# Posture Parameters for Personality-Enhanced Virtual Audiences

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#### ABSTRACT

This paper presents the development and preliminary evaluation of a personality enhancer behaviour model for virtual audiences to increase their realism and individualism. We conducted a systematic literature review and identified sixteen posture parameters to modify seated animations dynamically, calling them personality enhancers. We grouped them into four main categories: body, gaze, face and gesture behaviour modifiers. We implemented a unique animation modifier system on top of a game engine to apply these personality enhancers on existing pre-recorded generic seated animations. The first results with sixty participants in an online video survey show that the model can successfully simulate individuals with low and high levels of extroversion as well as with low and high levels of emotional stability.

## **CCS CONCEPTS**

• Human-centered computing  $\rightarrow$  Empirical studies in HCI.

### **KEYWORDS**

virtual audiences, personality

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#### **1** INTRODUCTION

A virtual audience is a group of virtual agents watching an activity without participating. These non-conversational, seated agents are mimicking virtual spectators [11]. Public-speaking training and anxiety treatments heavily rely on virtual audience simulations [2, 5, 9–12, 30, 36, 39]. The usefulness of virtual audiences lies in our ability to modify their behaviour so that they convey emotions from non-verbal behaviours and the various social signals emitted, such as backchannels or interactions between agents and users [4, 17]. The quality of the virtual audience is an essential aspect of creating

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immersive and engaging virtual experiences. However, to develop realistic and heterogeneous animations for virtual agents in a seated position, animators may use a variety of techniques and tools which are time and cost-consuming, including motion capture, keyframe animation, and physics simulation.

To overcome these limitations, we propose dynamically modifying existing agents' seated animations using a non-verbal personality behaviour model. A relationship exists between an individual's personality and how they behave and move [3, 32]. Previously virtual agents have been enhanced with personality traits for more realism and individualism.

However, in many of these previous works, dialogue and speech played an essential role in differentiating between personality traits [38]. This is a problem for applications where speech interactions are limited or not desired. Therefore, we present the development and preliminary evaluation of a non-verbal personalityenhancing behaviour model for virtual audiences.

#### MODEL AND EVALUATION

Table 1 summarises our non-verbal personality-enhancing behaviour model. We used the most common model of personality, the Big Five personality traits [24], which is also widely used in virtual agents research [37, 38]. The parameters extracted from the literature applying a PRISMA systematic review and meta-analysis [27] are customised in our system prototype and evaluated in an online video survey. We identified twenty-three relevant publications out of 1823 possible candidates from four databases, ACM digital library, IEEE Xplore, Web of Science and PubMed, using the following query of ("Non-verbal Behavior" OR "Nonverbal Behavior" OR "Nonverbal Cues" OR "Non-verbal Cues" OR "Nonverbal Behaviors" OR "Non-verbal Behaviors" OR "Nonverbal Communication" OR "Non-verbal Communication" OR "Body Language" OR Animation\* OR "Body Movement" OR "Body Movements" OR "Body Motion" OR "Body Motions" OR "Body Attitude" OR Posture OR Gesture\* OR Gaze\* OR "Facial Expression" OR "Hand Motion" OR "Hand Movement" OR "Head Orientation" OR "Head Movement" ) AND ("Personality" OR "Big Five Personality" OR "Big 5 Personality" OR "OCEAN Personality" OR "OCEAN Model of Personality" OR "Extraversion" OR "Neuroticism" OR "Emotional Stability" OR "Openness to Experience" OR "Conscientiousness" OR "Agreeableness").

The search was conducted on the 22nd of August 2022. We removed 388 duplicates out of 1823 possible candidates and then started the screening process. If we could not access the full text of an article, the article was also excluded. We furthermore excluded articles that discussed the relation between personality and

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ID	Parameters	Low Extroversion	High Extroversion	High Emotional Stability	Low Emotional Stability
	Body Behaviour				
1	Upper Spine	forward (+24°)	backward (-10 $^{\circ}$ )	neutral/straight (+10°)	forward (+10 $^{\circ}$ )
	(Roll)				
2	Middle Spine	forward (+12°)	neutral/straight	neutral/straight (+0°)	$forward(+0^{\circ})$
	(Roll)		$(+0^{\circ})$	_	
3	Lower Spine	forward (+24°)	backward (-5 $^{\circ}$ )	neutral/straight (+10°)	forward $(+10^{\circ})$
	(Roll)				
4	Pelvis (Roll)	backward (-40°)	forward (+10)	backward (-30°)	forward (+15°)
5	Head & Neck	downward	upward	neutral/straight	downward
	(Roll)				
6	Collar Bone (up/	downward(+6°)	upward(-5 $^{\circ}$ )	downward (+2.5 $^{\circ}$ )	upward (-15°)
	down)				
7	Arm Swivel	close to body	outward	medium	outward
8	Foot placement	close together	far apart	medium	medium - close together
9	Finger poses	small, inward	outward straight	relaxed	tense
10	Body sway	frequent	low/none	medium	low/none
	Gaze Behaviour				
11	Change	low (avg. 15 sec.)	high (avg. 9 sec.)	low (avg. 20 sec.)	high (avg. 7 sec.)
	Frequency				
12	Towards	avoidant	medium, direct	high, direct	avoidant
	Speaker				
	Face Behaviour				
13	Smile	medium (35%)	high (70%)	medium (35%)	low (10%)
	Likelihood				
	Gesture Be-				
	haviour				
14	Speed	slow (playrate 0.8)	fast (playrate 1.2)	slow, relaxed (playrate	fast, jerky (playrate 1.4)
				0.8)	
15	Direction	close or front of	away from body,	horizontal	towards self, or away
		body	towards interlocu-		from body, self-touch
			tor		
16	Specific	one-hand gesture,	gesture with both	horizontal body	self adaptors, finger
		hands together,	hands, leg	movement	manipulation, less
		finger	movement		nodding
		manipulation			

Table 1: Non-verbal personality-enhancing behaviour model for dynamic modification of seated animations.

movements under the context of individuals suffering from mental disorders like schizophrenia. After excluding articles based on their title and abstract, forty-seven articles were left for full-text review. If an article did not list specific behavioural cues related to personality traits or used a personality model that was not transferable to the Big Five model, it was excluded. Finally, the following twenty-four of articles were used for posture parameters and values extraction:[1, 3, 14–16, 18–23, 25, 26, 29, 31–35, 37, 38, 40–42].

Our research resulted in sixteen posture parameters to modify seated animations (Table 1). We called them personality enhancers and grouped them into four main categories: *Body*, *Gaze*, *Face* and *Gesture* behaviours modifiers. We determined values for each parameter to portray four personality traits: *Low* and *High Extroversion* and *Low* and *High Emotional Stability*. We focused on *Extroversion* and *Emotional stability* as the available information about the *Agreeableness*, *Openness*, and *Conscientiousness* traits is very limited. This decision is further based on [38] finding that they were unsuccessful in portraying Openness and Conscientiousness based on non-verbal behaviour alone. Furthermore, [37] also suggested that extroversion and emotional stability are more clearly distinguishable than the other traits.

We developed a unique animation modifier system within the *Unreal* engine [8] to apply these personality enhancers on existing pre-recorded seated animations combining the *Unreal Control Rig System* [7] and *Unreal Animation Blueprints* [6]. An example of one seated animation modified by our system is shown in Figure 1.

We evaluated the effectiveness of simulating the targeted personality traits using an online video survey. With our system, we produced eight videos showing a virtual human in a virtual seminar room, observed from a fixed point of view. Each video was 30 seconds long and altered between six seated animations modified using the parameters extracted from literature and refined during prototype iterations (Figure 1). Each video simulates only one level of Extroversion or Emotional Stability at a time with a single agent.

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Low Extroversion

**High Extroversion** 

**High Emotional Stability** 

Low Emotional Stability

Figure 1: Examples of personality-enhanced seated animations for virtual audiences. Each participant viewed a 30-second video featuring a single agent at a time. Each video showcased a distinct level of Extroversion or Emotional Stability, simulating only one personality trait per video. The agent, situated in a seminar-like room, remained seated and observed from a fixed perspective. Over the course of 30 seconds, the agent transitioned between six different seated animations, each modified using our personality-enhanced posture model.

We measured the perceived personality, boredom, gaze naturalness, and perceived agent- opinion and level of interest. Personality ratings were made using the *Ten Item Personality Inventory* [13], which was used in multiple studies rating virtual agents before [28] [38].



Figure 2: Mean scores of personality ratings.

The first results with sixty participants (all university students, 53 female and seven male, with an average age of 21) show that the model can successfully simulate individuals with low and high extroversion and low and high emotional stability, see Figure 2.

A one-way repeated measures MANOVA showed statistically significant differences between the animation modifications on the combined dependent variables of extroversion and emotional stability (F(6, 352) = 37.159, p < .001, partialeta = .388, Wilk'sLambda = .375).

In particular, there was a statistically significant difference between the high extroversion agent (M = 4.83, SD = 1.37) and the low extroversion agent (M = 2.62, SD = 1.33), as well as the high emotional stability agent (M = 3.65, SD = 1.23) and the low stability agent (M = 1.73, SD = .90). One sample t-test revealed that all traits were also statistically different from the neutral point (i.e. 4.0) on the scale (p < .001), which confirms that participants successfully perceived the intended personality traits.

#### 3 CONCLUSION

This paper described the implementation and preliminary evaluation of a new non-verbal personality behaviour model to enhance virtual audiences. We presented a model based on a systematic review of animation parameters and evaluated its capacity to simulate different personalities for a seated virtual agent.

Our first results demonstrated the system's ability to simulate low and high levels of extroversion and emotional stability traits.

Our future work will evaluate the model with multiple virtual agents in a public-speaking scenario. Our system provides insights into personality simulations and their technical execution in a personality enhancement system for intelligent virtual agents. IVA '23, September 19-22, 2023, Wurzburg, Germany

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