Relevance of Conscientiousness for Graphic Interface Design

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Abstract

Nowadays technology plays a key role in society. Therefore it is important that technology reach all users offering the best possible user experience. That is not possible using a single, fixed and constant interface since each individual has different experiences and characteristics that accompany the use of an interface. In particular, a construct that models the way they interacts with the world and process their thoughts is personality. In particular, Conscienciousness, one domain of personality, is high important in the organization, persistence and motivation for goal-oriented behavior. Thus, the goal of this work is to verify whether Conscientiousness is relevant for the adaptability of an interface and, if so, if this adaptability could lead to an improved User Experience. Results indicate that Conscientiousness is relevant to the design of an interface, leading to a better user experience only for users with high Conscientiousness, specifically regarding the overall appreciation and usability of the interfaces.
Keywords: Personality, Conscientiousness, Adaptative Interface, Physiological Computation;

1. Introduction

The human-machine interaction is made through an interface. Thus, an interface is required that offers the best possible user experience. The problem arises from the impossibility of constructing an unique interface that satisfies the needs of all users since each human being is unique, with its own behaviors and difficulties. In particular, personality is a construct that explains part of how we interact with the world and structure our thinking.

The concept of personality is so complex that it invalidates the possibility of creating a single interface that meets each requirement of every user. The motivation of this work is to investigate the possibility of creating an interface that adapts to the personality of each user. More specifically the want to verify if Conscientiousness is relevant to the adaptability of an graphical user interface, and if so, whether this adaptability could lead to an improved user experience (UX). In this work we created a set of guidelines for the different groups of Conscientiousness. In addition, to avoid the use of exhaustive questionnaires a classification framework was created. That framework receives physiological data and assesses their Conscientiousness level.

2. Background

Over the years there has been a concern to find the most complete and compact division of personality components. Therefore a model was popularized by L.M. Digman in 1900 and later worked by Costa and McCrae in which personality was divided into five groups (personality traits). This model is known as the Five-factor Model [11], the most recognized model for dividing personality into components [15].

The five components [15, 22] of this model are: Neuroticism, Extroversion, Openess to experience, Agreeableness and Conscientiousness.

2.1. Conscientiousness

In particular, Conscientiousness, one of the domains of personality, has particular interest. Conscientiousness is in several studies categorized as will to achieve [2, 6, 8, 15, 22] and has been considered the best of the five traits of personality to predict the performance of the work to be performed [2, 6, 8]. It evaluates the degree of organization, persistence and motivation for goal-oriented behavior. Facets of conscientiousness evaluated by the five factor model are: Competence, Order, Dutifulness, Achievement-striving, Self-discipline and Deliberation.

Of these facets, order, in which the organization and method of work are variable, as well as self-discipline and deliberation can be important parameters in interface design.

Different personalities lead to different needs and the satisfaction of these needs produces a higher user experience [19]. It is possible to divide Conscientiousness into groups with similar characteristics. Specific requirements are created to respond to the particular needs of each group of Conscientiousness. So it is important to choose what needs to be created to meet the needs of each type of Conscientiousness. Once a set of requirements is established, the design of a custom user interface (UI) starts.

3. Related Work

Customizing the UI for certain individual characteristics may be relevant to the user experience [5, 16, 21]. Personality differences can stimulate individuals' information processing capabilities according to their viewing preferences, thus creating an effective visual experience [21].

Sarsam and Al-Samarraie [21] studied an UI based on user personality types in the context of learning in mobile equipment. They attempted to increase the satisfaction of users during learning using a UI of a mobile device. They divided them into two groups (Neuroticism and Extra-Conscientiousness) and created specific interfaces for each of the groups. These two interfaces were created with variances in the following design elements: Information structure, Navigation, Layout, Font, Letter size, Buttons, Color, Lists, Information Density, Support and Alignment. The two interfaces created can be seen in Fig 1.

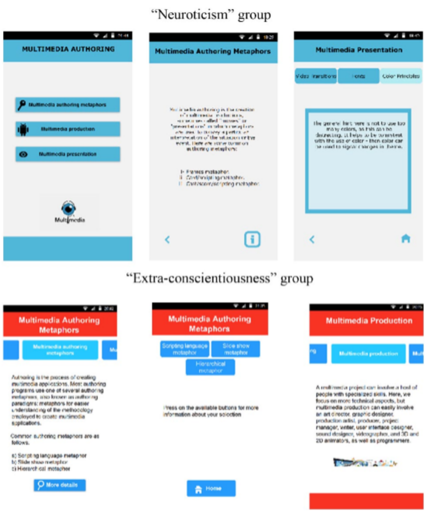

Figure 1: Custom interfaces for both personality groups [21].

They then verified that users were more satisfied with the custom interface for their group than an interface that would not be adapted to their characteristics. They conclude the relevance of the design of a personality-based UI.

Several studies have focused on verifying the influence that the personality can have on the information search in an interface [1, 22]. Al-Samarraie et al. [1] tried to find a relationship between the personality and the search for information online. Results showed that people with high Conscientiousness were faster in the information search tasks.

From this we can conclude that participants with high values of Conscientiousness exhibit fewer eye fixations and shorter eye fixation duration to extract information in all tasks. Several studies have also found an association between the personality type and certain characteristic eye movements (such as the number of fixations, mean duration of fixations and the residence time) [1, 17, 20, 22]. More specifically, that individuals with high values of Conscientiousness tend to explore and decide the information faster.

3.1. Discussion

In relation to the adaptability of the system several conclusions were drawn. Goren-Bar [12] highlights several important domains for the creation of an adaptive interface. Users preferred adaptive interfaces for the human characteristics inserted in the interface and for the ease in the use of this type of systems. However, the major argument used by users to prefer a non-adaptive interface is to have control over it. Then, in the execution of our adapted interfaces we will have the concern of not removing all control from the user. Regarding interface design, Sarsam and Al-Samarraie [21], there are several design elements that can be customized according to personality type.

These elements will be taken into account in their influence in the Conscientiousness of an individual, more concretely: Distribution of information, Density of information, Images, Color, Font, Letter size, Buttons and Alignment.

4. Methodology

We created research questions to evaluate the success of our objective. which are the starting point of this study and whose validity were verified at the end of the study. They are:

RQ1: *Can an interface tailored to the individual's conscientiousness type lead to an improved user experience?*

In order to answer this research question, four hypotheses were created. They are:

H1: *User Conscientiousness has an effect on preference of interfaces.*

H2: *User Conscientiousness has an effect on overall appreciation of interfaces.*

Additionally, two hypotheses were created to check if Conscientiousness has a functional impact on the user experience:

H3: *User Conscientiousness has an effect on* *perception of interface usability.*

H4: *User Conscientiousness has an effect on perception of interface usefulness.*

To expedite the work resulting from the assessment of the type of Conscientiousness of the individual, the possibility of building a classifier that receives as input the brain waves of the participant and associated him with a certain group of conscientiousness was tested. For this the following question was created:

RQ2: *Is it possible to predict the type of conscientiousness of the individual through their physiological data?*

4.1. Classification Framework

The function of the classification framework is to classify the user according to his level of Conscientiousness. This association of user Conscientiousness is done through a classifier after receiving his physiological data as input. For this it is necessary to model and train a classifier through the brain waves of the participants and the answers of the NEO PI-R questionnaires.

A total of 112 people underwent these tests. The age range of participants was between 18 and 36 years (M = 22.03, SD = 2.97).

4.2. Instruments

Bitalino (*https://bitalino.com/en/hardware*) is responsible for collecting physiological data. For this, Bitalino reads analog signals that are later transformed into digital signals. These signals cannot yet be processed by the BioSPPy tool and are therefore transformed into electroencephalogram (EEG) values. Thus, data can already be read and analyzed by this tool and therefore it is already possible to extract the bands α, β, θ e γ [4].

NEO PI-R was created by Costa and McCrae in 1992 after a reformulation of the NEO-PI also created by these authors [3]. Being all Portuguese users, we used the questionnaire translated into Portuguese by Lima and Simões [14]. During the collection of physiological data, several images were used to calm the user during the tests. It is important that all users start from the same state to allow comparisons between them.

4.3. Procedure

For this testing session the following procedure was performed:

1. Each user was asked to sit in a chair where he was then explained the entire process to be submitted, as well as the purpose of the work.

2. After the introduction, a consent form was read and signed authorizing the collection physiological and demographic data as well as the collection and processing of NEO PI-R questionnaire data.

3. Once the data collection and processing was authorized, the user was asked to start filling out the form regarding their demographic data. This form was available online through one of the computers provided for the test.

4. After completing this process, the physiological data collection phase began and some indications were given on how the user should behave during brainwave collection. This collection was divided into two phases [10]: at one stage users presented with their eyes open looking at one set of images and at the other with their eyes closed. Each phase was recorded over a two minute period with the users being in a rest state.

5. Finally, users have completed this testing phase by completing the NEO PI-R questionnaire.

During the two stages of collection the users remained with two sensors on the forehead (positions FP1 and FP2 in system 10–20) and one behind the ear that serves as ground for the difference between the two hemispheres. Two computers were used in this testing phase. The first computer was responsible for passing the images and allowing participants to answer the questionnaires. The second computer was responsible for storing the physiological data.

4.4. Data Analysis

Participants were classified into Conscientiousness groups. Two alternatives were tested:

- Split participants into low or high Conscientiousness

- Split participants into low, medium or high Conscientiousness

To split the participants into a type of conscientiousness, the NEO PI-R professional manual was used based on the percentage values of the Portuguese population [9]. To divide participants into two groups, the following distribution was made: 0% to 49% users are classified as Low Conscientiousness and 50% to 100% are classified as High Conscientious. To divide the participants into three groups, the following distribution was made: 0% to 29% are classified as Low Conscientiousness, 30% to 69% as Medium Conscientiousness and 70% to 100% as High Conscientiousness. Different scales were used for adults and young adults (participants under 22 years old).

Analyzing the counts for the division into two and three types of Conscientiousness, we opted for the first option (low and high Conscientiousness division) since the division into three groups presented a less balanced distribution compared to the division into two groups as can be seen in the dist$_{consc}$

	2 Groups	3 Groups
Baixa	55	46
Média	-	29
Alta	50	30

Table 1: Distribution of participants in different types of Conscientiousness.

Once the Conscientiousness groups were decided, the modulation of the classifier was started. To this end, it is necessary to have an algorithm that allows to generate a forecast from a set of data. Several metrics were verified to find the best solution. In the case of a classifier aiming to get as many predictions as possible, accuracy was chosen as the basis for comparing classifiers [18].

To model a classifier with the highest accuracy possible, seven classification algorithms were tested to see which one obtained the best results: Naive Bayes (NB), Linear discriminant analysis (LDA), Support-vector machine (SVM), Linear Support Vector (SVC), Decision Tree (DT), Random Forest (RF) and Neural Network (NN). With the exception of the NN algorithm all other algorithms ran 50 times with previously normalized data to obtain a considerable set of classifications, each time with different training and test sets (80/20).

The NN algorithm, more specifically one LSTM, has a different approach than the other algorithms. While the previously reported algorithms are concerned with features that are parsed to find a pattern without any temporal evaluation, recurrent LSTM have the notion of temporal contemplation and see how the values adjust over time. For the execution of this algorithm the data were previously normalized and for each user the last 100 moments were saved. The number of saved moments was tested and the number 100 reached the best values. The classifier was run in 500 epochs reaching 50% for open eyes (random results) and 61.70% accuracy for closed eyes.

With the exception of the NN algorithm, all other algorithms divided these records into time intervals. For EEG waveforms for closed eyes, for open eyes and for the difference between the two, the data were divided into 10, 20 and 30 second intervals separately to verify which of the ranges showed the best values for the metrics chosen for the classifier. The features chosen were mean, standard deviation, variance, median and skewness.

From the tables 2, 3 and 4 it can be concluded

	NB	LDA	SVM	LINEAR SVM	DT	RF
Accuracy	0,5525	0,6205	0,5347	0,6044	0,6651	**0,8136**
Precision	0,5467	0,6263	0,5321	0,6120	0,6736	**0,7935**
Recall	0,8584	0,6686	**0,9328**	0,6734	0,7096	0,8738
F1-SCORE	0,6660	0,6454	0,6771	0,6396	0,6903	**0,8304**
MAE	0,4475	0,3795	0,4653	0,3956	0,3349	**0,1864**

Table 2: Results of different algorithms with a ten second interval

	NB	LDA	SVM	LINEAR SVM	DT	RF
Accuracy	0,5474	0,5872	0,5282	0,6050	0,6393	**0,7746**
Precision	0,5429	0,5971	0,5261	0,6144	0,6414	**0,7618**
Recall	0,8574	0,6258	**0,9664**	0,6684	0,6943	0,8346
F1-SCORE	0,6636	0,6083	0,6798	0,6373	0,6651	**0,7947**
MAE	0,4526	0,4128	0,4718	0,3950	0,3607	**0,2254**

Table 3: Results of different algorithms with a twenty second interval

	NB	LDA	SVM	LINEAR SVM	DT	RF
Accuracy	0,5495	0,5865	0,5190	0,5806	0,6059	**0,7386**
Precision	0,5456	0,5891	0,5202	0,5839	0,6190	**0,7390**
Recall	0,8687	0,6350	**0,9820**	0,6385	0,6541	0,7882
F1-SCORE	0,6688	0,6083	0,6788	0,6061	0,6332	**0,7596**
MAE	0,4505	0,4135	0,4810	0,4194	0,3941	**0,2614**

Table 4: Results of different algorithms with a thirty second interval

that the RF and the time interval of ten seconds had the best results. Of the 50 iterations made for these choices that had the highest accuracy reached a value of 85.1 %.

5. Design Guidelines

The interface is the focus of the study and was customized to the individual's type of conscientiousness.

This phase counted on involving three steps: 1. Collection of user preferences; 2. Creation of design guidelines based on user preferences for Conscientiousness; 3. Validation of design guidelines.

The elements chosen to be tested were: Menu, Body, Text, Theme, Images, Buttons, Icons, Image Presentation, Presentation Style.

5.1. Preference Collection

The first step in designing and validating design guidelines is to understand which elements are most relevant to creating a Conscientiousness-based GUI. A set of elements was tested through an adaptable GUI in which the user could interact with each of the elements placing them according to their preference.

5.2. Adaptable Interface

Although it is extremely unlikely that two users eventually choose exactly the same interface with all the same elements, there are identical element patterns between the various users. The intention is in the end to find these patterns and to associate them with the different types of Conscientiousness. The adaptive interface was created as abstractly as possible. It was expected that each user chose the elements merely through their preferences and avoid associating the interface design with its content. So, we chose to use Latin text, in Lorem ipsum format (except some elements to contextualize the user) and merely symbolic images (just indicating that there is an image in that space) so that there is no relation between design/content. To avoid conditioning through the root interface presented to users, all elements are chosen at random causing each user to depart from a different interface, thus dispersing the initial effect caused. The user interaction with the adaptable interface was done through a movable menu that could be dragged to any position and contained all the elements and the various underlying possibilities.

After the adaptive interface was created, a new testing phase was started to collect the design preferences of different users.

5.3. Participants

From the list of participants recruited in the previous test session, 21 participants with low Conscientiousness and 21 participants with high Conscientiousness were randomly selected, thus completing a total of 42 users for this test session (M = 20.78, SD = 2.97). Of these 42 users two were used to test the protocol and ensure the tuning of the entire process. The results of these two users were discarded from the evaluation of the results.

5.4. Procedure

Tests took place in room 3.03 of the Pavilhão de Informática I on the Alameda campus of Instituto Superior Técnico (IST). Tests lasted about ten minutes each. The following procedure took place:

1. In this session each user was asked to sit in a chair where a computer was placed in front of them with a previously loaded random interface.

2. It was explained that from the mobile menu the user could customize each component to their liking.

3. At the end of the customization and the user was satisfied with the interface obtained, their preferences were duly identified by clicking on the 'save' button in a TXT file.

4. Finally, we expressed our gratitude for the time spent to complete the test.

5.5. Data Analysis

After knowing the preferences for each type of Conscientiousness, it was evaluated how these elements affect UX when interacting with content interfaces and associated tasks. This analysis was divided into two phases, one to verify the individual relevance of the elements and another to verify their global relevance.

6. Analysis of elements with singular changes

To see if the elements associated with a particular type of Conscientiousness have a practical effect on the individual user experience, it is first necessary to understand which elements differ most between the two Conscientiousness groups.

Using Fisher's test, it was verified that no element presented significant results and, therefore, we opted for the elements that presented the greatest differences between the two groups of Conscientiousness. We conclude that the elements most affected by the type of Conscientiousness are: **Image Caption Alignment** (p = 0.070), **Image Side** (p = 0.071) and **Font size** (p = 0.140).

6.1. Discussion

Although the Image Side has a very relevant value, this element is dependent on the Text Wrapping element, that is, if the participant chooses unmolded text, the Image Side element was not considered. This led to having several people choosing Unframed Text, fewer participants chose this element for less solid results. Thus, this element was discarded.

It is now possible to extract guidelines from these results. These guidelines are:

- **Low Conscientious users have a preference for small fonts;**

- **High Conscientious users have a preference for medium fonts;**

- **Low Conscientious users have a preference for aligning image captions on the left;**

- **High Conscientious users have a preference for aligning image captions on the center;**

7. Analysis of elements with global changes

In this analysis we did not study the most relevant elements, but all the elements whose choices vary between the two personality groups. The elements in question are: Body Size, Image Side, Image Caption Alignment, Font Size, Button Method and Button Shape.

From these elements we can draw the following design guidelines:

- **Users with low Conscientiousness prefer large body size interfaces, left side images, left image caption alignment, small font size, numeric buttons and square shape buttons**

- **Users with high Conscientiousness prefer interfaces with medium body size, right**

side images, center image caption alignment, medium font size, Previous / Next buttons and curved shape buttons

We built costumized interfaces based on these elements and validate these design guidelines to understand the degree of satisfaction and performance that each type of Conscientiousness demonstrates in relation to each of these interfaces.

To validate the design guidelines, each user was asked to rate the overall appreciation of each interface on a scale of 1-10 and after answering all the interfaces and rating them, the user was asked to choose the interface that most liked. Additionally, users were also asked to answer two questionnaires in order to understand if the interfaces with the collected guidelines give the user a greater perceived usefulness and if users see greater usability in those interfaces. The first test session evaluated the results against singular changes and the second test session evaluated the results against global changes.

We used the SUS scale [7] to measure the usability of interfaces and the TAM scale [13] to measure the perceived usefulness of participants.

The usability scale of a system was developed by Digital Equipment Corp. more precisely by John Brooke in 1986. It is built for quick measurement of how people perceive the usability of the computer systems they are using. The criteria that SUS helps to avail are the effectiveness, efficiency and satisfaction demonstrated by the user.

The Technology Acceptance Model, was proposed by Davis in 1989. TAM is basically based on two constructs: Perceived Usefulness and Perceived Ease of Use. Because users in this phase of testing have no components other than looking for information on the interface, Perceived Ease of Use is not interesting to evaluate and the Perceived Usefulness component was chosen. In this work a reformulation of TAM was used, constituting TAM3.

8. Validation with singular changes

It was found that the two most relevant elements for Conscientiousness were Font Size and Image Caption Alignment. For simplicity the Font size too small and too large options were removed because they are poorly chosen and do not represent variations between the types of Conscientiousness. Thus, for the **Font Size** element the options tested were: small, medium or large font size. For the **Image Caption Alignment** element, the options tested were: left alignment, center alignment, and right alignment.

Based on these elements, nine interfaces were created with different possible combinations:

1PE- Small Font size - P and image caption aligned with left - E

2PC- Small Font size - P and image caption aligned with center - C

3PD- Small Font size - P and image caption aligned with right - D

4ME- Medium Font size - M and image caption aligned with left - E

5MC- Medium Font size - M and image caption aligned with center - C

6MD- Medium Font size - M and image caption aligned with right - D

7GE- Large Font size - G and image caption aligned with left - E

8GC- Large Font size - G and image caption aligned with center - C

9GD- Large Font size - G and image caption aligned right D

The nine interfaces followed the same structure only varying in the elements described above. For users to focus on the tested elements the interfaces followed a simple formatting only with text groups accompanied each with an illustrative image of that group. The remaining elements were chosen to follow the common preference trends of both groups. Unlike the adaptable interface created, these interfaces had a subject and content for users to pull information from. The interface subject was a list of the rarest animals in the world in an attempt by users not to know the answers and need to look for information in the interfaces, thus interacting with all components of the interface.

8.1. Participants

From the list of participants recruited in the first test session, 50 users were randomly selected for this test session with 27 of them low Conscientiousness and 23 participants high Conscientiousness (M=22.67,SD=3.13).

8.2. Procedure

- Before the test began, the order of interfaces with which participants would interact was randomly selected so that there was no influence of the order of exposure of interfaces on user preferences.

- For the same reason, the order of tasks requested to the user were also previously randomly selected.
- Upon completion of test preparation, the sitting participant is asked to sit down.
- Test is explained and all the equipment involved is demonstrated.
- After, the participant is asked to complete the consent form for the test.
- Test is then started showing in the order previously selected the interfaces one by one. For each interface two questions are asked.
- After the participant correctly answering the two tasks proposed by the tester, the participant was asked to answer the System Usability Scale (SUS) questionnaire and the Perceived Usefulness questionnaire (part of TAM3), both answered through a computer.
- Finally, the participant was asked to rate the overall appreciation of the interface on a scale of 1 to 10. These steps were repeated on the nine interfaces.
- In the end the participant was also asked to choose which of the nine interfaces they preferred. The user was allowed to review the nine interfaces again in order to choose its favorite.
- At the end of the test, the participants were thanked for their time and given a rewarding chocolate. All responses to the questionnaires were recorded.

8.3. Data Analysis

For the tests, interface groups were created to evaluate the different guidelines.

1. Group 1: Interfaces 1, 4, and 7 with left-aligned image caption.
2. Group 2: Interfaces 2, 5, and 8 with center-aligned image caption.
3. Group 3: Interfaces 3, 6, 9 with right-aligned image caption.
4. Group 4: Interfaces 1, 2 and 3 with small font size.
5. Group 5: Interfaces 4, 5, and 6 with medium font size.
6. Group 6: Interfaces 7, 8 e 9 with large font size.

It was verified by the Kolmogorov-Smirmov normality test that none of the data followed a normal distribution, choosing nonparametric tests.

H1: Conscientiousness has an effect on user preference

Using Fisher's test the results showed no relevant differences between the two types of Conscientiousness for Font Size (D (49) = 1,871, p = 0.391) and for image caption alignment (D (49) = 2,933), p = 0.272). Thus hypothesis H1 is **refuted**.

H2: Conscientiousness has an effect on the user's overall rating

Font Size From the Table 5 it can be concluded that for both types of Conscientiousness there were significant differences between the interface classifications for the three groups.

	Low Cons		High Cons	
Interfaces	p value	chi-square	p value	chi-square
Group 1	<0.001	18.732	<0.001	19.311
Group 2	<0.001	16.075	0.009	9.433
Group 3	0.001	13.540	0.006	10.246

Table 5: Friedman test to analyze the relevance of user's overall rating in relation to font size

However, after individual analysis of each pair of interfaces using the Wilcoxon Post-Hoc Test with a Bonferroni correction it was found that there were no significant differences between the interfaces with small font size and medium font size.

Image caption alignment From the Table 6 it can be concluded that there are no significant differences into the groups for Low Conscientiousness and for High Conscientiousness.

	Low Cons		High Cons	
Interfaces	p value	chi-square	p value	chi-square
Group 4	0.244	2.821	0.614	0.974
Group 5	0.651	0.857	0.383	1.920
Group 6	0.177	0.177	0.668	0.808

Table 6: Friedman test to analyze the relevance of user's overall rating in relation to image caption alignment

Conclusion: There are no significant differences in overall appreciation ratings for image caption alignment. Regarding font size there are no significant differences between interfaces with small font size and medium font size so H2 is **inconclusive**.

H3: Conscientiousness has an effect on user usability.

Font Size From the Table 7 it can be seen that for users with low Conscientiousness there were significant differences between the usability values of the interfaces for the three groups.

	Low Cons		High Cons	
Interfaces	p value	chi-square	p value	chi-square
Group 1	0.004	11.049	0.017	8.121
Group 2	<0.001	15.390	0.085	4.926
Group 3	0.023	7.562	0.078	5.115

Table 7: Friedman test to analyze the relevance of user's perceived usability in relation to font size

However, after individual analysis of each pair of interfaces, no significant differences were found between the interfaces with small font size and medium font size. For users with high Conscientiousness there were only relevant results for Group 1, but it was also found that there were no significant differences between the interfaces with small font size and medium font size.

Image caption alignment From the Table 8 it can be concluded that there are no significant differences between the groups for Low Conscientiousness and for High Conscientiousness.

	Low Conscientiousness		High Conscientiousness	
Interfaces	p value	chi-square	p value	chi-square
Group 4	0.092	4.780	0.077	5.119
Group 5	0.525	1.289	0.557	1.170
Group 6	0.987	0.026	0.586	1.069

Table 8: Friedman test to analyze the relevance of user's usability in relation to image caption alignment

Conclusion: There are no significant differences in usability values for image caption alignment. Regarding font size there are no significant differences between interfaces with small font size and medium font size so H3 is **inconclusive**.

H4: Conscientiousness has an effect on user perceived usefulness

Font Size From the Table 9 it can be seen that for users with low Conscientiousness there were significant differences between the perceived usefulness values of the interfaces for the three groups.

	Low Conscientiousness		High Conscientiousness	
Interfaces	p value	chi-square	p value	chi-square
Group 1	0.001	13.028	<0.001	15.590
Group 2	0.001	13.890	0.223	3.000
Group 3	0.008	9.616	0.578	1.098

Table 9: Friedman test to analyze the relevance of user's perceived usefulness in relation to font size

However, after individual analysis of each pair of interfaces, no significant differences were found between the interfaces with small font size and medium font size.

Image caption alignment From the Table 10 it can be concluded that there are no significant differences between the groups for Low Conscientiousness and for High Conscientiousness.

	Low Conscientiousness		High Conscientiousness	
Interfaces	p value	chi-square	p value	chi-square
Group 4	0.382	1.926	0.068	5.389
Group 5	0.533	1.258	0.285	2.513
Group 6	0.869	0.281	0.368	2.000

Table 10: Friedman test to analyze the relevance of user's perceived usefulness in relation to image caption alignment

Conclusion: There are no significant differences in perceived usefulness values for image caption alignment. Regarding font size there are no significant differences between interfaces with small font size and medium font size so H4 is **inconclusive**.

9. Validation with Global Changes

All elements studied in the preference collection phase were used in these two interfaces. These interfaces varied in six elements, which can be seen in Table 11 with their options. The remaining elements remained the same on both interfaces.

Element	Low Cons	High Cons
Body Size	Large	Medium
Image Side	Left	Right
Image Caption Alignment	Left	Center
Font Size	Small	Medium
Button Method	Numbers	Previous/Next
Button Shape	Square	Curve

Table 11: Elements with variations between groups and their choices for each group

The interface used for the High Conscientiousness type is Interface **A** and the interface used for the Low Conscientiousness type is Interface **B**

H1: Conscientiousness has an effect on user preference

Using Fisher Test, the results showed relevant differences between the two types of Conscientiousness with a *p value* < 0.001. In this way hypothesis H1 is **accepted**.

H2: Conscientiousness has an effect on the user's overall rating

Results from the Wilcoxon test indicate that there is no significant difference for low Conscientiousness in classifications of the two interfaces, with a *p value* of 0.717 but there is significant difference for high Conscientiousness with a *p value* of 0.002.

Conclusion: The results showed relevant differences in overall appreciation between interfaces for users with high Conscientiousness. Thus hypothesis H3 is **accepted**.

H3: Conscientiousness has an effect on user usability.

For low Conscientiousness the results from the Wilcoxon test indicate that there is no significant difference in classifications of the two interfaces, with a *p value* of 0.830 but there is significant difference fow high Conscientiousness, with a *p value* of 0.008.

Conclusion: The results showed relevant differences in usability between interfaces for users with high Conscientiousness. Thus hypothesis H3 is **accepted**.

H4: Conscientiousness has an effect on user perceived usefulness

Results from the Wilcoxon test indicate that there is no significant difference in values of the two interfaces for low Conscientiousness with a *p value* of 0.975 and for high Conscientiousness with a *p value* of 0.975

Conclusion: The results showed no relevant differences between interfaces for low and high Conscientiousness. Thus hypothesis H4 is **refuted**.

10. Results and discussion

From the testing phase resulting from the changes in the interface of elements individually there were no conclusive results regarding either the preference and classification of the interfaces or the usability and usefulness of them, not allowing to conclude that these changes led to a better user experience. The reason that there were no significant differences in interface values may be due to the fact that the elements chosen as being the most relevant to Consciousness are not those that have the most expression in the design of an interface. Thus, although there are differences between the two interfaces in the chosen elements and they were highlighted in both the interfaces and the tasks required of users, the various interfaces would be very similar overall causing very similar values. Elements such as color and font size, and image size, for example, tend to have a greater preponderance in the attention and preference of interfaces than image caption alignment. Thus, although users have a preference for image caption alignment, it has no expressive user experience in the presence of elements with more impact on interfaces.

As for the testing phase in relation to interfaces with global changes, there was a significant difference in user preferences regarding the type of conscientiousness. That is, users with different Consciousness chose different interfaces. This hypothesis allows us to conclude that **Conscientiousness is indeed relevant to the design of an interface**.

After analyzing the remaining hypotheses, it was found that for users with high Conscientiousness there were results relevant to the overall appreciation of interfaces and usability, where all users rated the interface **A** higher than the interface **B**. Regarding the perceived usefulness there were no significant differences between the two interfaces.

For low consciousness, none of the metrics had significant results. For the three metrics there was a slight tendency for the interface **B** but not enough to achieve relevant results.

11. Conclusions

This research starts from the impossibility of creating a single interface that meets the needs of all users. As a solution to this problem, we investigated the relevance that Conscientiousness, one of the personality domains, had for the interface design and if there is significant relevance, understand if users would get an improved UX interacting with an interface tailored to the type of user awareness. For this purpose hypotheses were created to assess whether Conscientiousness had an impact on the preference, general appreciation, usability and perceived usefulness of an interface. An exhaustive statistical analysis confirmed that there is a relevance of Conscientiousness to an interface's design, with users preferring custom interfaces to their Conscientiousness type. This relevance only manifests itself in interfaces with multiple adapted elements but not in interfaces with single relevant element switching. There were relevance to the overall appreciation and usability of a custom interface for users with high Conscientiousness as opposed to users with low Conscientiousness where no significant differences were found. For the perceived usefulness of the interfaces, there were no relevant results for either type of conscientiousness. From these results, it can be concluded that **Conscientiousness is relevant to the interface design, leading to an improved UX for users with high Conscientiousness, specifically regarding the overall appreciation and usability of the interfaces**.

A set of design guidelines was derived from this work for each Conscientiousness group, as well as a classification framework that effectively detects the user's Conscientiousness type through their physiological responses in real time, with an accuracy of 85.1%.

In future work, more users should be used at different stages of testing to ensure stronger results and a classifier with higher accuracy. Other divisions in Consciousness groups should also be tested, because dividing Consciousness into just two groups allows users in the same group to have very different Conscientiousness values. For brainwave collection more sensors should also be used to ensure greater reliability.

Finally, in future work, relevant elements should be chosen through other metrics than user preference to avoid scenarios where one element is chosen because preferences varied widely between Conscientiousness groups but users were not convinced of that preference and discarding elements with a smaller preferential difference between the two Consciousness groups but with stronger convictions.

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