

# Psychologically Verified Player Modelling

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## ABSTRACT

This research attempts to measure personality by monitoring behaviour in a virtual environment. A computer game was created to measure a trait of the Five Factor Model of personality: extraversion. Test-items were created to measure extraversion and its facets, as specified by Costa and McCrae [7]. For this purpose, 25 items were built into the virtual environment. In order to test if these measures actually measure extraversion and its facets, an experiment was conducted. In this experiment 24 participants completed our computer game and filled out an existing personality questionnaire, the NEO-PI-R [7]. Multiple Regression Analyses was used to test the correlations between the test items and the NEO-PI-R scores. Five of the items had a positive correlation with the NEO-PI-R extraversion-score, indicating that test-items in a virtual environment can actually be used to measure extraversion. We conclude that it is possible to measure personality traits, and consequently a valid psychological profile, through automatic observation of player behaviour in games.

## INTRODUCTION

Personality profiling concerns the mapping of human characteristics to a model. Deciding what constitutes a good model has long been a matter of debate [18]. Over time the five factor model emerged as the best established and most validated model of personality [12]. Nowadays, the five factors of this model are generally considered to be the main structure of human personality [6]. Based on their research, Costa and McCrae [9] even suggest that the five factor model is the universal structure of personality.

The most widely accepted instrument for measuring the five factor model is the NEO-PI-R personality test [6], which is used in the present research. The factors of the five factor model are Extraversion, Neuroticism, Agreeableness, Conscientiousness and Openness to experience. The NEO-PI-R measures an individual's "characteristic and enduring emotional, interpersonal, experiential, attitudinal, and motivational styles" and is therefore suitable for measuring individual differences in various situations [11].

Personality theory has demonstrated its use in a variety

of areas. It has shown that there is a consistent relationship between conscientiousness and academic success [22], that drinking motives are related to extraversion [25], and that low agreeableness combined with low conscientiousness predicts juvenile delinquency [19]. Personality profiling is also used in practice to profile offenders and aid law-enforcement agencies in understanding their motives [3].

## Limitations in Personality Questionnaires

Current methods of personality profiling encompass written tests, verbal tests, and observational studies. These methods suffer from several drawbacks, which are discussed below.

Both written tests and verbal tests are based on the assumption that a respondents reports are truthful. Thus, they are vulnerable to inaccurate or untruthful self-reporting. It has been shown that respondents are unable to accurately report their own habits. Gross and Niman [17] point out that self report data have little correlation to actual behaviour frequencies.

Observational studies are considered to be more reliable and more objective than self reports [1]. However, these studies suffer from high cost and high effort in data collection. Gathering sufficient data through observational studies to form an adequate model of personality may take years of work and involves numerous observations on numerous subjects [10].

All explicit tests of personality are vulnerable to socially desirable behaviour. People tend to act more socially favourable when they feel they are being evaluated or judged, by presenting themselves in a more accepted fashion. An example of this is that people tend to act more conscientious than they really are [15].

## Motivation

To alleviate the problems of the personality tests in use today, this research aims to create an implicit observational test that is administered by a virtual environment. The function of this test is to measure personality using automated observation without the need for human effort. In the past this was considered to be virtually impossible [10].

The goal of the present research is to model a sub-

ject's personality automatically based on their actions and choices in the game. The risk of using a game is that players can act unlike their 'real-life personality' and more like the role of the character that they play. However, we assume that, even if subjects are playing a role, there will still be characteristic behavioural patterns that belong to their personality.

Game environments have the advantage that they provide the opportunity to incorporate many types of personality tests. In a game information can be offered in implicit and explicit ways as well as in observational items and self-report fashions.

## Problem Statement

This research investigates the possibilities of using virtual environments to profile personality. We investigate the correlations between behaviour in the game and personality test scores. The problem statement that guides the research is: *To what extent is it possible to build a psychological profile of a person by monitoring his actions in a virtual world?*

We attempt to solve this problem by comparing behaviour in a virtual environment to responses on the NEO-PI-R test. To the best of our knowledge, no previous research on this topic exists. In the present paper we limit our research to just one personality trait, namely extraversion.

## Outline

This first section provided a short introduction to the field of psychological profiling and the reasons why we think a new way of testing would be a welcome addition to the currently available tests. The next section gives an overview of the theoretical framework of the history of the five factor model and its most important tests and practical uses. A further insight into the extraversion trait is also given. We then describe our experimental setup used for conducting the experiment, after which we present our results and derive conclusions and recommendations for future research.

## BACKGROUND

In this section we present a theoretical framework for our research, discussing the five factor model, the extraversion personality trait, and player modelling and profiling.

### The Five Factor Model

Comparisons between people are commonly based on traits [18]. The earliest known personality descriptions were suggested by philosophers. They first explored personality through observation and reasoning. They tried to understand illness, emotional suffering, and be-

haviour [20]. Thinking about personality followed a logical rather than empirical line of thought.

In the 19th century psychiatry explored personality in an attempt to cure mental illness. Freud and Jung were among the first to examine properties of the mind in order to diagnose dysfunctional behaviour [16]. Freud's ideas were based on personal philosophies, while Jung required empirical evidence and fact to support his theories [24]. Jung's ideas are at the basis of modern psychology.

If a psychological theory is empirically validated and the model is standardised it can be used to compare individuals to groups of people. William Wundt started the empirical validations of personality by using experimentation. Wundt laid the basis for modern experimental research methodology, and investigated various domains of psychology including consciousness, perceptions, sensations and feelings [20]. These accomplishments lead directly to the domain of psychological profiling.

At the start of the 20th century personality theory was seen as a chaotic and unstructured field. Personality was being researched in different levels of abstraction and from different perspectives [19]. Each perspective contributed to the field but the diversity of personality scales measuring the different perspectives on personality made it impossible to compare and choose scales [18, 19]. In order to give structure to the field of personality research, a descriptive model was needed. A single taxonomy would allow for comparison and structure between scales and perspectives [19]. One taxonomy was found in which the entire field could be represented: *the five factor model of personality*.

The five factor model was based on the terms people use to describe each other's stable attributes. The model divides personality into five domains by which a description of someone's personality can be given. The model was designed by analysing the natural language terms people use to describe one another [19]. Thurstone [27] was the first to suggest a system of five domains. Several other researchers found evidence for a system of five factors. This marked the start of the five factor model [28].

The five factor model was independently confirmed in several studies but received near fatal criticism. Mischel [21] criticised the trait approach in general and disputed the reliability of five factor research up to that time. Costa and McCrae [11] also provided criticism but also provided a more reliable instrument as the solution to the criticisms: the NEO-PI-R.

### The NEO-PI-R

Costa and McCrae developed the first robust tool for measuring the five factor model: the NEO-PI (which is an abbreviation for Neuroticism, Extraversion and Openness to experience Personality Inventory). The NEO-PI was meant to replace earlier, suboptimal tests

measuring the five factor model [11]. The earliest versions of the NEO-PI measure only three personality traits, in the following years two others were added.

The NEO-PI divides every trait into six facets. These facets provide a detailed specification of the contents of each domain [8]. The facets were designed to be supported by existing literature. They were meant to be similar in breadth and should represent “maximally distinct” aspects of each domain.

A more modern test, the NEO-PI-R (the ‘R’ standing for ‘revised’), is now considered a reliable and valid test for personality. It contains 240 items measuring the five domains and their facets. It has been thoroughly tested [11], and is widely accepted as the standard model of personality structure. The domains of the five factor model as labelled by Costa and McCrae and tested by the NEO-PI-R are: Extraversion, Neuroticism, Agreeableness, Conscientiousness and Openness to Experience.

## Extraversion

In this research we focus on the trait of extraversion. This trait was first proposed by Jung, who described it as the inward or outward focus of libido. Introverts tend to turn their energy, focus and orientation towards themselves, while extraverts focus outside themselves. Costa and McCrae [7] describe people with high extraversion as sociable, meaning they prefer to be in the company of others and in social situations. They introduced six facets of extraversion, namely:

- *Activity*: Active, energetic people have high pace and powerful movement. They need to be busy and radiate a feeling of energy. They have a busy and hasty life.
- *Assertiveness*: Assertive people are dominant, self-confident and controlling. They talk without hesitation and often lead groups.
- *Excitement-seeking*: Excitement seekers desire adventure, stimulation, and action. They like bright colours, noisy environments, and prickly sensations.
- *Gregariousness*: Gregarious people prefer the company of others. They seek out others and like crowds and group activities.
- *Positive emotion*: People with positive emotion have fun, and feel happy and joyful. They laugh easily and are often cheerful and optimistic.
- *Warmth*: Warm people desire to form emotional bonds with others by showing warmth and affection. They are friendly and show that they genuinely like others.

These facets can provide interesting information on their own but should always be considered in relation to the other facets and the domain as a whole [8]. Low scores on a facet do not indicate the opposite of the facet, just the absence of the tendencies of that facet. For instance, low positive emotion does not mean unhappiness, just an absence of positive emotion.

## Player Modelling versus Player Profiling

Player modelling is a technique used to learn a player’s tendencies through automatic observation in games [26]. The technique can be used to improve gameplay by, for example, adjusting difficulty or storyline to the player’s preferences.

The origin of player modelling is found in the domain of classic board games under the name of opponent modelling. It was simultaneously discovered in Israel and the Netherlands [13]. The goal of opponent modelling was to model the opponent’s decision making process in order to make the best counter moves.

Opponent modelling spread to modern computer games as a means of calculating the best way to defeat opponents. As in classic games, opponent modelling tried to model the opponent’s decision making strategies in order to make the best moves. Recently this goal has shifted. The emphasis is no longer on making the strongest moves but rather it is on increasing entertainment [2]. A good example of player modelling attempting to enhance the entertainment of games is the research by Thue [26] and by El-Nasr [14], in which player models are used to adapt the story and action in the game in order to fit the player’s preferences.

The major differences between player modelling and player profiling lie in the features modelled. Player modelling attempts to model the player’s playing style, while player profiling attempts to model the player’s personality. The models produced by player profiling are readily applicable in any situation where conventional personality models can be used. Player profiling is also supported by a large body of psychological knowledge.

## EXPERIMENTAL SETUP

To test our hypothesis that a player profile can be constructed by automatically observing player behaviour in a game, we developed a game using the Neverwinter Nights environment. Neverwinter Nights is particularly suitable for this purpose, as it comes with a powerful, easy-to-use toolset that allows the creation of large virtual worlds with social interaction and conversation. It also allows for the logging of player behaviour and choice.

We created a short story for the game that the player experiences. Playing through the story takes about half an hour. The story starts with a little girl asking the player to deliver a message to the king. The road to

the king is filled with several obstacles and encounters including: a beggar, several guards, a cleric, and several townspeople. Finally, the player will meet the king, and the game ends upon delivery of the message.

## Test items

It was impossible to directly convert items of the existing personality questionnaires into game test items. The NEO-PI-R asks introspective questions *about* behaviour. We needed to construct in-game situations in which the player had the opportunity to display actual behaviour. Our primary source of test item guidelines was Costa and McCrae [7]. Items were based on NEO-PI-R items as well as on real life situations that were expected to elicit extravert and introvert behaviour. The items were designed to give the players a broad range of possible behaviours to facilitate them in acting in a personal and natural way.

Items were divided into three categories: choice and Action, implicit Behaviour, and Conversation. These categories were guidelines in creating items for different types of behaviour. We attempted to create at least one item in each category for every facet of extraversion.

- *Choice and Action* (A) encapsulates explicit and rational choice. In test items belonging to this category the player faces a number of options from which to choose. The choices represent options ranging from those an extravert would make to those an introvert would make.
- *Implicit Behaviour* (B) covers unconscious behaviour that is performed as an automatic preference. In test items belonging to this category no conscious choice is involved. They often involve measuring the time a player takes to make a decision to distance that is travelled within a certain amount of time.
- *Conversational items* (C) can be found in the conversations and the available choices therein. Differences between choices can be found in the way information is being conveyed or in styles of conversation and presentation.

All items are sorted by facet of extraversion. As listed earlier in this paper, the facets are Activity (Act), Assertiveness (Ass), Excitement Seeking (Exc), Gregariousness (Gre), Positive Emotion (Pos), and Warmth (War). The items are coded to be a combination of the facet measured and the category used. For example: GreB is an item measuring gregariousness (Gre) through implicit behaviour (B). The list of items follows below.

### *Activity (Act)*

ActB\_1: The time it takes the player to complete the entire experiment. Active people are expected to finish the game faster.

ActB\_2: The player is forced to wait in a big, empty room for one minute. Active people are expected to cover more in-game distance during this period.

ActC\_1: The player gets to respond to a request to wait. Active people are expected to respond negatively to this request.

ActC\_2: The player is asked to confirm his response to ActC\_1. Active people are expected to stick by their choice.

### *Assertiveness (Ass)*

AssA\_1: The player gets a choice to lead or to follow. Assertive people are expected to desire to lead.

AssB\_1: The player needs information from an NPC who is in a conversation. Assertive people are expected not to hesitate to interrupt the conversation.

AssC\_1: The player gets a choice in how to address the king. Assertive people are expected to speak dominantly.

AssC\_2: A beggar continues to hassle the player for gifts in an increasingly aggressive way. Assertive people are expected to stand up for themselves.

AssC\_3: The player gets to confirm or retract his response to AssC\_2. Assertive people are expected to stick by their choice.

### *Excitement-seeking (Exc)*

ExcA\_1: The player gets to change the decoration of a room. Excitement-seekers are expected to select bright colours.

ExcA\_2: The player gets to choose music to play in the previously-mentioned room. Excitement-seekers are expected to prefer louder and faster music.

ExcB\_1: The player gets to choose a costume to wear. Excitement-seekers are expected to prefer colourful clothes.

ExcB\_2: The player gets a choice to fight with an annoying NPC or to flee. Excitement-seekers are expected to pick the option to fight.

ExcC\_1: The player gets a choice to either finish the story or ask for more work. Excitement-seekers are expected to ask for more work.

### *Gregariousness (Gre)*

GreA\_1: The player gets to search information in either a bar or a library. Gregarious people are expected to prefer the bar.

GreA\_2: The player gets a choice to continue on his own or in the company of a guard. Gregarious people are expected to prefer the company.

GreB\_1: The player needs to approach some NPCs in a bar. Gregarious people are expected to approach larger groups of NPCs.

GreC\_1: The player has a choice to explain his quest to a guard in terse or verbose terms. Gregarious people are expected to be more verbose.

### *Positive Emotion (Pos)*

PosA\_1: The player must comment on his chances to complete the task. Positive people are expected to respond optimistically.

PosA\_2: The player gets to sell a drink to a guard. Positive people are expected to try to fetch a higher price for the drink.

PosC\_1: The player gets to express his thoughts in different manners.

PosC\_2: The player gets to reflect on his disposition in different manners. Positive people are expected to be more optimistic in their answers, and take an active interest in their conversational partner.

### *Warmth (War)*

WarA\_1: The player gets to donate some gold to a beggar. Warm people are expected to donate more.

WarB\_1: The player gets a chance to converse with NPCs that are inconsequential to the story. Warm people are expected to address more of these superfluous NPCs.

WarC\_1: The player gets to approach an NPC in either a straight-to-the-point or a more roundabout manner. Warm people are expected to be willing to chat a bit before getting to the point.

## **Experiment**

We hypothesised that our test items have a correlation with the facet and extraversion scores of the NEO-PI-R. Therefore, they should function as predictors for extraversion and its facets. This is what our experiments want to demonstrate.

The experiment was set up to have subjects take the extraversion part of the NEO-PI-R and play the game. In order to control for any possible order effects, the test subjects were divided into two groups that had a different order of playing the game and taking the test. At the end of the experiment, subjects were asked to fill in a brief questionnaire containing questions about topics that might influence the outcome of the experiment. These topics included age, sex, and experience with computers and games.

Upon entering the test room, participants were asked to read some instructions, and proceed with either playing the game or filling in the NEO-PI-R extraversion questionnaire depending on the group they were in. After finishing the first task the participant proceeded to perform the other part of the experiment.

For the questionnaire, the test subjects were asked to fill out the 48 questions of the NEO-PI-R that relate to extraversion. The time needed was approximately 10 minutes.

The game was presented with an instruction booklet asking participants to try to respond like they would in real life. Instructions on playing the game were included

in the booklet. After reading the instructions the participant played the game which took between 30 and 40 minutes.

A pool of 24 participants, containing 18 males and 6 females, was tested. Ages ranged from 21 to 28 with a mean age of 24.2. Most participants were either students or former students. Subjects were randomly divided into two groups, one receiving the NEO-PI-R first and the game second and the other group received the game first and the NEO second. All subject data was processed anonymously.

The results were analysed with SPSS using a standard multiple regression analysis. The NEO-PI-R returns results on a one to five scale. Correlations were calculated using extraversion and the facet scores as dependent variables and the 25 game items as independent variables. Furthermore, regression analysis was conducted to inspect the relationships between the control variables and the extraversion scores.

## **RESULTS**

The results of this experiments have been summarised in Tables 1 and 2. The tables contain the variables that have an effect size with a significance of 0.05 or smaller (the generally accepted significance level in psychology). For the variance of human behaviour,  $r = .30$  is considered a medium effect while  $r = .50$  is considered a large effect [4, 5]. For those interested in a complete overview of the results independent of significance, we refer to the work by Schreurs [23].

Table 1 contains the correlations between game items and the NEO-PI-R scores. Its columns stand for: activity, assertiveness, excitement seeking, gregariousness, positive emotion and warmth, respectively.

Table 2 contains the correlations between the control items and extraversion and the game items. Its columns stand for: sex, age, education, experience with computers, experience with games, english language skill, ease of the controls, and clarity of the in-game missions.

### **Extraversion**

The NEO-PI-R results show that our test subjects scored above average on extraversion. Scores range from 1 to 9 with 4 as the lowest measured score for our participants. Table 1 shows that significant correlation is shown between five of the game items and extraversion. Four of the correlations are positive and one is negative. All correlations are significant on a level of  $p < 0.05$ . Items ActC\_1, ActC\_2 and ExcC\_1 were conversation items involving the willingness to wait, and item GreA\_1 represents the choice between preference of going into the library or into the bar. Item ExcB\_1 is the choice of colourful clothing which was scored from low being black to high being very colourful. Three of the five items showing correlation are conversation items, one

		Extraversion	Act	Ass	Exc	Gre	Pos	War
ActC_1	r	.456	.474	-	-	.474	.373	.365
	p	.013	.010	-	-	.010	.036	.040
ActC_2	r	.439	-	-	-	.650	-	-
	p	.016	-	-	-	.000	-	-
AssA_1	r	-	-	-	-	.348	-	-
	p	-	-	-	-	.048	-	-
AssB_1	r	-	-	-	.369	-	-	-
	p	-	-	-	.038	-	-	-
ExcB_1	r	-.409	-	-.434	-.390	-	-	-.389
	p	.024	-	.017	.030	-	-	.030
ExcC_1	r	.455	.394	-	-	-	.360	-
	p	.013	.028	-	-	-	.042	-
GreA_1	r	.498	-	-	-	-	.437	-
	p	.007	-	-	-	-	.016	-

Table 1: Correlations between NEO-PI-R scores and game items

being an implicit and one being an explicit choice. None of the 20 other game items showed any correlation sufficiently high to be significant.

While only 20% of our test items demonstrated correlation with extraversion, this result at least shows that it is possible to measure extraversion by observing player behaviour in a game. Our expectation was that each of the items would correlate with their given facet. However, we found that this is not the case. Items ActC\_2, AssA\_1, AssB\_1, ExcC\_1 and GreA\_1, while showing correlation with some of the facets, do not display the expected correlation with their corresponding facets. Each facet has at least two items correlating with it. Inter-facet correlations show that some of these correlations are lower than in the questionnaire.

### Control Questions

Table 2 shows that a large number of effects were found in the control questions. Elements such as age, sex, experience with computers and games, and skill of interacting with the game seem to be correlated with many of our test items and even with extraversion itself. For instance, it seems to be the case that experience with games is indicative for lower extraversion scores, which underlines the stereotype of the introverted gaming nerd. This means that values for test items, facets, and extraversion might be derived not only from observing a player’s behaviour in the game, but also from his handling and understanding of, and attitude towards the game. It also means that, in future work, we might need to correct the results derived on test items for the meta-information from the control questions.

### CONCLUSIONS

The research goal was to make a test that measures extraversion and its facets in a virtual environment. In

order to answer this question we created an item set in the game Neverwinter Nights using the aurora toolset. The items were based on the items of the NEO-PI-R and were divided into three categories: choices and actions, implicit behaviour, and conversation.

In order to answer the question of correlation between in-game behaviour and personality scores on the NEO-PI-R, the test was administered to a pool of 24 participants and yielded results in 25 different items. Results were analysed for correlations using regression analysis. Results indicate that it is possible to measure extraversion and its facets using behaviour in a virtual world. Five of our items had significant correlation to extraversion scores on the NEO-PI-R.

We may conclude that it is possible to measure extraversion using a virtual environment. We currently lack evidence indicating whether a virtual world measurement or NEO-PI-R measurements reflect real life more accurately. This research provides a basis for future research in this field.

### Future Work

In future work we will expand our research to include the other four traits of personality. There is also a need to compare the predictiveness of player profiling to written personality tests. Furthermore, in future work we will not design our test items by hand, but will attempt to discover them automatically by registering substantial volumes of game-playing data and correlating these with NEO-PI-R results.

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		Sex	Age	Edu	ExpC	ExpG	Eng	Eas	Cla
Extraversion	r	-	-	-	-	-.417	-	-	-
	p	-	-	-	-	.021	-	-	-
ActC_2	r	-	.344	-	-.364	-	-	-	-
	p	-	.050	-	.040	-	-	-	-
ExcA_1	r	-.462	-	-	.518	.469	-	-	.518
	p	.011	-	-	.005	.010	-	-	.005
ExcB_2	r	-	-	-	-	.347	-	.356	-
	p	-	-	-	-	.049	-	.044	-
ExcC_1	r	-	-	.364	-	-	-	-	-
	p	-	-	.040	-	-	-	-	-
GreA_1	r	-	-	-	-	-	-	-.420	-
	p	-	-	-	-	-	-	.021	-
GreA_2	r	-	-	-	-	-	-	.394	.393
	p	-	-	-	-	-	-	.029	.029
GreB_1	r	-	-	-	-	-	-	.353	-
	p	-	-	-	-	-	-	.045	-
GreC_1	r	-	-	-	-	-	.376	-	-
	p	-	-	-	-	-	.035	-	-
PosA_1	r	-	-	-	-	-	-	-	.360
	p	-	-	-	-	-	-	-	.042
PosC_2	r	-	.355	-	-	.360	-	-	-
	p	-	.044	-	-	.042	-	-	-
WarC_1	r	-.376	-	-	-	-	-	-	-
	p	.035	-	-	-	-	-	-	-

Table 2: Correlations between control questions and game items

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