison and Social Learning. Finally, a number of studies have investigated the relationship between personality traits and persuasive strategies. Orji at al.[13] found that individuals that are low in Openness, high in Extraversion or Agreement are more susceptible to Reward. Moreover, Oyibo et al. [25] as well as Alkış and Temizel [26] found that individuals that are low in Openness are more susceptible to Consensus (Social Learning). However, the effect of cognition on the susceptibility of individuals to persuasive strategies has been scarcely investigated in the extant literature. Our paper intends to bridge this gap.

4 Method

In this section, we present the research instruments used to measure the participants' cognitive level and persuasive strategies. Also presented is the demographics of participants.

4.1 Research Objective

This study aims to investigate the relationship between cognitive level and individuals' susceptibility to three persuasive strategies (Reward, Social Learning and Trustworthiness) from the PI [15] using an exploratory approach. We adopted the exploratory approach because of the paucity of research in this area in the extant literature.

4.2 Measurement Instruments

We used existing validated instruments to measure individual's level of cognition and susceptibility to persuasive strategies. Cognitive ability was measured using the Wechsler Abbreviated Scale Intelligence-II (WASI-II) [8]. WASI-II is a reliable measure of cognitive ability for educational and research setting. There are four sub-

scale tests on WASI-II: Bloch Design (BD), Vocabulary (VI), Matrix Reasoning (MR) and Similarities (SI). The VI and SI subtest scores are combined to give the broad Verbal Comprehension Index (VCI) score and the BD and MR subtest score are combined to form the Perceptual Reasoning Index (PRI) score. A Full-Scale IQ (FSIQ) score is computed as a combined performance of the VCI and PRI. The FSIQ score is used to summarize the general intellectual abilities of participants. The FSIQ has a standard score with a mean of 100 and standard deviation of 15. For example, a participant who obtained a FSIQ score between 90 and 109 falls into the average range.

To measure the participants' susceptibility to Reward, Social Learning and Trustworthiness strategies, we used the respective scales in the PI [15]. As shown in Table 1, 6 items were used to measure Reward, 5 items to measure Social Learning and 3 items to measure Trustworthiness. Each item in each construct was measured using a Likert scale ranging from "1 = Strongly Disagree" to "9 = Strongly Agree."

Table 1. Study's measurement instruments [15].

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Strategy	Measurement Instrument's Items
Social Learning	1. I often modify myself to other people.
	2. I ask for advice from other people, before I make a decision.
	3. I adopt my behavior quick to the model of other people.
	4. I adapt my behavior to other people around me.
	5. I take other people as role models for new behaviors.
Reward	1. It is important to me that my actions are rewarded.
	2. It is important for me to see my success before me.
	3. I put more ambition into something, if I know I am going to
	be rewarded for it.
	4. I do more work, when I know that I will get something for it
	(something materialistic).
	5. I am willing to change myself if I get rewarded.
	6. Rewards motivate me.
Trustworthiness	1. I think carefully about if I trust a system before I use it.
	2. I trust information better where the source is specified.
	3.It is important for me to be precisely informed about things
	that I need to do, before I do them

4.3 Participants

The study focuses on participants studying in Northern Nigerian universities (our case study). A total of 365 participants from different levels, faculties and programs took part in the study. However, only 117 met the condition of inclusion (see Section 4.4). Table 2 shows the demographics of participants, which cut across people studying different courses (e.g., Mathematics, Economics, Criminology, Forestry and Wildlife Management, etc.) as shown in Table 2.

CriterionBreakdownAge16-25 (47%), 26-35 (23%), 36-45 21(%), 46+ (9%)GenderMale (94), Female (23)Computer Science (18%), Mathematics (12%), Physics (14%),CourseBiotechnology (16%) Criminology (10%), Economics (9%),of StudyForestry and Wildlife Management (10%), Environmental
Management and Toxicology (11%)GroupsHCL group (32), LCL group (85)

Table 2. Demographic of participants (n = 117).

Note: HCL = High Cognitive Level and LCL = Low Cognitive Level

4.4 Data Analysis

In our study, we used participants' FSIQ scores for our analysis. The FSIQ is considered the most representative estimate of global intellectual functioning. A FSIQ score is computed as a combined performance of the four subtests. A wide range of FSIQ score is observed from the test. The mean is 102.17 and the standard deviation is 15. The mean score and standard deviation of our data are similar to the WASI-II standardized IQ scores. Table 3 shows the descriptive statistics and percentile rank of participants' FSIQ scores. For this study, because we aimed at two groups of individuals with a considerable cognitive level difference, we selected and considered participants with FSIQ scores from the 91st percentile above as learners with high cognitive level. On the other hand, we considered participants with FSIQ scores from the 23rd percentile below as learners with low cognitive level. We performed Analysis of Variance (ANOVA) test on the two groups of learners (HCL and LCL) with respect to their susceptibility to Reward, Social Learning and Trustworthiness.

Full Scale IQ Classification Percentile 98 - 99.5130 and above Very gifted 91 - 97120-129 Gifted 110-119 75 - 90High Average 90-109 Average 25 - 7380-89 Below Average 9 - 2370-79 Border Line 2 - 869 and below Intellectually Poor 0.01 - 2

Table 3. Full-Scale IQ and percentile rank.

4.5 Validity of Measurement Instrument

We performed Principal Component Analysis (PCA) to validate the reliability of our study's instruments. The scatterplot showed linearity between all variables, the Measure of Sampling Adequacy (MSA) for the overall data set is as follows: KMO = 0.691, the Bartlett's test for sphericity was significant at (χ 2) = 1225.563, the degree of freedom (df) equaling [p x (p-1) / 2] and p < 0.001. The WASI-II is a well-established scale with high consistency with a test-reliability between 0.70 and 0.90 and inter-scorer coefficient 0.90.

5 Result

In this section, we present the participants' average performance with respect to the persuasive strategies, the results of our Repeated-Measure ANOVA and how both groups of learners are similar and different.

5.1 Average Ratings of Persuasive Strategies

We computed the average scores of each persuasive strategy for the two groups. Fig. 1 shows the plot of both groups' average scores for Reward, Social Learning and Trustworthiness. The plot shows that both groups are not susceptible to Reward, as the average score is less than the neutral score of 4.5. However, the HCL group is susceptible to Social Learning, while the LCL group is not susceptible. Finally, the LCL group is susceptible to Trustworthiness, while the HCL group is not susceptible. Finally, to determine whether the differences between the two groups are statistically significant, we conducted a Repeated-Measure ANOVA.

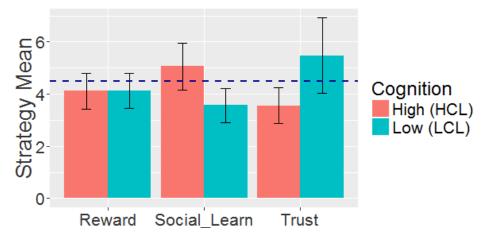


Fig. 1. Susceptibility of high and low cognitive learners to all three persuasive strategies

5.2 Between Group Analysis

To determine how the two groups (LCL and HCL) are different with respect their susceptibility to the persuasive strategies (Reward, Social Learning and Trustworthiness), we carried out an ANOVA. The results are presented as follows:

- 1. There is a significant difference between the HCL group and the LCL group in their susceptibility to Social Learning [F (1, 115) = 15.67, p < 0.001]. HCL learners (M = 5.06, SD = 0.90) are more susceptible to Social Learning strategy than LCL learners (M = 3.57, SD = 0.66).
- 2. There is a significant difference between the HCL group and the LCL group in their susceptibility to Trustworthiness [F (1, 115) = 11.70, p < 0.001]. LCL learners (M = 5.47, SD = 1.45) are more susceptible to Trustworthiness strategy than LCL learners (M = 3.56, SD = 0.69).

3. There is no significant difference between the HCL group and the LCL group in their susceptibility to Reward [F (1, 115) = 5.34, p = 0.061]. This is evident in their respective average scores: HCL group (M = 4.11, SD = 0.68) and LCL group (M = 4.12, SD = 0.67).

6 Discussion

We have presented the result of our investigation of the relationship between learners' cognitive level and their susceptibility to three persuasive strategies which we adopted from the PI. Our result shows a significant difference between HCL learners and LCL learners in their susceptibility to two of the persuasive strategies: Social Learning and Trustworthiness.

First, our findings reveal that learners with low cognitive level are more susceptible to Trustworthiness strategy than learners with high cognitive level. In the Persuasive System Design (PSD) model [8], the Trustworthiness strategy falls under the system credibility support category, which holds that credible systems will be more persuasive than less credible systems. Specifically, the Trustworthiness strategy entails the provision of information that is truthful, fair and unbiased by a persuasive system. Research has shown that a trustworthy system is more likely to be persuasive than a less trustworthy system. In our exploratory analysis, we found that LCL learners are more likely to be persuaded by systems they perceived trustworthy than HCL learners. More specifically, we found that the trustworthiness of a system may not be as important in determining its persuasiveness for HCL learners and hence may not be able to persuade them to take a certain course of action. One possible explanation why LCL learners are more influenced by trustworthy systems than HCL learners is as highlighted on the Elaboration Likelihood Model [27]. People with less cognitive ability are more likely to be persuaded by superficial qualities such as perceived trustworthiness because they are less willing to elaborate [28]. In other words, they are less willing to invest the time and effort to critically scrutinize a persuasive system based on other non-superficial (relevant) criteria apart from perceived trustworthiness (e.g., perceived/actual usability, perceived/actual usefulness, etc.), probably due to low cognitive ability.

Research has shown that people who are low in the need for cognition, for example, are more likely to be influenced by speakers or sources which they perceived credible or honest [29]. For this reason, it is more likely that LCL people will be influenced by a persuasive system based on its perceived trustworthiness than relevant arguments which HCL people may value more in a persuasive system. Thus, we recommend that, in personalized PT design, the Trustworthiness strategy should be specifically leveraged in motivating users with a low level of cognition.

Second, our findings reveal that people with high cognitive level are more susceptible to Social Learning strategy than people with low cognitive level. A possible explanation for this finding is that people with high cognitive level are more open to experience than people with low cognitive level. As a result, HCL learners are more likely to explore new ideas and learn from others owing to their curiosity compared to LCL learners. This may increase the tendency of HCL learners to interact with peers and learn from them as opposed to people with low cognitive level who might find

Social Learning too intimidating because of their closeness. For example, a complex task that requires high level of cognitive ability will often be carried out collectively as a group work, this collective work might be comfortable for people with high cognitive level as it affords them the opportunity to flaunt their skills and gain self-enhancement. On the other hand, people with low cognitive ability might find this collective work system as an invasion of their intellectual privacy. This has similarly been explained by Finn [30] found that people with high cognitive level possess technical skills that helps in team work. This finding implies that people with high cognitive level can be more motivated when they are made to learn from each other as a team. This also implies that people with high cognitive level can be more persuaded using Social learning strategy. Thus, we recommend that, in designing personalized PTs, Social learning strategy should be used to persuade people with high cognitive level rather than people with low cognitive level.

Finally, our findings show that there is no significant difference between HCL and LCL learners in their susceptibility to the Reward strategy. One possible explanation for this finding is that incentives are generally appreciated by people irrespective of their personality, age, gender or culture [21, 22]. However, for the population we investigated, our findings reveal that neither HCL nor LCL learners are susceptible to Reward given that their susceptibility scores (4.11 and 4.12, respectively) are less than 4.5 (the neutral score). This finding is surprising and contradicts Oyibo et al.'s [22] results among Africans (predominantly Nigerians), in which they found that respondents are susceptible to Reward. One possible explanation for this finding is the influence of cultural and religious beliefs. This study was conducted among university students in Northern Nigeria, where most people are of the Islamic faith, in which monetary and material rewards are discouraged [31]. This finding suggests, that, irrespective of the cognitive level of users, the Reward strategy may not be effective in motivating behavior change in persuasive systems, especially among people of Islamic faith in Northern Nigeria. However, this finding of non-susceptibility to Reward need to be further investigated among other Islamic communities beyond Northern Nigeria.

7 Conclusion and Future Work

This paper presents the results of an empirical study among 117 participants from Northern Nigeria, which investigated the influence of cognitive level on the susceptibility of individuals to three persuasive strategies: Reward, Social Learning, and Trustworthiness. The results of our analyses show that people with high cognitive level are more susceptible to Social Learning and less susceptible to Trustworthiness than people with low cognitive level. In contrast, people with low cognitive level are more susceptible to Trustworthiness and less susceptible to Social Learning than people with high cognitive level. These results suggest that, in the context of personalization of PTs for the investigated population, Social Learning will be an effective persuasive strategize in motivating people with high cognitive level, but Trustworthiness may not be an effective strategy. On the other hand, Trustworthiness will be an effective persuasive strategy for motivating people with low cognitive level, but Social Learning may not be an effective strategy. Moreover, our findings reveal that, irre-

spective of the cognitive level, Reward is not likely to be effective as a persuasive strategy for motivating behavior change among Northern Nigerians. To the best of our knowledge, our study is among the first, in the context of PT research, to investigate the relationship between users' cognitive level and their susceptibility to various persuasive strategies. Thus, our contribution to knowledge is that we provided empirical insight into how individuals with different levels of cognition are responsive to three important persuasive strategies in PT design in the educational domain. Our findings can be leveraged in group-based tailoring of persuasive applications to users with different levels of cognition. In future work, we intend to investigate how other factors such as age and gender influence the susceptibility of individuals from Northern Nigeria to these and other persuasive strategies. We also hope to validate our findings among other Islamic communities to establish the generalizability.

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