Exploring Non-Verbal Behavior Models for Believable Characters

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Abstract. Believable characters constitute an important component of interactive stories. It is, therefore, not surprising to see much research focusing on developing algorithms that enhance character believability within interactive experiences, such as games, interactive narrative, and training environments. These efforts target a variety of problems, including portraying and synchronizing gestures with speech, developing animation tools that allow artists to manipulate and blend motions, or embed emotions within virtual character models. There has been very little research, however, devoted to the study of non-verbal behaviors, specifically mannerisms, patterns of movement including postures, gaze, and timing, and how they vary as a function of character attributes. This paper presents a work in progress of a study conducted to (1) identify key character characteristics recognized by animators using an acting model, and (2) formalize non-verbal behaviors patterns that animators use to express these character characteristics.

Keywords: believable characters, animation, acting, virtual characters, embodied agents, articulate 3D characters

1 Introduction

Believable characters play an important role in many interactive entertainment productions, including computer and video games, training simulations, and educational games [1, 2]. Current industry methods rely on heavy scripting, where voice acting, dialogue scripts, hand-coded animation routines, and hard-coded behaviors are used to portray the desired character; examples of games that employ very detailed motion-captured characters, include Assassins' Creed and Prince of Persia (developed by Ubisoft) and Façade (developed by Mateas and Stern). In these games, artists work very diligently to detail characters' mannerisms and body motion to exhibit the right culture and character characteristics [3]. Such attention to detail of the non-verbal character behaviors is a crucial element for character believability [4]. However, this kind of scripting is labour intensive and rigid, as it does not adapt to all variations induced by interaction.

An alternative is to use artificial intelligent algorithms and graphics techniques to adapt character behaviors to variations in context induced by interaction. This alternative, however, is not as simple as it sounds, as it has been under research for many years and is still an open problem. Researchers have been working on several fronts to create believable expressive characters that can dynamically adapt within interactive narratives. Graphics researchers, for example, focus on embedding emotions and personality as parameters that can be used to modify virtual character animations [5-7]. Conversational agents researchers focus on building articulate virtual characters that can automatically synchronize gesture and speech [8]. Artificial intelligence researchers focus on integrating models of emotion and personality to build characters that have the ability to improvise [9-11].

As researchers tackle different aspects of this open problem, gaps between these different directions start to appear. One important gap is the gap between character models (artificial intelligence) and how these characters are portrayed through animation (graphics). While there are models that formalize emotional expression through facial muscles [12], there is very little work that explores methods of formalizing non-verbal body motions as a function of character characteristics. We note two previous attempts that looked at body movements as a function of emotions [13] and [14]. These studies, however, focused on emotions rather than character characteristics, such as personality, age, or culture.

In this paper, we study two concepts: *non-verbal behavior patterns* and their relation to *character attributes*. We define non-verbal behavior patterns as: a list of two or more movements linked with specific timing and pacing constraints. For example, the motion of quickly glancing at a character then at the ground is considered a non-verbal behavior pattern. We use the terms character attributes, character characteristics, and character model to mean a list of parameters that define a character, including age, physique, personality, behavior tendencies, quirks, habits, mind-set, and belief system. These concepts are not formalized; our goal is to formalize and define these concepts as part of our ongoing research. In this paper then, we attempt to describe a work in progress exploring two main research goals: (a) develop a set of character attributes that can be used to describe the essence of a character from a narrative perspective, and (b) identify non-verbal behavior patterns that are linked to the character attributes identified in (a).

2 Previous Work

2.1 Believable Characters

The topic of believable characters has been under research for many years. The Oz project presented an early work that developed believable agents for interactive drama [15]. They developed an authoring language for encoding character attributes, such as emotions, personality, and attitudes [16]. They also proposed an agent architecture composed of a reactive planning system which was used to select behaviors, from an authored set of behaviors, dynamically based on context. Mateas and Stern later extended their system by developing ABL (A Behavior Language), which was used to encode behaviors for the interactive drama *Façade*. ABL extended previous work by integrating a mechanism for handling joint behaviors [17]. While Façade and the Oz project showed expressive characters that employ several non-verbal behavior patterns, such behaviors were hand coded by the authors within the authored behavior routines. Thus, there were no formal models used. In addition, several researchers explored the integration of emotions and personality as character attributes within believable characters [10, 11, 18, 19]. While these architectures presented an adaptive routine for selecting behaviors that depend on characters' emotions and attitudes, non-verbal behaviors were manually encoded within the behavior specification. This limits the design as authors still need to hand-code all non-verbal behavior patterns and vary them based on variations in the character models.

There are several graphics researchers who have attempted to address this problem from the graphics end. Specifically, they focus on developing real-time algorithms that modify animation routines, such as walk, run, jump, by adding mannerisms, emotions, and personality [5-7]. For example, Perlin created a framework for *procedural emotion shaders* [20, 21]. The goal of his work is to allow designers to dynamically encode mannerisms for their character animations, and thus they can convey mood, emotions, and very simple personalities through the base movements and actions the animators create. His work has been integrated into Poser and the Half Life engine. Thus, artists can create several variations to their animation by simply selecting an option to modify the animation in a certain way. An example is adding 'sexy' modification for a 'walk' animation developed by the animator. Allbeck et al. developed a similar system for encoding mannerisms in animation [7]. They proposed PAR (Parameterized Action Representation), an action encoding method based on the Laban movement notation [1] [22]. While the examples discussed above have demonstrated great efforts in varying character mannerisms and expressive abilities, they do not address the concept of non-verbal behavior patterns, i.e. including sequence or parallel behaviors with timing and spatial constraints, or relate such patterns to characters attributes, other than emotions and moods.

2.2 Understanding Non-Verbal Body Motion Patterns

There are few research projects that attempted to understand non-verbal behavior patterns and their link to character attributes. Wallbott and Scherer [13] presented a seminal work in this area. They studied a sample of 224 videos, in which actors portrayed a variety of emotions in a scenario. Through this study, they found that some body movements and postures can be specifically mapped to certain emotions. For example, 'arms crossed in front of chest' is typical for pride.

Marsella et al.'s work presented yet another example of a study focused on understanding non-verbal behaviors. In their work, they verified Delsarte's model, specifically hand movements [23]. Delsarte was a 19th century musician who developed an acting system that connected the internal state of an actor to a formalized set of gestures and movements. This model was developed based on observations of human interactions across a range of situations [24]. The result of

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[1] Laban movement notation is a system for understanding, observing, describing and notating all forms of movement for dance.

Marsella et al.'s work showed considerable consistency in the subjects' interpretation of given hand movements in animation based on Delsarte's rules.

In addition to this work, Brenda Harger proposed an early study of using improvisational theatre models to develop believable characters. Specifically, she showed a simple animation of characters entering a room, where users can vary the characters' projected movements through one quantitative parameter: status. Through this parameter one can see different ways that characters can perform the entrance action [25, 26]. While Harger's work did not formalize a model for non-verbal behaviors, it built one step towards that goal by showing the effect of one parameter, *status*, on defining characters' posture, gaze, and mannerisms.

3 Our Study

We seek to extend the studies discussed in section 2.2 in search for a model that links non-verbal behavior to character attributes. To that end, we define three research questions:

1. Is there a set of character attributes, e.g., status, that are commonly understood by animators and can be used by designers to adequately describe a character?
2. Are there non-verbal behavior patterns that involve posture, gaze, and body movements with pacing and timing constraints?
3. Do variations in character attributes defined in 1 dictate distinct non-verbal behavior patterns defined in 2?

3.1 Character Attributes

What defines a character from a narrative and drama viewpoint? What attributes or parameters can be used to define such a character? These are still open questions. While there are several models available, they have not been computationally validated for the purposes of building believable characters. Previous research in interactive narrative used two models: Five Factor Model[2] [19] and a model based on traits [15]. In our view, the Five Factor model is very general and does not necessarily link well to non-verbal behaviors from a performance perspective. Character traits, on the other hand, are widely discussed, but have no standard definition.

Johnstone [27, 28] formulated two character models for describing a character for improvisational purposes; these models are: Fast-Food Laban based on the Laban movement notation [22] and Fast-Food Stanislavsky based on Stanislavsky's model [29, 30].

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[2] A psychology-based personality model comprised of five personality dimensions: openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism. This model was believed to explain all personality types [http://www.personalityresearch.org/bigfive.html].

Stanislavisky is a famous Russian director who composed a theory for acting that is currently used by many acting schools to teach actors how to build and develop their characters. In his teachings, he discussed the importance of purpose for a character. Thus, instead of an actor playing an emotion, the actor would develop his actions depending on his character's goals, tactics, and purpose.

Johnstone then took the Stanislavsky model and developed several characters (examples are shown in table 1) defined in terms of purpose. He uses this model, which he named Fast Food Stanislavsky, in his improv exercises. In this paper, we propose to verify the utility of Fast-Food Stanislavsky regarding research question 1.

Table 1. Two character definitions from Johnstone's Fast-Food Stanislavsky

To Give Someone a Bad Time	*To be Thought a 'Computer'*
• Invade their space. • Be restless, tap fingers. • Cross your legs away from them. • Frown; sigh; 'tut'. • Glare at them. • Laugh at wrong time. • Poke them with finger.	• Be cold and distant. • Be insensitive to pain or pleasure. • Dislike physical contact. • Other people are slow. • Pause before answering. • Be efficient – everything in its right place.

In addition, Johnstone identified several parameters of character representation that can affect non-verbal behaviors. One such parameter is *status*. *Status* is a major signifier that defines posture, gaze, and use of space in movement. A person of high status, for example, occupies more space, with erect posture, and always looks people in the eye. A person of low status, on the other hand, tends to occupy less space, with more inward posture, hunched back, and always looks away from people. Johnstone stated that characters often identify their status in comparison to other characters in the space, and behave relatively low or high by modifying their posture, gaze, and use of space in opposition to other characters in the space.

3.2 Study Design

In our study, we intend to verify the usefulness of the model defined above as well as identify a link between the model and non-verbal behavior patterns, addressing research questions 2 and 3. To this end, we recruited three animators. We gave them the task of animating ten variations of a simple two-character scenario, where the variations constituted variations in character definitions using Fast Food Stanislavsky.

While previous research targeting similar questions, such as [13], used actors to perform the scenario, we asked for the participation of animators rather than actors. We made this decision for various reasons. First, to gauge research question 1, we wanted to involve animators rather than actors, since the question involves the acceptance of the character model by animators. Second, while actors are good at performing through externalizing their internal feelings, animators are good at creatively thinking and composing of all facets of non-verbal behaviors. Third, actors think of only their part in relation to other characters. Animators, on the other hand, think of the scene as a whole and develop the characters in the scene from the ground up. We believe this is the first study we know of that was designed with participation of animators in the way discussed above. Thus, we will report on the process as well as the results in the discussion section.

3.2.1 The Scenario

The scenario is set up in an office environment with fixed dialogue between two male characters (see Table 2) [28]. We chose to use this scenario, because it has been successfully used by Johnstone [28] and Harger [26] to show variations in non-verbal behaviors.

Table 2. Simple Scenario taken from Johnstone's work [28]

Setting: Internal. An Office. Day.
- Officer (male): Come in, Smith. Sit down. I suppose you know why I've sent for you?
- Smith (male): No, Sir.
[*Officer slides a newspaper over to Smith.*]
- Smith: I was hoping you wouldn't see that.
- Officer: You know we can't employ anyone with a criminal record.
- Smith: Won't you reconsider?
- Officer: Good-bye, Smith.
- Smith: I never wanted your bloody job anyway. [*Exit.*]

3.2.2 The Character Variations

The animators were given the scenario above and were told to animate it ten times with variations in characters using Fast-Food Stanislavsky (see Table 3). We chose to begin our study with only ten variations—a small sample, to validate the character model before we perform a full study. The animators were all given a 3D Maya file containing an office scene modelled with a desk, two chairs, a paper used as a prop for the scene, and two skeleton 3D characters models, which the animators used as their base for animation.

Table 3. Scene variations

Scene Number	*Officer*	*Smith*
1	High Status	Low Status
2	Give someone a bad time	To show people you are happy about everything
3	To show someone they are boring	To get sympathy
4	To flirt with someone	To accept guilt
5	To be thought normal	To flirt with someone
6	Low status	High status

7	To give someone a good time	To be thought a hero
8	To be thought a computer	To impress someone
9	To show people you are happy about everything	To show someone they are boring
10	To be thought intelligent	To be thought mysterious

3.2.3 The Animators

The animators recruited for this study are third to fourth year undergraduates studying at the School of Interactive Arts and Technology (SIAT) at Simon Fraser University. They all completed the animation course required as part of the SIAT curriculum. The three animators were of different skill levels, namely professional, amateur, and beginner. While all animations produced for the project were of good quality, there were several differences in quality and assimilation of character descriptions that we attribute to the animators' varied skill levels. The professional animator works part-time at an animation company, and thus he was able to produce professional animations for the project. The amateur animator produced high quality animation, but had no industry experience, and thus his animations were not as good in quality as the professional animator. The beginner animator completed his animations, but it was obvious from our meeting notes that he was learning as he produced them. Videos of these animations will be presented at the conference.

3.2.3 The Process

The three animators worked independently on the initial Maya file to produce the scene variations described above. We had several group meetings: one at the beginning, one in the middle, and one at the end of their animation process. In these meetings, we clarified the confusions about the scenes and character variations; in the last meeting, we asked animators to share their experience and thoughts. These interactions were all documented as part of the study. The deliverables for each animator were ten scenes in Maya file format; we also asked them to produce ten rendered video clips of the animation with voice-over for demonstration.

We performed two kinds of analysis: high-level, namely, observations of animations, and low-level computational analysis of motion data. The former focuses on postures, actions, gaze, mannerisms, behavior habits, and character proximity, whereas the latter focuses on finding out details of timing, spatial relations, and movement of different body parts including head, arms, hands, and legs. In this paper, we discuss only the high-level analysis as the low-level analysis is still undergoing.

4 Results of the High-Level Qualitative Analysis

At the current stage, we have obtained some initial qualitative findings from the meeting notes and manual video coding of the animated scenes. The meeting notes informed us about the acceptance and appropriateness of the character models described by Johnstone (i.e. targeting research question 1) and the coding results showed some high-level patterns of character postures, gaze, mannerisms, gestures, unscripted actions as well as behavior habits as a function of the character model (i.e. targeting research question 2 and 3).

4.1 Validating the Character Model (question 1)

Our first research question was designed to validate the character attribute model used. In part, we needed to verify if this model was understood by artists, specifically animators who will be involved in the design of interactive stories. This is an important step as it has implications on the use of this model as a tool for artists or designers to encode characters with improvisational ability within interactive stories.

Among the three versions (one for each animator) of the 10 scene variations, there were considerable consistency among the portrayal of specific characters, which indicates a coherent understanding of the character attributes of these characters and a well defined model as an indicator of non-verbal behavior. However, there were some minor inconsistencies. From our discussions and meeting notes, we deduced that the animators had difficulty portraying characters with such purposes as ‘to be thought as hero’, ‘to impress someone’, ‘to be thought a computer’, and ‘to be thought mysterious’.

4.2 Non-verbal behaviors (question 2)

While the goal of the study is to identify patterns of non-verbal behaviors–sequence and parallel behaviors with time and spatial constraints, we report only on non-verbal behaviors here, since it is hard to quantify patterns and timing constraints qualitatively. In our next step, we will perform a computational analysis that will help identify non-verbal behavior patterns.

Among the ten scene variations, there were 15 character variations selected, among which 5 were used by both characters (see Table 3). During the video coding, for each scene variation we noted the postures, gestures, and actions that appeared in all three animators’ works. In analyzing these variations and the meeting notes of all scenes, we found that 11 out of the 15 character models were consistently portrayed by the animators, i.e., these 11 models all have more than four noted consistent entries, be it posture, gesture, or action.

Among the 11 consistent models, 5 were those used by both characters. 3 out of these 5 character models were portrayed similarly for both Smith and the Officer. However, the other 2 character models showed different results in the animation. For the character model ‘to show people you’re happy about everything,’ Smith was portrayed similarly by animators in one way, whereas the Officer was portrayed similarly by animators in another way. While both Smith and the Officer would gesture moderately and hold eye contact, they used different postures. Smith sat or stood, depending on the Officer’s position. The Officer appeared to always touch the table and support part of his body weight on it. This pattern was convincing because the Officer was the owner of the space and naturally his posture showed ownership. Thus, we believe, in this case, that characters’ power in the story context is a factor affecting non-verbal behavior. For the character model ‘to flirt with someone,’ however, our three animators portrayed the Officer quite similarly, but Smith very differently. In fact, our meeting notes showed that two animators had troubles imagining a flirting scene between characters of the same gender.

In opposition to the 11 consistent models, the rest 4 models, which were 'to be thought hero', 'to be thought a computer', 'to impress someone' and 'to be thought mysterious,' were less consistently portrayed by the three animators. The characters based on these models behaved either very differently, or in a rather inexpressive way. For example, there was a difference among three animators' portrayal of 'to be thought mysterious' character model. Two of them thought to be mysterious means not showing people a full self; therefore their character was either hiding behind objects or staying as far as possible. The third animator, however, considered a mysterious person a spy type; hence, the character showed curiosity and constantly peeked into the document the other character is reading.

Table 4 shows a segment of our results for research question 2. The table only shows non-verbal behaviors for two different character models that were consistently portrayed. The table shows non-verbal behaviors categorized in three dimensions: body motion in relation to self, body motion with interactions with props, body motion with interactions with other characters.[3]

Table 4. Results: non-verbal behavior as a function of character characteristics

Character	Motion Description
(Officer) To show people you're happy about everything	<u>General Body Motion:</u> [Posture] stand with fingers on table supporting some weight [Gesture] moderate amount; head moves when talking <u>Motion with Props:</u> [Action] point and touch the paper when calling attention from Smith <u>Motion in relation to others:</u> [Eye] hold eye contact most of the time
(Smith) To show someone they're boring	<u>General Body Motion:</u> [Gesture] minimal amount with little actions (e.g. yawning, tapping, etc.) <u>Motion with Props:</u> [Eye] follows when Officer is calling attention of the paper [Action] look at watch in the latter half of the conversation <u>Motion in relation to others:</u> [Distance] far (table in between)

4.3 Link of Character Attributes and Non-Verbal Behavior (question 3)

From the data table we obtained from the video coding, for each Fast-Food Stanislavsky character model we can conclude there were corresponding non-verbal behaviors used to portray this character. In other words, the non-verbal behaviors vary for each character model. We can reach this conclusion only for the models animated with consistency as described above. We believe the inconsistent models imply a varied interpretation, and thus cannot be used to deduce non-verbal behaviors.

[3] The animation videos can be found at: http://emiie.iat.sfu.ca/believablecharacters/videos/

5 Discussion

Our first step of data analysis was a manual coding of the video content of the 30 clips we collected from the three animators. From the above factual summary of the coding results, we are able to deduce ***three*** findings, which constitute the contribution of this paper. It should be noted that the study is still on going, and thus the findings are continuously growing as the study continues.

Our first finding focuses on a character model based on Johnstone's Fast-Food Stanislavsky (*research question 1*). 11 out of the 15 character models we tested showed a considerable degree of consistency among the three animators in terms of how they portrayed the non-verbal behaviors of the characters. This reflects an adequate degree of consistency of how animators understand and interpret these character models. Thus, we can assert that the Fast-Food Stanislavsky model can be used with some refinement as a character attribute model for interactive stories. With further studies, we can identify which attributes are consistently interpreted and which are not, and refine our model accordingly.

Using this model to indicate character instead of hand coding the animation presents two opportunities. First, it provides a faster content development cycle. Second, it provides improvisational space for virtual characters, i.e. it is a model with which characters can adapt their behaviors without reverting to hand coded routines. However, further experimentation with this model is required. Specifically, in the follow up study, we intend to examine ways of computationally encoding the model, its non-verbal behaviors, and algorithms for adequately firing and adapting the identified non-verbal behaviors to the context.

The second finding is concerned with the non-verbal behaviors identified (*research question 2*). Even though Johnstone listed many different non-verbal behaviors in his description of the Fast-Food Stanislavsky model, there are several details and non-verbal behaviors that were not fully discussed, specifically reactive and expressive actions, distance between characters, gaze, and how frequent the character gestures. These non-verbal behaviors are important in complementing the character models described by Johnstone. They are an extension from the existing acting rules and a stepping stone to defining the character non-verbal behavior patterns for computationally encoding character characteristics. As we continue with the computational low-level analysis of our animation data, we intend to develop patterns, which, as defined earlier, are lists of two or more movements with timing and spatial constraints.

The third and final finding is a list of two interesting lessons that we note from our qualitative analysis and meeting notes. First, while we treated each character separately in our discussion and study design, it was apparent that animators did not. They have indicated that they can show a character as intelligent for example by making the other characters in the scene impressed with what he/she is saying. Thus, this interaction between characters in the scene can also be a way of formulating a character in relation to others. Second, the recruited animators were all different in terms of their skill level, and thus their results also varied. Any model that we report on in the future will need to take these variations into account.

6 Conclusion and Future Work

The study described in this paper started with the premise that non-verbal behavior patterns can be identified as a function of character attributes. While there are many interesting findings noted in this paper, there is no theoretical model that can be concluded from this study. The road to such end requires several studies and exploratory experiments. The contribution of this paper is two-fold: (1) identify the problem and (2) present an approach to resolving the problem. The findings reported in the paper show success in the choice of the character attributes model and the beginning of the discovery of non-verbal behaviors that can be formulated as patterns linked to the character attributes defined.

Our job is still at its early stage. The next step is to computationally analyze the animation data, which will allow us to analyze the non-verbal behaviors in depth and identify low-level movement patterns related to each joint, which possibly can be grouped by body parts including head, eye, arm/hand and legs and which include timing and spatial constraints. To address the implications of the study, our future plans will involve more animators, ideally all professional ones coming from different education background, to ensure the generality of the data. We will also refine the description of each character variation, so that each item on the definition list is relevant to animating body motions, and change the wording when necessary.

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