Don't Scratch! Self-adaptors Reflect Emotional Stability

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Abstract. A key goal in agent research is to be able to generate multimodal characters that can reflect a particular personality. The Big Five model of personality provides a framework for codifying personality variation. This paper reviews findings in the psychology literature to understand how the Big Five trait of *emotional stability* correlates with changes in verbal and nonverbal behavior. Agent behavior was modified based on these findings and a perceptual study was completed to determine if these changes lead to the controllable perception of emotional stability in virtual agents. The results reveal how language variation and the use of self-adaptors can be used to increase or decrease the perceived emotional stability of an agent. Self-adaptors are movements that often involve self-touch, such as scratching or bending one's fingers backwards in an unnatural brace. These results provide guidance on how agent designers can create particular characters, including indicating that for particular personality types, it is important to also produce typically non-communicative gestural behavior, such as the self-adaptors studied.

Keywords: personality, gesture, conversational and nonverbal behavior, evaluation

1 Introduction

Animated Intelligent Virtual Agents are a key component for many emerging applications, ranging from virtual worlds to interactive story systems to educational games. As with previous media such as books and film, for these agents to be effective, they must convey the richness of traditional characters, showing clear personality and mood. Yet it remains an open challenge as to how to imbue an agent with these qualities and how to organize the underlying range of expressive variation. The "Big Five" or "OCEAN" model of personality represents an appealing organizing framework [5, 23, 22, 26]. The model has emerged as a standard in psychology, with research over the last fifty years systematically documenting correlatons between a wide range of behaviors and the Big Five traits (extraversion, neuroticism/emotional stability, agreeableness, conscientiousness, openness to experience) [24, 30, 33].

Table 1: Example adjectives associated with the extremes of the Big Five traits of Emotional Stability and Agreeableness.

Big Five Trait	**High**	**Low**
Emotional stability	calm, even-tempered, reliable, peaceful, confident	neurotic, anxious, depressed, self-conscious, oversensitive, vulnerable
Agreeableness	trustworthy, friendly, considerate, generous, helpful, altruistic	unfriendly, selfish, suspicious, uncooperative, malicious

This work examines how both an agent's verbal and nonverbal behavior can be altered to control the perception of one of the Big Five traits, *Emotional Stability*. As a control, we test whether the same parameters affect the perception of *Agreeableness*. Emotional stability (EMS) ranges between two extremes, *Emotionally Stable* and *Neurotic*. Emotional stability—or neuroticism—is the second most studied personality trait after extraversion; it is part of most existing frameworks of personality, such as the Big Five and the PEN model [30, 12]. The trait adjectives associated with both emotional stability and agreeableness are shown in Table 1. Neurotics tend to be anxious, negative and oversensitive, while emotionally stable people are calm and even-tempered. Eysenck et. al (1985) suggest that this dimension is related to activation thresholds in the nervous system, i.e. neurotics turn more easily into a 'fight-or-flight' state when facing danger, resulting in an increase in heart beat, muscular tension, and level of sweating [12]. Previous findings such as these suggest parameters for controlling the perception of neuroticism. For example, neuroticism findings suggest a CONTENT POLARITY parameter for selecting negative content, as well as a REPETITIONS parameter [33, 40]. Neurotics are also more likely to engage in self touch [43] and less likely to gesture towards others [3].

We begin by first reviewing and summarizing previous work on how neuroticism is expressed. Section 2 summarizes these findings and describes how they are mapped to agent behavior in order to produce multimodal animation clips. These animations are then used in a perceptual study to evaluate if the variations are sufficient to control the perception of emotional stability in virtual agents (Section 3). As detailed in Section 4, key results include that: (1) generated utterances previously validated only as written text also effectively capture variation in emotional stability when used in a multimodal agent; and (2) that there is a significant relationship between the use of self-adaptors, such as head scratches, and the perception of neuroticism. A detailed discussion of the results is presented in Section 5, along with a comparison to recent related work.

2 Nonverbal and Verbal Expression of Personality

For nonverbal expression of emotional stability, we systematically organize findings relating gesture, posture and hand-movement to emotional stability. For verbal expression, we build on Mairesse & Walker's personality models for the expression of EMS through linguistic reflexes alone, but introduce linguistic parameters related to the voice, speaking rate, and pause length [22].

2.1 Nonverbal Expression of Emotional Stability

Emotional stability provides particular challenges for findings related to nonverbal communication. While the literature describes numerous characteristics regarding general body language for neurotic, nervous, and anxious personality types, it offers little detail or operationalization of the exact variations in motion for low and high dimensional values.

Gesture Behavior. The psychology literature provided qualitative descriptions of how EMS modifies nonverbal communication, but little in the way of quantitative measurements. In order to form a cohesive model of gesture behavior, we classified the results and our postulates into three categories based on the aspect of nonverbal communication they govern: gesture direction, gesture form, and timing. Argyle [3] notes that high levels of neuroticism results in fewer other-directed gestures, or gestures that are directed at a target that is not the person performing the gesture.

Gesture form touches on discoveries in both psychology and linguistics. Furnham describes a reduction in fluency, a higher proportion of silence to speech, and the presence of speech discontinuities in anxious speakers [14]. Cappella and Palmer investigate the relationship between speech and gesture, noting that the two aspects of communication are strongly synchronized, despite being conveyed separately through body language and verbal utterance [7]. This work allowed us to consider two properties for low EMS types: pauses in speech synchronize with pauses in gesture, and speech discontinuities might be accompanied by gesture discontinuities (repetition or stuttering motion, filled pauses, etc.). Other descriptions, including higher levels of tension and irregularity of motor activities, aided in the synthesis of gesture form control [41].

Finally, we determined that it was important to control the **timing** in conversation, e.g. how the gesture planning framework should control the speed of gestures and other forms of body language for an EMS level. Campbell and Rushton observed that people with a high level of anxiety made longer pauses before responding than participants with a normal emotional stability level [6]. Daly cites early work that verifies the presence of speech disturbances in individuals with transient anxiety, in addition to conflicting results on whether individuals with anxiety spend less time talking, or generate fewer utterances [9]. Given the disruption of fluency described by Furnham, we decided to use pauses in speech and gesture as a form of discontinuity for both verbal and nonverbal communication.

Self-adaptors. Hand gestures can be classified into two categories: signaling, where the performer intends to transmit a message using motion, and non-signaling, where the motion of the hand is not intended to convey a particular meaning [43]. Signaling gestures could include a point directed at a target, or a chopping motion to emphasize a key phrase whereas a non-signaling gesture could be a scratch on the body, or the massaging of a sore neck. Waxer [43] concluded that individuals with low EMS scores produced more non-signaling hand

motion, also called self-adaptors, during speech. Other research supports this [3, 11], even showing a negative association between outward-directed gestures and self-adaptors [6]. These findings indicate both the importance of self-adaptors in conveying a personality with a particular EMS level - as well as that behavior not intended as communicative can still be interpreted by others as an indicator of personality. Because of the pervasive evidence on self-adaptors, we sought to extend the existing gesture planning framework to generate these motions.

We found no literature that explicitly described when and how such self-adaptors should be realized, so we made its planning system independent of the existing hand gesture system. If a hand is not being used for a gesture, it can be used for a self-adaptor. Figure 1 displays a left-handed neck scratch that occurs during a right-handed conversational gesture. Based on comments collected during Waxer's experiments, we focused on self-adaptors involving scratching a body part, tapping nervously, unnatural bracing of the hands, rubbing the face or head in soreness or fatigue, and adjusting the hair. These represent a subset of possible self-adaptors.

Body language. After hand gestures and self-adaptors, the two aspects of body language most commonly described to vary with EMS were posture and head movement. Feyereisen and de Lannoy observe more changes in posture for individuals with low EMS ratings, but do not explain how or when such changes occur [13]. Waxer's results suggest that individuals with low anxiety move the upper body more freely than individuals with high anxiety, though the differences were not significant. Wallbott notes the presence of a more "collapsed" posture for low EMS individuals [42]. Campbell and Rushton observed greater forward lean in individuals who tested high for anxiety, which could possibly be a property of the posture collapse observed by Wallbott [6]. With respect to these observations, we controlled the variance in posture for low EMS by increasing

Fig. 1: A neck scratch self-adaptor occurring simultaneously with a gesture using motion planning for an emotionally stable personality type.

the frequency and speed of weight shifts and torso swivels in order to generate posture changes that seem forced or uncomfortable.

There are significant previous findings on the impact of EMS on gaze and head motion [13, 6, 9]. However, controlling eye motion is beyond the scope of this work. Worth noting, the literature consistently suggests that increased gaze aversion and decreased head height are features of low EMS.

Motion Generation. In order to map the findings from the literature to character motion, we divided the variation in nonverbal behavior into two categories: the use of self-adaptors and a set of variations related to gesture performance. *Self-adaptor use* was either active or not. If active, self-adaptors were added to the motion from a list including: scratches (face, chin, neck), rubs (forehead), asymmetric shrugs (twitch), and an unnatural brace in which the one hand pushes the other hand's fingers back in an uncomfortable way. These were timed to occur quickly, consistent with a sense of unease.

Gesture Performance involved variations in both gesture and collarbone use. Reflecting a tendency to make fewer outward or other directed gestures, the path of low EMS gestures were adjusted to move inward, across the body whereas they moved outward in the high EMS case. The gestures were also made smaller. Abrupt downward beats were added to the low EMS gestures, reflecting reported increased irregularity. Posture adjustments for low EMS included bringing the collarbones up and in, bringing the elbows in and making more rapid posture shifts. These reflected a less relaxed posture and more rapid posture changes. Figure 2 illustrates differences in gesture placement and posture.

Fig. 2: A comparison between low EMS (left) and high EMS (right) motion for the same utterance.

Table 2: Summary of language cues for emotional stability, with corresponding generation parameters. See Mairesse & Walker (2010) for more detail.

Neurotic findings	Stable findings	Parameters	NeuroEmot	
Content planning:				
Problem talk, dissatisfaction	Pleasure talk, agreement, compliment	CONTENT POLARITY	low	high
		REPETITION POLARITY	low	high
		CONCESSION POLARITY	low	high
Direct claim	Inferred claim	POSITIVE CONTENT FIRST	high	low
High verbal productivity	Low verbal productivity	VERBOSITY	high	low
Many lexical repetitions	Few lexical repetitions	REPETITIONS	high	low
Polarised content	Neutral content	POLARIZATION	high	low
Stressed	Calm	REQUEST CONFIRMATION	low	high
		INITIAL REJECTION	high	low
Syntactic Structural Template selection:				
Many self-references	Few self-references	SELF-REFERENCES	high	low
Problem talk	Pleasure talk	TEMPLATE POLARITY	low	high
Aggregation:				
Low use of 'punct *which*'	High use of 'punct *which*'	RELATIVE CLAUSE	low	high
Many conjunctions	Few conjunctions	MERGE	high	low
Few short silent pauses	Many short silent pauses	CONJUNCTION	low	high
Low use of 'punct *so*'	High use of 'punct *so*'	JUSTIFY - SO CUE WORD	low	high
Low use of clause final *also*	High use of clause final *also*	INFER - ALSO CUE WORD	low	high
Many inclusive words (e.g. *with*, *and*)	Few inclusive words	WITH CUE WORD	high	low
High use of final *though*	Low use of final *though*	CONCEDE - BUT/THOUGH CUE WORD	high	low
Many long silent pauses	Few long silent pauses	PERIOD	high	low
Many 'non-ah' disfluencies	Few 'non-ah' disfluencies	RESTATE - OBJECT ELLIPSIS	high	low
Pragmatic marker insertion:				
Many pronouns, few articles	Few pronouns, many articles	SUBJECT IMPLICITNESS	low	high
		PRONOMINALIZATION	high	low
Few tentative words	Many tentative words	SOFTENER HEDGES	low	high
Many self-reference	Few self-references	·I THINK THAT	high	low
Many filled pauses (apprehensive)	Few filled pauses	FILLED PAUSES: · ERR, I MEAN, MMHM, LIKE	high	low
More aquiescence	Few aquiescence	ACKNOWLEDGMENTS	high	low
Many self references	Few self references	·I SEE	high	low
High use of 'punct *well*'	Low use of 'punct *well*'	·WELL	high	low
Exaggeration	Realism	EMPHASIZER HEDGES	high	low
Many rhetorical interrogatives	Few rhetorical interrogatives	TAG QUESTION	high	low
Frustration	Less frustration	EXPLETIVES	high	low
Many 'non-ah' disfluencies	Few 'non-ah' disfluencies	STUTTERING	high	low
Lexical choice:				
Many frequent words	Few frequent words	LEXICON FREQUENCY	high	low
Exaggeration	Realism	VERB STRENGTH	high	low
Speech:				
Many long pauses (+2 sec.)	Few long pauses	TTS PAUSE INSERTION	high	low
Short response time	Long response time	TTS RESPONSE DELAY	high	low
High speech rate	Low speech rate	TTS SPEECH RATE	high	low
Loud	Quiet	TTS LOUDNESS	high	low

2.2 Verbal Expression of Emotional Stability

Our experiments use the PERSONAGE generator with rule-based models of emotional stability for verbal realization. We utilize utterances that were found in previous work on text-based perception [22] to reliably be perceived as either

Table 3: PERSONAGE outputs for the **emotional stability** personality model. Score is the average of user judgments on a scale from 1 = very low and 7 = very high.

#	Content plan	End	PERSONAGE's output	Score
L1	**recommend(V)**	**low**	Ok, although Vinnie's Pizza has awful ambience, its price is 13 dollars. Even if the waiters are bad, I mean, the food is just nice somewhat, the food is quite decent. It's located in Manhattan. There could be worse places, alright?	2.2
L2	**compare(LR,PP)**	**low**	Obviously, ok, I might recommend Le Rivage and Pintaile's Pizza. Actually, I suppose Pintaile's Pizza's price is 14 dollars. Err... on the other hand, Le Rivage's price is 40 dollars.	2.3
H1	**compare(A,M)**	**high**	Did you say Acacia and Marinella? I imagine you would appreciate them, you see? It seems to me that Marinella provides kind of satisfactory food, also it's an italian place mate, but Acacia offers sort of acceptable food, you know.	6.0
H2	**recommend(E)**	**high**	You want to know more about Edgar's Cafe? Basically, I think that Edgar's Cafe, which has rather decent food, is kind of the best restaurant.	5.5

low EMS or high EMS. Table 2 summarizes the linguistic cues for emotional stability and the hypothesized personality models, and Table 3 provides example utterances generated using the personality models. Here, we explore for the first time parameters related to speech synthesis, also motivated by findings from previous studies. These are shown under the heading **Speech** in Table 2. For example, pauses are a significant feature that are incorporated as part of speech synthesis by inserting longer pauses in the low EMS vocal track.

Note that in Table 3 that some parameters are illustrated in the primarily negative and neutral content selection mechanisms, with negative content repeated and foregrounded in utterances L1 and L2. The high STUTTERING parameter is also seen in utterance L2. Weaver [44] shows that neuroticism is associated with frustration and acquiescence, which we model respectively with high EXPLETIVES and ACKNOWLEDGMENTS parameter values (e.g. *okay, although* in utterance L1). We hypothesize that neurotics are more likely to exaggerate, based on the impulsiveness facet of that trait, so we associate it with high EMPHASIZER HEDGES parameters (e.g. *obviously, actually* in utterance L2). Neuroticism is conveyed through a high VERBOSITY parameter value, e.g. utterance L1 describes 5 restaurant attributes, whereas utterance H2 only mentions the claim and one attribute.

3 Experimental Design

For the purpose of evaluating their impact on EMS, the variations found in the pyschology literature were coalesced into three factors: gesture performance (incl. changes to posture and communicative gesture), whether self-adaptors were present, and linguistic variation in text and speech production.

We used PERSONAGE to generate utterances of restaurant recommendations for high and low EMS personalities as shown in Table 3. The Loquendo

TTS was used to produce audio for each utterance and annotated with respect to theme and rheme. Gesture strokes were aligned with the rheme.

Software based on [25, 28] was used to generate the accompanying animation clips. Both the communicative gestures and self-adaptors were generated by editing sampled motion data and these can be controlled independently. The same background body motion was used in all clips, but posture shifts were time warped in the low EMS case to make them more rapid.

Four clips were generated for each utterance, with the variations of "low" and "high" gesture performance and "self-adaptors" or "no self-adaptors", yielding a total of 16 clips. The same gesture placement was used for each variant of an utterance. When self-adaptors were active, between one and three were added to the test utterance, based on the length of the utterance and the presence of appropriate locations for the behavior. The same adaptors were always used for a given utterance and the sequence was not otherwise changed.

The avatar's face was blocked with a mask to avoid judgements based on his facial expression, or lack thereof, while still allowing the general motion and position of the head to remain visible.

3.1 Experiment Execution

We recruited 30 participants for a web-based experiment (12 female, 18 male; 18 between age 18 and 30, 9 between 31 and 50, 3 over 50; 20 spoke English as their first language). Prior to taking the survey, participants were shown a training video consisting of four of the clips in order to familiarize them with the experiment's material. Example clips are included in the accompanying video.

A clip could be viewed as many times as desired, but returning to previous clips was not permitted. After watching each clip, participants were asked to rate the avatar's levels of emotional stability and agreeableness using the questions representing these traits taken from the Ten-Item Personality Inventory. This instrument was shown to be psychometrically superior to a "single item per trait" questionnaire [16]. Although the agreeableness dimension of the Big Five model was not a targeted part of the experiment, we included it in order to measure the impact of our system on unintended personality features. The ratings began with the statement "I perceive the speaker as...", followed by 7-point Likert scale ratings for: "Anxious, Easily Upset," "Calm, Emotionally Stable," "Critical, Quarrelsome," "Sympathetic, Warm", and "Natural". The first two ratings represent low EMS and high EMS measurements, respectively. The third and fourth ratings represent high agreeableness and low agreeableness. For analysis, the reverse-scored item for each personality type was flipped (e.g. a low EMS score of 2 corresponds to a high EMS score of 6) and averaged with the positive rating to provide a final score. Naturalness ratings were included to see if changes in agent behavior affected how natural the resulting clip appeared.

Our hypotheses were:

- **H1**: The linguistic manifestations of emotional stability will affect perceived emotional stability when used in a multimodal agent.

- **H2**: The use of self-adaptors will be perceived as less emotionally stable
- **H3**: The changes in gesture performance will affect perceived emotional stability
- **H4**: There will be no correlation between agreeableness and the three variations.

4 Results

We ran a repeated measures ANOVA with the factors "self-adaptors" (on, off), "EMS linguistic parameters" (low, high), and "gesture performance" (low, high) and dependent variables our ratings of Emotional Stability, Agreeableness, and Naturalness. Our principal novel finding is that the presence of self-adaptors made agents appear less emotionally stable, 4.18 (.11 SE) with adaptors to 4.60 (.12 SE) without, on a scale from 1 (less stable) to 7 (most stable), $F(1, 29) = 11.50$, $p = .002$, confirming Hypothesis 2. At the same time, adaptors had no effect on agreeableness ratings, 4.16 (.12 SE) with adaptors to 4.26 (.11 SE) without, $F(1, 29) = .62$, $p = .44$. Importantly, agents were rated as equally natural with and without adaptors, 3.51 (.18 SE) to 3.51 (.22 SE), $F(1, 29) = .002$, $p = .97$.

Linguistic parameters affected ratings as expected. The low and high stability utterances as spoken by the male avatar were judged to be equally natural, 3.43 (.23 SE) low to 3.60 (.20 SE) high, $F(1, 29) = .85$, $p = .37$. The high stability spoken utterances were judged to be more stable, 4.25 (.11 SE) low to 4.53 (.12 SE) high, $F(1, 29) = 5.44$, $p = .03$. This confirms Hypothesis 1. The high stability utterances were also judged to be more agreeable, 4.05 (.11 SE) low to 4.37 (.11 SE) high, $F(1, 29) = 8.32$, $p = .007$. In addition, the lack of interaction suggests an additive effect between (1) presence of linguistic parameters and (2) presence of low EMS adaptors, such that either one changes perception to be of lower EMS and more so with both, as shown in Figure 3.

There was no effect of non-adaptor gestures on naturalness ratings (3.52, .19 SE, low to 3.50, .20 SE, high, $F(1, 29) = .12$, $p = .73$), emotionality ratings (4.37, .12 SE, low to 4.42, .09 SE, high, $F(1, 29) = .42$, $p = .52$), or agreeableness ratings (4.22, .10 SE, low to 4.20, .10 SE, high, $F(1, 29) = .05$, $p = .83$). These findings disconfirm Hypothesis 3.

The perception of agreeableness seems to have no simple relation with the presence of self-adaptors or non-adaptor gestures, but high measures of agreeableness correlate with high EMS voices. This disconfirms Hypothesis 4.

Across all variables, there were only two interactions, for the agreeableness variable: adaptors X gesture performance, $F(1, 29) = 4.64$, $p = .04$, and adaptors X gesture performance X voice, $F(1, 29) = 5.12$, $p = .03$. The adaptors X gesture performance interaction suggests that adaptors do not make a difference for low EMS gesture performance for agreeableness. For high EMS gesture performance, having adaptors made agents appear less agreeable. Inspection of the three-way interaction suggests that low EMS gesture performance plus adaptors made agents appear more agreeable when presented with a low EMS voice, but less agreeable when presented with a high EMS voice.

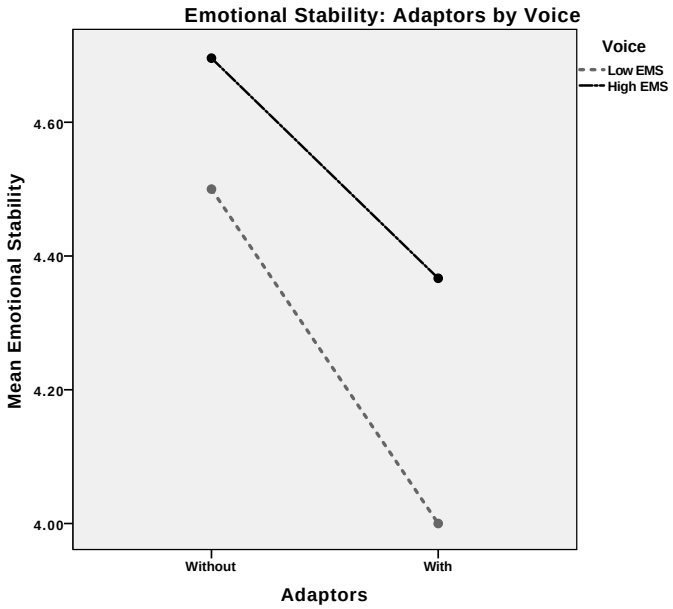

Fig. 3: The effect of linguistic variation and the use of adaptors on the perception of emotional stability.

5 Discussion and Conclusion

This paper summarizes findings on verbal and nonverbal manifestations of emotional stability from the psychology literature and reports results of an experiment analyzing the perception of EMS when these findings are mapped to a virtual agent. This work is part of a broader effort to establish empirical principles for modifying agent behavior in order to control the perception of personality.

Our work builds on recent work on gesture form and performance in interactive contexts, across many different settings and contextual and cultural assumptions. While we do not consider at all the effect of culture on agent gesture, it is clear that there are culturally-defined preferences for expressive behaviors. Thus it is possible that the expression of an agent's personality is subject to a cultural filter, or may even be culturally defined [36, 20, 4, 35]. Related work on gesture [39, 37, 34] has addressed how high level characteristics of an agent, such as culture or age, and of the situation (listener, physical context) affect the choice and the performance of gestural and postural behaviors. Recent work has shown the importance of an agent displaying emotion [29] and we expect personality plays a similarly important role. This represents one aspect of a very significant effort to design emotion and personality models for agents (e.g.[2, 17, 10, 38, 32, 1, 15, 31]).

There has been considerable previous work developing methods for procedurally varying the expressive qualities of character motion (e.g. [8, 18, 27]). While

establishing useful tools, these approaches do not define what variations are necessary to obtain a particular personality. The idea of mapping motion variations to traits in the Big Five model was suggested by Badler et al. [5] in connection with their Laban Movement Analysis-based EMOTE system. Our work establishes mappings between changes in motion generation, language and perceived personality and validates the mappings experimentally.

Recently, Neff et al. [26] examined the combined effect of linguistic and nonverbal expression of personality for the Extraversion trait of the Big Five. Previously, Isbister & Nass [19] presented the only other work we are aware of to explore the combined gestural and linguistic expression of personality, also focusing on extraversion. They used fixed poses to accompany hand scripted utterances, rather than a multimodal agent. Kipp et al. [21] demonstrated that gesture units consisting of multiple gestures performed better than singleton gestures on a variety of criteria such as naturalness and friendliness and found singleton gestures appeared more nervous. Our work is the first we are aware of to address the combined verbal and nonverbal expression of emotional stability.

Our results demonstrate that the inclusion of self-adaptors significantly impacts the perception of neuroticism. This provides clear evidence that noncommunicative gesture movements contribute significantly to particular aspects of personality, suggesting that future agent architectures should be extended to support self-adaptor production, which may occur simultaneously with communicative gestures. In addition, our results demonstrate that linguistic variations that work for written text, along with appropriate speech variations such as increased pauses for low EMS, transfer successfully to the agent domain.

We suspect that we did not get a significant result for "gesture performance" because the differences between the two variations were too subtle. The literature offers limited guidance on the exact form and degree of variation and we may need to arrive at better definitions for descriptors like "fluency" in terms of low-level gesture parameters. Including more disruptions in the low EMS gestures and more erratic body behavior seems likely to yield stronger results. Gesture placement rules may also need to differ with variation in this dimension.

It is interesting to note that linguistically, emotional stability and agreeableness are highly correlated, while the nonverbal factors in the experiment had no effect on perceived agreeableness for our agent. This may signify an area of interest that future work should return to in order to unify the perception of agents through both verbal and nonverbal means.

The three way interaction for agreeableness suggests that consistent expression in which each factor (linguistic, performance and adaptor use) is aligned may have a positive impact on agreeableness. This also seems worth further investigation.

A significant challenge faced in this work concerned limitations on what the literature was capable of advising in terms of detailed reproduction of body language to match human EMS varation. The qualitative descriptions often seen in the literature provide a reasonable mental picture for a human reader, but lack the specificity to directly translate into parameters for agent behavior. Neverthe-

less, the results of this experiment provide meaningful guidance on how to refine our model and will hopefully inspire future work that will further define the key aspects of physical motion that express particular personality types, both for virtual agents and human interaction.

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