Evaluating Older Adults' Engagement and Usability with AI Driven Interventions

Marcia Shade, Changmin Yan, Valerie Jones, Julie Boron

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Marcia Shade[1*] BS, PhD; Changmin Yan[2*] PhD; Valerie Jones[2*] PhD; Julie Boron[3*] PhD

[1]University of Nebraska Medical Center College of Nursing Omaha US
[2]University of Nebraska Lincoln College of Journalism and Mass Communications Lincoln US
[3]University of Nebraska at Omaha Department of Gerontology Omaha US
[*]these authors contributed equally

Corresponding Author:
Marcia Shade BS, PhD
University of Nebraska Medical Center
College of Nursing
985330 Nebraska Medical Center
Omaha
US

Abstract

Background: Technologies that serve as assistants are growing more popular to entertain and help with daily tasks. The artificial intelligence (AI) in these technologies could also be helpful to deliver interventions that assist older adults with symptoms or self-management. To create the best delivery and dose of an intervention, we must understand older adults' usability and engagement behaviors.

Objective: The purpose of this analysis was to describe how older adults engaged with a commercially available AI assistant that delivered prescribed routines as interventions.

Methods: A randomized pilot trial was conducted for 12-weeks in adults aged 60 years or older, self-reported living alone, and having chronic musculoskeletal pain. Participants (N=50) were randomly assigned to one of two intervention groups to engage with the AI assistant Alexa. One group interacted with a standard intervention with a priori activities, and the other group interacted with enhanced (tailored) intervention based on participant input. Participants were encouraged to interact with Alexa routines prescribed twice daily (morning and evening) and as needed. Data were collected and analyzed on routine engagement characteristics and perceived usability of the AI assistant. To understand how to improve the personalization of the user experience, an analysis was conducted on participant's personality trait scores.

Results: Participants were on average 79 years of age. In both intervention groups, morning routines were initiated more frequently than evening routines. The enhanced group perceived routine usability as good, and the standard group reported lower usability scores. Higher extraversion personality scores predicted higher rates of routine initiation, while higher agreeableness and higher conscientiousness personality scores positively predicted better usability.

Conclusions: These findings support the feasibility of using prescribed interactive AI assistant routines with older adults. Routine engagement and usability may be enhanced with the development of skills and interactive features for aging populations. Older adults' engagement with prescribed interventions with AI assistants may be influenced by personality traits, preferences for routines, and symptom characteristics. Clinical Trial: NCT05387447

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xx BS., PhD., RN[1]
xx, PhD[2]
xx, PhD.[2]
xx, PhD.[3]

University of Nebraska Medical Center, College of Nursing[1]
University of Nebraska Lincoln, College of Journalism and Mass Communications[2]
University of Nebraska at Omaha, Department of Gerontology[3]

Corresponding Author: xx, PhD, BS, RN University of Nebraska Medical Center College of Nursing-Omaha, 985330 Nebraska Medical Center, Omaha, NE, 68198 402-559-6641, xx@unmc.edu

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Abstract

Introduction: Technologies that serve as assistants are growing more popular to entertain and help with daily tasks. The artificial intelligence (AI) in these technologies could also be helpful to deliver interventions that assist older adults with symptoms or self-management. To create the best delivery and dose of an intervention, we must understand older adults' usability and engagement behaviors. The purpose of this analysis was to describe how older adults engaged with a commercially available AI assistant that delivered prescribed routines as interventions.

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Discussion: These findings support the feasibility of using prescribed interactive AI assistant routines with older adults. Routine engagement and usability may be enhanced with the development of skills and interactive features for aging populations. Older adults' engagement with prescribed interventions with AI assistants may be influenced by personality traits, preferences for routines, and symptom characteristics.

Keywords: voice assistant, interventions, usability, engagement, personality, older adults

Introduction

A recent review found that digital technologies may be beneficial for helping older adults stay connected and linking them to health resources.[1] Newer, technology-based interventions may provide a way to assist with self-management of chronic illness and improve social connection for older adults.[2] Traditional technologies such as computers and mobile tablets have been adopted by aging adults but can be abandoned depending on acceptance and ease of use.[3] Newer technologies such as conversational voice assistants (CVAs) , are a type of artificial intelligence (AI) that have the capacity to assist and have basic interactions with individuals. Older adults can engage with conversational AI through voice, an advantage over spending extensive time learning a new program

or manually operating small sized device features. Of Americans 18 years of age and older, 62% use an AI conversational/voice assistant on any device, including: smart speakers, smartphones, TV remotes, in-car systems, a computer/laptop, tablet, among others.[4] With the increasing population of older adults, CVAs may be an optimal modality to deliver interventions.

The use of CVAs has been studied as an intervention for chronic conditions such as heart failure, lung disorders, and mental health.[5] Their utility has been explored for promoting behaviors such as physical activity and for health care support.[6,7] Studies are emerging in relation to CVAs independently influencing loneliness, social isolation, and pain.[8-13] These studies have primarily focused on acceptability, barriers and the design of CVAs in older adult populations. In addition, a recent review of literature only focused on use and acceptability of CVAs to reduce loneliness, none of the CVA-based interventions were personalized.[13,14] Further exploration is needed to understand older adults' engagement with CVAs to ensure optimal outcomes when used as a modality for intervention delivery.

An individual's personality can influence acceptance and needs to be considered as a part of usability and the engagement with technology-driven interventions.[15] Personality traits are characteristics of individuals that typically remain stable over the adult life course. Adults from their mid-to-late 20s and older were found to score similarly across the lifespan on the Big Five (i.e., neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness) personality traits.[16] Loneliness, which is prevalent in older adults, may influence the presentation of personality traits. A meta-analysis documented negative associations between loneliness and extraversion, agreeableness, conscientiousness, and openness, and a positive association between loneliness and neuroticism.[17] When using technology to deliver interventions in older adults, engagement may differ in those that self-report loneliness; this warrants further exploration.

An individual's personality may influence the engagement and user experience with AI technology. Within the realm of traditional technologies, the strongest correlates of older adults'

perceived usefulness and ease of use of computers were the personality traits of agreeableness and openness.[18,19] Openness to experience has been associated with increased probability of internet use.[16] Further, higher agreeableness and lower neuroticism in older adults have been associated with perceived usability with an automated vehicle.[20]

Since the AI boom, the relationship between the personality traits of older adults and use of CVAs has not been extensively explored and may impact engagement with AI driven interventions. A commercially available AI voice assistant was used to deliver prescribed interactive routines as non-pharmacologic interventions for pain and loneliness. In this analysis of the data, the following research questions were explored:

1. When do older adults initiate the different prescribed routines?
2. What are the older adults' perceived usability scores with different intervention routines delivered with AI through CVAs?
3. What is the relationship between older adults' personality and their engagement with the different intervention routines?
4. What is the relationship between older adults' personality and the perceived usability of different intervention routines delivered with AI through CVAs?

Methods

The University of Nebraska Medical Center Institutional Review Board approved the study protocol, IRB #0177-21-EP. This study was a 12-week pilot randomized controlled trial conducted with participants who were 60 years of age or older and self-reported living alone, spoke English, and self-reported pain symptoms.

Intervention Groups

Prescribed routines were employed for the intervention, like how an individual is prescribed prescription medications (ex. daily, twice daily, as needed). The prescription was for participant

engagement with AI assistant routines twice a day and as needed depending on pain symptoms and feelings of loneliness. The routines were created based on non-pharmacologic strategies[21] and selected from evidence-based interventions that have a positive influence on pain and loneliness.[2,22,23] After screening and enrollment participants were randomly assigned to intervention groups. The two intervention groups included the conversational voice assistant standard routine (CVA-S) and the conversational voice assistant enhanced routine (CVA-E). Standard routines were more generalized and static, while the enhanced routines were tailored, as it has been well documented that individualized or tailored interventions increase engagement and adherence.[24-26]

Routine Programming

The voice-controlled intelligent personal assistant Alexa was used for this study because the 65+ population prefers Alexa among commercially available voice assistants.[27] Routines were programmed within the Alexa app using available actions and skills created by software app developers. Actions are standard preprogrammed interactions and skills are voice-activated apps such as health fitness, education, games/podcasts/meditations that can be used with Alexa and the smart speaker. Prior to skill selection for this study, research personnel reviewed ratings and tested the skills to make sure they worked and would be appropriate for older populations. Routines were initiated by participants speaking to an Amazon Echo Dot device and stating “Alexa, start my routine.”

Measures and Instruments

Data was collected on sample characteristics such as demographics, health history, and comfort and trust of technology on a 4-point scale ranging from 1 (none) to 4 (high). The Big Five Inventory (BFI) was used to measure personality traits of the participants. The BFI contains 44 questions that represent the different dimensions of openness (Cronbach’ $\alpha = 0.77$), conscientiousness (Cronbach’ $\alpha = 0.72$), extraversion (Cronbach’ $\alpha = 0.79$), agreeableness (Cronbach’ $\alpha = 0.78$), and neuroticism (Cronbach’ $\alpha = 0.70$).[16,28]

Feasibility outcomes included capturing engagement with the AI assistant routines and self-reported usability. *Engagement* with routines was measured at the end of the study. Participants' voice assistant profiles were securely accessed to track the date and time stamps on the frequency of routine initiation with the standard and enhanced loneliness routines. *Usability* was measured using the System Usability Scale (SUS) administered at the end of the study. A 10-item system usability scale (ranging from 0 to 100) was created (Cronbach's alpha=.75).[29]

Data Analysis

The data analysis strategy for this study was multifaceted, aimed at understanding the impact of different intervention conditions on routine initiation rates, the influence of personality traits on engagement with Alexa-based routines, and perceptions of system usability. Given the nature of the data and the research questions, the analysis employed both descriptive statistics and inferential statistical tests to explore these relationships and test hypotheses. This comprehensive data analysis strategy, incorporating both non-parametric tests for hypothesis testing and regression analysis for exploring relationships between personality traits and key outcomes, facilitated a nuanced understanding of the factors influencing routine initiation and system usability in the context of Alexa-based interventions.

Descriptive statistics in addition to normality tests were conducted. Initial analysis involved descriptive statistics (mean, median, standard deviation, skewness, and kurtosis) to summarize the central tendency and dispersion of routine initiation rates and system usability scores. The Shapiro-Wilk test was used to assess the normality of distributions for these variables. Given the significant results from the Shapiro-Wilk test, indicating non-normal distributions for both routine initiation rates and system usability scores, non-parametric tests were chosen for hypothesis testing.

To test the differences in routine initiation rates and SUS scores across conditions (morning vs. evening, standard vs. enhanced), the following non-parametric tests were applied:

Wilcoxon Signed-Rank test was used to compare morning and evening routine initiation rates within participants. Mann-Whitney U test was employed to test differences between the standard and

enhanced conditions in terms of routine initiation rates and SUS scores. This test was chosen due to its suitability for comparing two independent samples without assuming normal distribution.

Personality Traits Analysis

Multiple regression analyses were conducted to explore the relationship between participants' personality traits and their engagement with Alexa routines, as well as the perceived usability of the system. These analyses were performed for the total sample and then separately for each condition (standard vs. enhanced), to determine if personality traits differentially influenced outcomes based on the intervention type. The choice of multiple regression was guided by the interest in assessing the predictive power of multiple independent variables (personality traits) on a continuous dependent variable (number of routine initiations or system usability scores).

Results

The study included N=50 participants with an average age 79.24 (SD = 7.85; Range: 65-98; median = 78). The majority (88%) were female (12% male) and reported being of white (96%) race (4% African American). Most of the older adults were widowed (44%) or legally divorced/separated (42%), while the remaining participants were either physically living apart from their partner due to health (10%) or single (4%). Most (80%) participants had completed college or higher education (16% high school, 4% trade school). The majority (64%) reported incomes between $10,000-$50,000 (4% below $10,000, 14% $50,001-$90,000, 18% above $90,000). Participants reported moderate to high levels of comfort (M = 2.75; SD = 0.67) and trust in technology (M = 2.94; SD = 0.91).

Engagement and Perceived Usability of Prescribed Routines

Participants were encouraged to engage and initiate the routines twice daily for 12 weeks, which equated to 168 interactions in total. As shown in Table 1, the rates of routine initiations were significantly higher among participants in the CVA-E group than the CVA-S group. When observing the prescribed time of day for engagement, the routine initiation rates were higher in the morning.

Given the variances in rates of routine initiations, and a notable preference for morning over

evening initiations across conditions, group comparison via Wilcoxon analyses were conducted to examine the interaction between intervention timing (morning vs. evening) and intervention groups (CVA-S vs. CVA-E via Whitney U test). As presented in Table 1, the CVA-E group initiated "morning routines" significantly more often than those in the CVA-S group. During the evening, the rates of routine initiation were not significantly different in the groups.

The perceived usability of the AI assistant had favorable results. The SUS scores of the overall sample of participants were "good" (M=70.56, SD=10.58). When conditions were analyzed separately, the CVA-E group's SUS scores were good (M=74.50, SD=11.90), while the CVA=S group scores were "OK" (M=66.29, SD=6.94).

Personality and Engagement with Prescribed Routines

The overall model including all Big Five personality traits was not a good fit as a predictor of the daily number of routine initiations ($F(5, 44) = 1.45$, $P = .23$, R Square = .14), morning routine initiation ($F(5, 44) = 2.19$, $P = .07$, R Square = .20), or evening routine initiation ($F(5, 44) = 0.72$, $P = .61$, R Square = .08) at $\alpha = .05$. The extraversion personality trait was significantly associated with routine initiations. It was a significant predictor of overall daily routine initiations ($B = 0.42$, $t = 2.65$, $P < .05$) and initiation of morning routines ($B = 0.47$, $t = 3.07$, $P < .01$), but not the evening routines ($B = 0.28$, $t = 1.73$, $P = .09$). The other four personality traits did not predict routine initiations.

Similar patterns were observed when comparing the CVA-S and CVA-E groups. Extraversion significantly predicted all routine initiations in the CVA-S group, ($B = 0.47$, $t = 2.13$, $P < .05$ and the CVA-E group, $B = 0.44$, $t = 2.09$, $P < .05$). Specifically, extraversion was a significant predictor of morning routine initiations in the CVA-S group, $B = 0.50$, $t = 2.35$, $P < .05$, and the CVA-E group, $B = 0.53$, $t = 2.54$, $P < .05$. None of the Big Five personality traits significantly predicted evening routine initiations in either group.

Personality and Perceived Usability of Prescribed Routines

Among the Big Five personality traits, only agreeableness (B= 0.43, t = 4.67, P < .001) and conscientiousness (B = 0.35, t = 3.99, P < .001) positively predicted SUS scores in the overall sample, F (5, 44) = 29.60, P < .001, R Square = 0.77. As shown in Figure 1., when analyzed separately, both the CVA-S and the CVA-E groups reported agreeableness (B = 0.50, t = 2.49, P < .05; B = 0.46, t = 3.31, P < .01 respectively) and conscientiousness (B = 0.33, t = 2.15, P < .05; B = 0.38, t = 2.97, P < .01 respectively) were positively associated with SUS scores.

Discussion

Technology is becoming a popular vehicle to deliver interventions for health care and self-management. In this analysis we examined older adults' engagement with and usability of AI-delivered routine interventions. Overall, the older participants engaged with the assistant throughout the 12-weeks of the study. Perceived usability was acceptable with routine initiation rates being higher in the morning. Personality traits of the participants in this study may have impacted engagement with the prescribed routines. The following discussion will provide additional insights into the findings.

Older Adults' Engagement with Prescribed Routines and Perceived Usability

Our study revealed significant differences in routine initiation rates between morning and evening sessions, with participants demonstrating a higher propensity to engage in prescribed routines during the morning. One potential explanation for this finding is within circadian rhythm science. Circadian rhythms are internal processes that regulate the sleep-wake cycle, repeating roughly every 24 hours. They influence physical, mental, and behavioral changes in living organisms. Circadian rhythms are crucial for determining human sleep patterns and have significant implications for designing technology that aligns with these natural processes.[30] Research suggests morning hours are associated with higher alertness and cognitive functioning, which could facilitate the initiation of health-related routines.[31] The enhanced intervention components may have amplified these effects, indicating that tailored interventions can effectively increase engagement with health-

promoting behaviors. The integration of technology with human circadian rhythms and mornings may enhance intervention engagement and adherence.

Another possible explanation of the higher initiation rates in the morning may be due to arthritic pain. Inclusion criteria was a self-report of pain symptoms and most of the participants reported a diagnosis of arthritis. Commonly, individuals have stiffness in the morning that may impact pain symptoms and need for management.[32] In older adults with musculoskeletal pain, technology-based routines or interventions may be best encouraged in the morning.

Older Adults' Personality and Engagement

The results from this study highlight the influence of personality traits on engagement and usability. Extraversion was a significant predictor of routine initiation, particularly in the morning, which is consistent with previous research indicating that extraverted individuals are more likely to engage in health-promoting activities.[33] Extraverts, characterized by their energy, enthusiasm, and sociability, might have the most inherent motivation for social interaction and stimulation. When they perceived the routines as opportunities for engaging experiences or personal growth, it may have made the process of initiating routines more appealing.[34,35] The finding that this effect was more pronounced in the morning suggests that, consistent with their circadian rhythm, extraverts may be prone to engage with technology during early hours, setting a positive tone for the rest of their day.

Agreeable and conscientious personality predicted higher perceived usability, suggesting that these traits may influence individuals' perceptions and interactions with technology-based health interventions. It is worth noting the older participants in this study reported moderate to high levels of comfort and trust in technology. Agreeable individuals, known for their cooperative and trusting nature, may be more predisposed to view the Alexa-based intervention in a positive light, attributing any potential usability issues to their own learning curve rather than the system's design flaws. This optimistic viewpoint may lead to higher perceived usability. Conscientious individuals, with their focus on diligence, organization, and reliability, may appreciate systems that are consistent and

efficient. The participants' positive evaluation of the system's usability might stem from a recognition of its potential to support their goal-oriented behavior and routine adherence. The structured nature of the pre-set routines could align well with their preference for orderly environments, further enhancing their perception of the system's usability.

The study reveals a nuanced differentiation between participants' engagement with prescribed routines and their perceptions of system usability, emphasizing the distinct roles of personality traits. Extraversion was found to drive the frequency of routine initiations, particularly in the morning, suggesting that an action-oriented engagement is influenced by a desire for stimulation and interaction. Perhaps, older adults with extraverted personality traits may be more likely to seek that interaction and treat AI with anthropomorphic properties.[36] Anthropomorphism is when a human attributes human traits to entities or devices that are not human.[37] Researchers have found that people interact with CVAs in anthropomorphic ways, greeting them, asking them personal questions, exhibiting polite behaviors such as saying "please" and "thank you," and reacting to what the voice assistant did or did not say.[12] Thus, there is a possibility that anthropomorphic interactions with the CVAs may have impacted engagement and usability of CVAs to deliver interventions.

Conversely, agreeableness and conscientiousness were associated with more favorable perceptions of system usability, indicating a cognitive evaluation process that values trust, adaptability, and reliability. This distinction underscores the importance of differentiating the motivational drivers behind the use of technology-based health interventions and the cognitive evaluations that shape user satisfaction. By acknowledging the interplay between action-oriented engagement and cognitive evaluations, designers can create more effective, user-friendly interventions tailored to diverse user preferences and personality profiles.

The findings in this study underscore practical implications regarding the potential of tailoring health interventions to individual characteristics, including the timing of interventions and the inclusion of personality-tailored components. Extraverts, who are stimulated by social interaction

and are more action-oriented, particularly in the morning, may benefit from interventions scheduled during this time. Health platforms can incorporate adaptive scheduling features that customize the timing of prompts based on the user's personality profile, thus optimizing the likelihood of engagement and adherence which could impact health outcomes.

Furthermore, understanding the role of personality traits in the acceptance and usability of health technologies can inform the development of more personalized, effective, and user-friendly interventions. The significant role of agreeableness and conscientiousness in shaping perceptions of system usability suggests that these traits should be considered when designing user interfaces. Users high in agreeableness and conscientiousness value trust, adaptability, and reliability. Therefore, health interventions should prioritize these design elements to cater to their cognitive evaluation processes. For example, features that provide consistent feedback, allow for personalization, and are easy to navigate could be more appealing to these users. Researchers have found that CVAs exhibit “personality type” traits. The Google Assistant and Alexa AI assistants have personality traits of functional intelligence, sincerity, sociability, and creativity.[38] Future interventions could be tailored for optimal engagement when matching AI assistants and human dominant personalities.

Although the results of this pilot study are informative there are limitations worth noting. There were an even number of participants in each intervention group, however, our sample was relatively small and lacked diversity. The findings are not generalizable to all older adults who report loneliness and pain. Our participants self-reported loneliness and pain, but our study may not have enrolled individuals who were really struggling more intensely with loneliness and pain. Primary care providers could help us identify older adults with more severe pain and or loneliness. Those without regular internet access in their home due to location (e.g. rural areas) or lack of broadband access (due to personal choice or financial restraints) would not be able to interact with conversational voice assistants. Some of these sources of variation could also interact with personality differences. For example, those that choose not to have internet in their homes for

personal reasons, may differ from those that do. Further, exploring how to engage those with differing personality characteristics is an important area for future research, so that routines are individualized enough to produce an impact on daily life. Finally, our study was 12-weeks in duration; however, a longer study with follow-up would be beneficial to explore what length of time is needed to integrate routines that impact well-being and to sustain that impact long term.

Conclusions and Implications

Commercially available conversational voice assistants have the potential to deliver nonpharmacologic interventions that are individualized for older adults. Prescribed interactive routines were feasible to use in older adults who self-reported loneliness and pain. Routine engagement may be influenced by the older adults' pain characteristics and personality. A standard routine can have an impact, but engagement may be more substantial with individualized routines based on personality. Tailoring these routines to align with individual pain profiles and personality traits can significantly improve the efficacy and user satisfaction of interventions. This personalized approach can potentially enhance adherence and overall outcomes by addressing specific needs and preferences of older adults, making technology-assisted interventions more relevant and supportive in managing their conditions.

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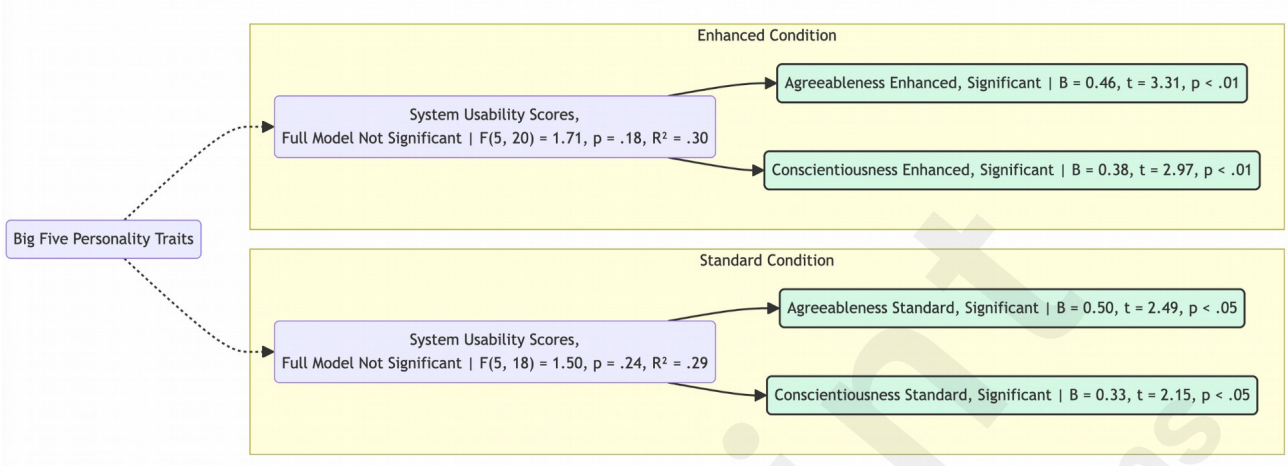
Table 1: Comparisons of Conversational Voice Assistants (CVA) Routine Engagement

Condition	Routine Initiation Time of Day	Comparison (M, SD)	Z-Score	p-Value
Full Sample (n=50)	Morning	62.13, 32.85		
Full Sample (n=50)	Evening	51.94, 32.13	-2.81	< 0.01
CVA-E (n=26)		126.53, 59.9		
CVA-S (n=24)	Overall Day	100.56, 54.88	-1.98	<0.05
CVA-E (n=26)		74.24, 31.86		
CVA-S (n=24)	Morning	49.01, 29.17	-3.16	<0.01
CVA-E (n=26)		52.29, 32.3		
CVA-S (n=24)	Evening	51.55, 32.63	-0.13	0.9

Figure 1: Treatment Group-based (Standard vs. Enhanced) Regression Analysis of Big Five Personality Traits as Predictors of System Usability Scores.

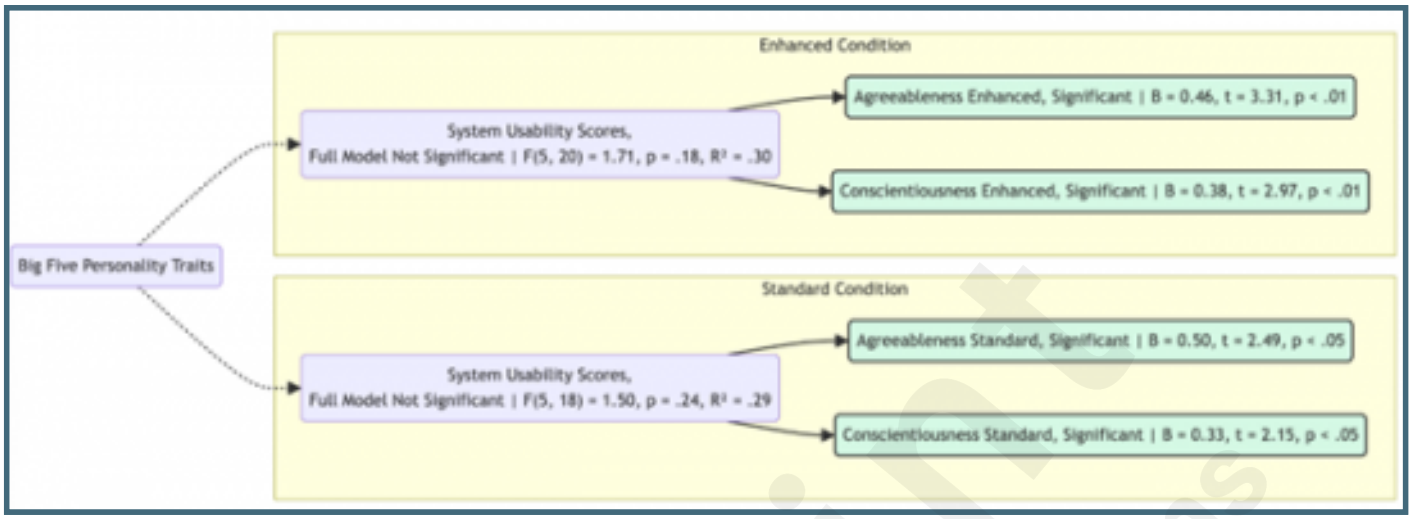


Supplementary Files

Untitled.
URL: http://asset.jmir.pub/assets/12ee61d6ff4f9f5aa8dc66729fa54085.docx

Figures

Treatment Group-based (Standard vs. Enhanced) Regression Analysis of Big Five Personality Traits as Predictors of System Usability Scores.



Multimedia Appendixes

Comparisons of Conversational Voice Assistants (CVA) Routine Engagement.
URL: http://asset.jmir.pub/assets/560a6418a16be832ee4f7a3f0378d61f.docx