Games as Personality Profiling Tools

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***Abstract*—In this paper we investigate whether a personality profile can be determined by observing a player's behavior in a game. Five personality traits are used to define a personality profile. They are adopted from the Five Factor Model of personality. The five traits are measured by the *NEO-PI-R* questionnaire. For our purpose, we developed a game module for the game *Neverwinter Nights*. The module automatically stores a player's behavioral data. Experimental trials were run measuring the behavior of 44 participants. The experiment produced game behavior scores for 275 game variables per player. Correlation analysis shows relationships between all five personality traits and the video game data. From these results, we may conclude that a video game can be used to create an adequate personality profile of a player.**

I. Introduction

Personality is a way for humans to describe themselves and others. Personality descriptions are made up of statements about behavior patterns that are stable over time and across situations [7]. An example of a personality description is that people who consistently act friendly to those around them are considered to have an agreeable personality. Scientists have been searching for models to describe personality. During the twentieth century, the Five Factor Model (FFM) has emerged as the most widely accepted model for that purpose [4].

Gathering data to score individuals on the FFM is generally done using personality questionnaires, even though data gathered through interviewing or observation is considered to be more reliable [8]. Still, questionnaires are frequently used because rating personality requires many samples of data across a wide range of situations. The need for extensive and wide data gathering makes interviews and observation time consuming and expensive. Questionnaires provide a reasonable alternative to interviewing and observing but their advantage in time requirements comes with a decrease in reliability [5].

Differences between players lead to different playing styles and preferences. Assuming that there are stable patterns in game behavior and assuming that these patterns are related to personality, games may be used as an alternative method of establishing personality profiles in the FFM. In this research we investigate whether individual differences in video game behavior are related to differences in personality.

In the present research, we investigate whether personality is present in game behavior by correlating recorded game behavior to scores on the *NEO-PI-R* personality questionnaire. We use a scenario similar to those found in commercial computer games on the market today. In Section 2 we provide background information on personality and on the FFM. In Section 3 we provide our experimental setup. In Section 4 we explain our analysis and present our results. In Section 5 we discuss our results. Finally, Section 6 provides conclusions and points to future work.

II. Background

According to Costa and McCrae [3] personality is defined as the stable pattern of variation in individual acting, thinking, and experiencing. Personality arises from interactions between (1) the situation in which the individual is placed and (2) processes that take place in the individual [1]. Personality theory implicitly assumes personality results from interactions but personality scores are a result of measurements across situations and can therefore be generalized [9].

In this research we focus on the Five Factor Model of personality (FFM). This model claims that by using five personality traits we can describe all variations of personality across all ages, sexes, and cultures. The five traits used to describe personality in this model are (1) openness to new experience, (2) conscientiousness, (3) extraversion, (4) agreeableness, and (5) neuroticism (these five traits are often abbreviated as "OCEAN") [7]. Trait scores follow a normal distribution. We will give a description per trait in terms of behavior that can be seen in natural human settings. The exact definition of a trait tends to vary slightly between researchers. Here we adhere to the common definitions.

- *Openness:* The interest in novel stimuli. A high score is typically accompanied by curiosity and willingness to deviate from social conventions.
- *Conscientiousness:* The propensity to adhere to rules, both social and personal. This trait is also tied to the ability to restrain oneself and the ability to stick to a plan during periods of stress and difficulty.
- *Extraversion:* High scorers seek excitement and positive stimuli. This often leads to individuals seeking the company of others and seeking exhilarating situations like high speed driving, rollercoasters and other high adrenaline activities.
- *Agreeableness:* Explained as compliance, willingness to cooperate and friendliness. Low scorers tend to follow their own needs over those of others. High scorers are seen as empathic.
- *Neuroticism:* This trait is connected to fluctuating and negative emotions such as anger and fear. High scorers are more likely to check situations for safety. There is also a relationship to shyness and social anxiety.

Commonly, personality is measured using personality questionnaires. These questionnaires contain a list of descriptive statements for which the participant has to indicate the measure in which the statements describe him[1]. Ques-

[1]For brevity, we use "he" and "his" wherever "he/she" and "his/her"are meant.

tionnaires are typically designed by using factor analysis to cluster large lists of descriptive terms. The resulting structure of the clusters found describes the five traits in the FFM [7]. Scores on personality questionnaires correlate strongly with various areas of human behavior and preference. Examples are human job preference, relationship styles [10] and smoking behavior. The *NEO-PI-R* questionnaire, developed by Costa and McCrae [3], is a widely accepted test for measuring the FFM.

III. Methodology

In our experiment we attempted to correlate personality scores to game behavior. In order to perform our experiment we applied two measurements, (1) participants took the *NEO-PI-R* personality test, and (2) the same participants played a game and we recorded their behavior. A description of the *NEO-PI-R* has already been provided in the background section. In Section III-A we present general information on the participants and the setup of our investigation, we continue in Section III-B with a description of the game we have used. We finish in Section III-C with a description of the variables we have constructed in the game in order to measure behavior in the game.

A. Participants and Timeframe

In total we worked with 44 Dutch speaking participants. Playing the game lasted 60 minutes at maximum. If the player does not finish the game within 60 minutes the game automatically stops. To fill in the full *NEO-PI-R* five-factor personality questionnaire took between 45 and 60 minutes. The resulting complete experiment took an average of 90 minutes.The participants were informed that all data would be collected anonymously. The order in which the questionnaire and the game were given was reversed for half of the participants. This was done to counterbalance any effects that playing the game might have on responses on the personality questionnaire and vice versa.

B. Game

We chose to design a game scenario in which the player experiences many of the situations commonly found in role playing games. We wanted participants to experience a wide range of game situations in the timeframe of 60 minutes because we felt this would provide us with a more complete view of player behavior. We created a game scenario (henceforth module) for the game *Neverwinter Nights* (*NWN*). The module contains the story, characters, and the relevant locations in the game. In order to accurately show the experimental setting, our description of the game includes (1) the controls used, (2) the story, and (3) the world the story takes place in.

1) Controls: Our aim was to keep the game controls as simple as possible in order to minimize the learning curve involved to master gameplay. To reach this goal we only use mouse movement and the left mouse button to control the game.

The interaction between participant and the game is by mouse control. The player can (1) move by clicking in the area, (2) interact with objects by clicking on them, and (3) start conversations by clicking on a non-player character (NPC). Conversations are in the form of menus; the player chooses a response on an NPC statement from a list of possible answers (lists contain 1 to 5 items).

2) Story: The game's story consists of three parts; (1) a training sequence, (2) the main story, and (3) several smaller side-stories that are unrelated to the main story. Table III-B3 contains a list of the characters in the game that are important to the main and side stories. The game starts with a training area in which the participants learn how to perform the various actions that are possible in the game. Participants also learn how to use the map and their inventory. The training also explain the use of the logbook. The logbook records the events of the main story line in case the participant errs. After the training, the participant starts the main story. The main story involves a multi-step mission that leads the participant through various situations commonly found in games. A short summary of the main storyline is as follows.

- Go to the village for an errand.
- Discover the poisoned shopkeeper.
- Go to a sage for advice.
- Go to the cave to stop the cause of the poisoning

There are two side stories. The completion of these stories is not required for the completion of the main story. The side stories are only encountered if the participants take the time to talk to the NPCs that start the stories, Siline and Evana. In the first side story the participant has to go talk to an NPC to ask him to stop bothering Siline. The second side story starts when the poisoning is discovered. In this story, the participant has to tell a child to go home to its mother in order to reduce the risk of her being poisoned. Following these side stories will lead to delay in completing the main story. Such a delay is one of the indicators for playing style, preference or behavior.

3) World: The world is made up of 16 areas. There are 5 outside areas and 11 inside areas. Except for the training area, the player can freely move between all areas once he has opened the way to them. There is only one way closed to the player. This is the way from the village to the forest and it is closed for story purposes. If the participant has not found the poisoned shopkeeper he has no reason to be in the cave or to talk to a sage in order to follow the main storyline. The participant can only advance past this obstacle after having found the dead shopkeeper.

C. Variables and Analysis

In this experiment we collected data of the participant's game behavior. We describe two categories of variable, unpooled and pooled. The number of unpooled variables was 226 and the number of pooled variables was 49, making a total of 275 variables for the entire game. All variables in the game are natural numbers with unlimited range. Subsection III-C1 explains the rationale behind unpooled variables while Subsection III-C2 explains the pooled variables.

TABLE I
THIS TABLE CONTAINS THE NAMES OF THE CHARACTERS ENCOUNTERED IN THE MAIN STORY AND SUB STORIES.

Character Name	Area
MrRed	Dream
MrBlue	Dream
Siline	Lumbercamp
Dara	Village
Old man	Village
Burrick	Village
Evana	Village
Myztor	Forest
Moricho	Cave

1) Unpooled Variables: In order to gather our data, 226 variables were created. They were split up into three types of behavior, (1) movement, (2) conversation, and (3) miscellaneous (e.g., interaction with objects). There were 133 variables that recorded conversation behavior, 89 that recorded movement behavior, and 4 that recorded miscellaneous behaviors. Each variable recorded the total number of times its monitored behavior was performed. Conversation variables recorded choices made in conversations. Each time one of the conversation choices was made, the value of its respective variable increased by one.

Figure 1 contains an example of conversation. For clarity we have made a translation from Dutch to English. The conversation occurs when the participant first encounters the NPC Siline. Siline: *Hi Moris how are you?*. Possible player responses are. (1) *I'm fine*, (2) *What are you doing here?*, (3) *Who are you?*, and (4) *I had the most bizarre dream*.

Fig. 1. A screenshot of a typical conversation.

The movement variables similarly record the total number of movement behaviors for each variable. The value of a movement variable was raised every time the participant entered the area in the game monitored by the variable. The movement variables were placed along the doors between the areas, halfway across areas, and around special objects such as trees and gardens.

2) Pooled Variables: We suspected that there might be personality effects of conversation or movement that only appeared when we looked at average effects across entire areas of game behavior. To comply with these considerations we also created pooled variables that collect the values of all unique variables per area, per NPC, and for the entire game. These pooled variables could for example be used to examine the overall tendency of a player to move around or to engage in conversation. Individual unpooled variables might miss such tendencies. In pooling we counted and summed the values of the variables to form the pooled variable. The following list presents the overview of the final variable set we used. The variables are divided into five groups in order to clarify the results presented in the next section. The first four groups contain the pooled variables while the final group contains the unpooled variables.

- *Group 1* contains 6 pooled game variables monitoring conversation, total movement time and game finished conditions for the entire game.
- *Group 2* contains 16 pooled move variables per area.
- *Group 3* contains 9 pooled conversation variables per area.
- *Group 4* contains a pooled conversation variable per NPC; 18 variables in total.

A fifth group was added to make the variable collection complete. This group contains the 226 unpooled variables.

IV. RESULTS

All variables, individual and pooled, were analyzed using correlation analysis. We investigated the correlations between the game variables and scores on the five traits measured by the *NEO-PI-R* personality questionnaire.

Because of the large variations commonly present in human behavior and the large number of factors influencing this behavior (personality, intelligence and learned associations) psychologists consider the following correlations to be indicative for effect sizes in a relationship between personality and the participants game behavior [2].

- *small effect* r = .10 (1% of variance explained)
- *medium effect* r = .30 (9% of variance explained)
- *large effect* r = .50 (25% of variance explained)

The analysis shows significant results for all traits of the FFM. Correlations with $p < 0.05$ are considered to be significant. Below, we describe the results by personality trait.

Table IV contains the total number of positive and negative significant correlations per group. Empty cells indicate a lack of significant correlation. Table IV contains the minimum, maximum and average of positive and negative correlations per group.

Significant correlations are found between all five personality traits and game variables in all groups. We observe effects of openness on all five groups in specifically negative correlations. This is shown in Table IV, where most correlations for openness are negative. Conscientiousness shows mostly positive effects that can be found in groups 3, 4,

TABLE II
THIS TABLE CONTAINS TOTAL NUMBER OF POSITIVE AND NEGATIVE CORRELATIONS PER GROUP.

	Group 1		Group 2		Group 3		Group 4		Group 5	
	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg
Openness	1	5	1	5		5		8	8	68
Conscientiousness					3		4		22	4
Extraversion			1				2		11	10
Agreeableness								1	7	7
Neuroticism	1							1	7	7

TABLE III
THIS TABLE DISPLAYS THE MINIMUM, MAXIMUM, AND AVERAGE CORRELATIONS FOR EACH GROUP.

		Group 1		Group 2		Group 3		Group 4		Group 5	
	Corr.	Pos.	Neg.	Pos.	Neg.	Pos.	Neg.	Pos.	Neg.	Pos.	Neg.
Openness	Min.	.281	-.439	.293	-.258		-.280		-.274	.251	-.251
	Max.	.281	-.508	.293	-.464		-.530		-.513	.322	-.551
	Avg.	.281	-.478	.293	-.357		-.396		-.398	.272	-.358
Conscientiousness	Min.					.266		.281		.254	-.257
	Max.					.371		.423		.458	-.340
	Avg.					.317		.331		.331	-.289
Extraversion	Min.			.293				.283		.252	-.261
	Max.			.293				.285		.350	-.374
	Avg.			.293				.284		.290	-.304
Agreeableness	Min.								-.255	.257	-.263
	Max.								-.255	.458	-.367
	Avg.								-.255	.314	-.314
Neuroticism	Min.	.273							-.274	.255	-.260
	Max.	.273							-.274	.354	-.329
	Avg.	.273							-.274	.287	-.296

and 5. Overall, we observe that all traits have effects in the conversation domain. We also observe that only for openness and extraversion movement related results are found. The complete collection of results can be found on *anonymous*.

We observe a total number 68 positive correlations and 121 negative correlations. This means that 189 of our 275 variables had significant relationship to any of the personality traits. This is 69% of all the variables. Correlated variables can be seen for each of the five personality traits. From these results we may conclude that significant effects of all five personality traits are present in conversation and movement behavior in the game.

V. DISCUSSION

The goal of this research was to investigate whether relationships between personality and video game behavior exist. All five traits of the FFM, as measured by the *NEO-PI-R* have been found to correlate significantly with game behavior. We discuss our results per group of variables. These groups are subdivided in subsections V-A to V-E. We finish our discussion with general remarks about our results.

A. Openness

We found the following results per trait and per group.

- Group 1; one variable correlated positively with openness (0.281). Five variables correlated negatively with openness (between -0.439 and -0.508). Openness shows strongly negatively correlated effects for number of movement variables, and number of total conversation behavior on starts, choices in behavior and endings. The only exception is the positive relation for the chance of ending the game within 60 minutes In summary, participants with higher openness spend less time in the game, are more likely to finish the game, start and end less conversations and make less choices in the conversations; they also trigger less movement variables in the game.
- Group 2; one variable correlated positively with openness (0.293). Five variables correlating negatively with the openness trait (between -0.258 to -0.464). We see that the majority of the movement-related effects are correlating with openness. This shows that a higher openness score relates to less movement per area.
- Group 3; five variables correlated negatively with openness (between -0.280 and -0.530). Group 3 and 4 both show that high scores in openness mean that the participant is conversing less with the game characters than those with lower openness scores.
- Group 4; eight variables correlated negatively with openness (between -0.247 and -0.531). Almost half of all the characters were negatively correlated to openness. None of the main plot related characters had any correlation.
- Group 5; eight variables correlated positively with openness (between 0.251 and 0.322). 68 variables correlated negatively with openness (from -0.251 to -0.551). The majority of these variables show that those with lower openness cause more activity on all variables and vice versa. It should also be noted that the participants with higher openness spent less time in the game and

have therefore less opportunity to increase the variable values.

Large trends can be seen in the variables in this trait. High scorers only score positively on variables related to the main story of the game, uncorrelated to conversation items relevant but not directly related to the main plot line and negatively to items completely unrelated to the main story. It seems that high openness participants tend to focus mainly on completing the main story of the game.

B. Conscientiousness

- Group 3; four variables correlated with conscientiousness (between 0.281 and 0.423). Two of the variables relate to a side quest in which the participant has to go and send a child home before it is poisoned. They involve talking to the child's mother and to the child itself. The third variable measures the amount of conversation in the inn area. There are many characters in the inn that have no relevant information to the main quest.
- Group 4; three of the variables correlated positively with conscientiousness (between 0.266 and 0.371). Two of the four variables relate to finishing side quests. The other two measure talking to the characters in the inn that have the longest conversations. In these conversations they only give personal information and opinions. Their conversations have no relevance to either the main quest line or the side quests.
- Group 5; conscientiousness correlates positively to 22 variables (between 0.254 and 0.458) and negatively to 4 variables (between -0.256 and -0.340). The variables relate mainly to the completion of side quests.

C. Extraversion

- Group 2; one variable correlated positively (0.293). This variable measures the amount of movement in the dream training area. This is the only area with surrealistic lighting conditions and could relate to the need for excitement seeking.
- Group 4; two correlated positively with extraversion (between 0.283 and 0.285). One of the variables measures talking to the waitress in the inn. The other variable measures the amount of conversation to the NPC with a bad temper in the inn. The NPC only responds in a rude manner and there is a side quest in which the participant has to tell this character to leave another character alone.
- Group 5; eleven variables correlated positively (between 0.252 and 0.350) and ten variables correlated negatively (between -0.261 and -0.374. Compared to conscientiousness and agreeableness this trait relates to many movement variables.

D. Agreeableness

- Group 4; one variable correlated negatively with agreeableness (-0.255). This variable relates to the amount of conversation with the old man NPC. He is part of the main quest line. About half of the conversation choices the participant can make with this NPC are relatively rude compared to the other conversation choices in the game. The other conversation choices relate about receiving personal information from the old man and gaining instructions required to follow the main quest.
- Group 5; seven variables correlated positively (between 0.254 and 0.458) and seven variables correlated negatively (between -0.263 and -0.367). The variables agreeableness relates to are those related to warning the villagers about the poisoned water in the lake. Other variables this trait relates to are common curtesy variables like saying thank you and greeting others in a friendly manner.

E. Neuroticism

- Group 1; neuroticism correlates positively to the amount of play time (0.273). This means that higher neuroticism scorers take longer to finish the game.
- Group 4; one variables correlated negatively with neuroticism (-0.274). The NPC that this variable relates to has conversation relating to his secret love for another NPC and the resulting conflicts with a rival.
- Group 5; seven variables correlated positively (between 0.255 and 0.354) and seven variables correlated negatively (between -0.260 and -0.329). Neuroticism shares second place with extraversion for relating to movement variables.

F. General Remarks

In this experiment, positive correlations in conversations can have two explanations (1) the choice was made because it was more attractive than the others, or (2) the other choices were in some way less attractive. With negative correlation this means that (1) the choice was less desirable than the other choices, or (2) some aspect of other choices made them more important. These distinctions are relevant because explanation 1 implies that the reason for actively choosing or avoiding a choice is inherent to the correlation variable. Explanation 2 implies that the cause of the variation lies in other variables but is expressed in the correlation. For example, not choosing choice 1 (out of 1, 2, or 3) could be because choice 1 is unattractive or because choice 2 and 3 are both more attractive than choice 1. The reverse is true for positive correlations, choice 1 (out of 1, 2, or 3) could be the most attractive or 2 and 3 could both be unattractive.

Openness is the most influential variable for the overall game behavior effects. High scorers tend to finish the game more often and show less conversation or movement triggers. Movement triggers could be considered to be explorative behavior of the game world or goal directed behavior. Openness is often linked to curiosity and the willingness to try new things. Surprisingly, the results show that openness has negative correlations to many of both the individual as well as the pooled variables. At first glance, this effect seems counter-intuitive. We would expect individuals with high openness to be interested in the various aspects of the

game that can be explored but when we inspect the data we see the opposite effect. A possible explanation for this effect is that high scorers are mostly interested in novel situation and thus hurry through the game looking for variation while experiencing the various types of situations briefly. Another possible explanation is that the module we built is not original enough, this could cause high openness individuals to seek their novelty elsewhere.

One of the limitations of our approach is that the variable information gained is hard to generalize across games. A first possible solution could be to identify situations that are similar across games and to investigate the correlations of behavior between games within these situations. A second possible solution is to reduce the complexity of the game and correlate many game properties to personality in order to extract the specific interactions between the game properties and the traits.

Our correlations do not often reach the large effect sizes (correlation of 0.5 or higher) but they are significant. We suspect this is owing to the fact that we did not fine-tune our game as primarily a personality test. There may be dozens of factors influencing behavior in a natural setting. Because of this it is reasonable to expect low correlations when looking at any single factor. As said before in Section III-B2, correlations between 0.1 and 0.5 are, when significant, very reasonable results [2]. We wanted to see whether personality effects can be found in games similar to those normally played and we have succeeded. Previous reseach indicated that trait prediction can be improved by putting situations in the game that are optimally suited to each trait's expression [6].

The argument could be made that our conversation items are multiple choice questions and that they are therefore the same as the multiple choice items in personality questionnaires. Conversation choices in the game are multiple choice but they are not the same as the multiple choice items in a personality questionnaire. Items in a questionnaire are descriptive statements on which the participant has to rate himself. In contrast, conversation choices in the game are responses to NPC statements. These statements are not descriptive statements about the player. The player expresses his personality through his behavior in the game rather than describing himself.

VI. Conclusion

In our research we tested 44 participants on 275 game behavior variables and on the *NEO-PI-R* personality questionnaire.

From our results we may conclude that personality effects on game behavior exist for all five traits of the FFM. We found these effects when we correlated the game behavior variables to scores on a personality questionnaire. Therefore we also conclude that we are able to produce accurate estimates of a participants personality based on the game variables.

This investigation examines the effects of personality in only one game with the role playing game type. In future work we will investigate the effects of personality in other games and in other game types. A second aim for the future is testing whether personality preferences can be used to improve the game experience for participants. Finally, we are interested in investigating whether a game is more suitable to predicting behaviors in a natural setting than a personality test is.

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