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Expressing Digital Character Personality through Motion capture: A study of body movements and personality traits

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IMAGINE MOCAP

Developing Personality in Digital Character Design using Motion Capture, Wearable and Live Coding Technologies, applied to IMAGINE (Interactive Media, Animation, Games, Interactive Networked Environments) Narrative Worlds

Greece 2.0 NATIONAL RECOVERY AND RESILIENCE PLAN
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ΠΑΝΕΠΙΣΤΗΜΙΟ ΑΙΓΑΙΟΥ UNIVERSITY OF THE AEGEAN
ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΕΛΟΠΟΝΝΗΣΟΥ UNIVERSITY of the PELOPONNESE
HELLENIC REPUBLIC IONIAN UNIVERSITY 1984

Introduction

According to theorists...

Paul Wells → Emphasis on the narrative function of movement and the exaggerated expressivity in animation.

Ed Hooks → Advocated for the integration of acting principles into animation practice.

F. Thomas & O. Johnston → '12 Principles of Animation' foundational in character animation design and application in 3D computer Generated Imagery

Our goal

The exploration of how **body movement** alone—without facial expressions or speech—can convey a **digital character's personality**.

Our scope to create a **framework** that combining personality traits with **character body movement**.

Research questions

- To what extent **nonverbal communication**—such as gestures, posture, and body movement—influence the audience's perception of digital characters' personality.
- Whether using the personality models (OCEAN model) can act as a framework/tool to facilitate a **characters' personality** across digital media platforms.

Contribution

The study contributes to future **digital character creation** by linking personality with movement, providing insight for **animators, directors, artists,** and **performers**.

Related work

What is the **OCEAN personality model**?

- **OCEAN Model**: Framework describing personality through five traits: Openness to experience, Conscientiousness, Extraversion, Agreeableness, and Neuroticism.
- **Purpose**: Helps explain differences in behavior, emotions, and interactions across individuals.
- **Applications**: Widely used in psychology and research on personality and behavior.

What is the **'12 Principles of Animation'** ?

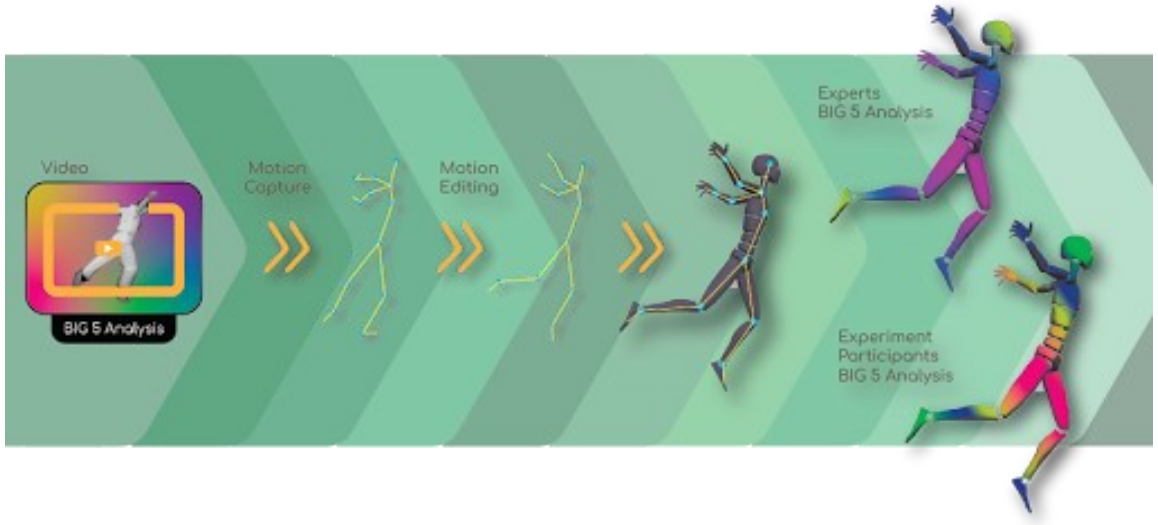
- **The 12 Principles of Animation**: Are foundational techniques developed by Disney animators to create more realistic, appealing, and engaging body motion.
- **Purpose**: They guide animators in achieving lifelike movement, emotional expression, and storytelling impact.
- **Applications**: Used in traditional 3D animation across animated films, video games, and interactive media.

What is the **Laban Movement Analysis (LMA),** by Leslie Bishko?

- **Laban Movement Analysis (LMA)**: Expanded by Leslie Bishko, is a structured method to observe, describe, and interpret human body movement.
- **Purpose**: Analyzes movement through 4 dimensions—**Body, Effort, Shape, and Space**.
- **Applications**: Widely used in dance, performance, therapy, and animation to understand and communicate movement qualities.

Methodology

- Research from existing literature and film studies and recorded conclusions according to behavioral and motion descriptors correspond to the **OCEAN personality traits.**
- Association of **personality traits** with specific qualities and **features of movement** (motion tags).
- Selection of **10 video segments** from the short film ***A Chairy Tale (1957)*** to identify the presence of the kinesiological characteristics (motion tags) with **OCEAN personality traits**.
- Use of **motion capture technology.**
- Crossover of personality traits and body movements by the **experts.**
- **Evaluation** by the participants.



Other studies notes: Adjectives + Kinesiological tags related to the Ocean model → **Written record by experts** → **Correlation of the literature with the movements of the short film *A Chairy Tale (1957)* .**

Methodology

Annotation Session on *A Chairy Tale* (1957): Developing a Motion Vocabulary for Performance Capture

Scene	Motion-Action	Type of movement	12 Principles of Animation	LMA (8 Efforts)	Expression characteristics	Description	Low	Neutral	High
Scene 1 [0:01:27–0:01:37]	Walking & standing	Body movement	Squash & stretch, pose to pose	Indirect, sustained, heavy, bound	Curious, concerned, skeptical, hesitant	Tilt head in different directions, hunched torso, arms and legs create angles, explore what's happening	A	E, N	O, C
Scene 2 [0:02:15]	Standing	Gesture & posture	-	-	Curious, confused, Skeptical, hesitant, anxious	Tilted head, hands close to body and create angles, legs close with toes open	E, A	O, C	N
Scene 3 [0:02:25–0:02:38]	Walking	Body Movement	Pose to pose	Direct, sustained, heavy, bound	Careful, controlled, attending, dominant, confused, scary	Tilted head, symmetrical movement, slow, steady small steps close to body, straight torso with weight in back	E, A	O	C, N
Scene 4 [0:03:30–0:03:34]	Running	Body movement	Exaggeration, slow in - slow out	Direct, quick, light, free	Energetic, active, confused, tired	Head centered-down, long steps with open, intense movement indicates a call, arms far from the body	C, A	O, N	E
Scene 5 [0:03:43]	Sitting	Gesture & posture	-	-	Happy, warm, relaxed, friendly, confident, satisfied	Tilted and centered head, arms and legs create angles, feet face outwards, tense posture and smiling	O, N	C, A	E
Scene 6 [0:04:55–0:05:05]	Sitting	Body movement	Squash & stretch, arc body	Indirect, quick, heavy, bound	Anxious, nervous, uncomfortable, annoyed, hyperactive	Head centered-down, arms and legs close to body, rapid change of sitting posture, bent torso, small and compact body	O, C, E, A	-	N
Scene 7 [0:07:09]	Standing	Gesture & posture	-	-	Curious, attending, outgoing, skeptical, dominant, satisfied	Head down, body straight and stretched, arms create angles, asymmetrical legs, forward stance, first fingers	A, N	C	O, E
Scene 8 [0:08:01–0:08:05]	Walking & jumping	Body movement	Exaggeration, arc body, pose to pose, slow in - slow out	Direct, quick, light, free	Happy, playful, optimistic, outgoing, energetic, excitement	Head straight and centered, wide hand position, fingers and feet open, stretched torso with elevation	C, N	-	O, E, A
Scene 9 [0:08:35–0:08:47]	Walking	Body movement	Pose to pose, slow in - slow out	Direct, sustained, heavy, bound	Nervous, anxious, skeptical, concerned, stressed, hyperactive	Head changes everywhere, hands grabbing face and scratching neck, fingers fast and sharp, bent body	O, E, A	C	N
Scene 10 [0:09:27–0:09:29]	Jumping	Body movement	Exaggeration, squash & stretch, arc body, slow in - slow out	Direct, quick, heavy, free	Happy, friendly, enthusiastic, accessible	Head up and centered, bent torso, arms, fingers and legs spread, Big movement, hand bowing	A, N	C	O, E

Methodology

Annotation Session on *A Chairy Tale* (1957): Developing a Motion Vocabulary for Performance Capture

Example (scene 4)

Scene 4 [0:03:30–0:03:34]

Motion – Action
Running

Type of movement
Body movement

12 Principles of Animation
Exaggeration & slow in –slow out

LMA (8 Efforts)
Direct, quick, light, free

Expression characteristics
Energetic, active, confused, tired

Description
- Head centered-down
- long steps
- open & intense movement
- indicates a call
- arms far from the body

Methodology

How did the experts rate the 10 movements based on the personality traits of the OCEAN model ?

1. Searching for overlaps **between OCEAN model descriptions** (literature) and **expression characteristics** (short film).

2. Determination of the **OCEAN values** in each **movement segment**.

3. Rating of the scenes on a scale of **LOW–NEUTRAL–HIGH** for each personality trait (OCEAN model).

4. Quantifying the scores on a scale of **0–100** and grouped our findings as low (0–33), neutral (33.1–66),and high (66.1–100).

The aim was to create a descriptive movement vocabulary, which served as the basis for recording the selected scenes using motion capture, presenting a structured approach to dynamic movement in 3D digital characters.

Experimental Study

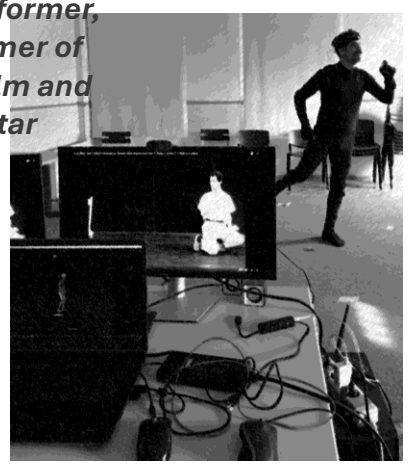
Motion capturing

- Recording process in the **Motion capture Lab**.
- Guidance of the **performer** by the experts.
- Motion capture technology **Rokoko Smart Suit Pro II** (v2) & **Rokoko Smart Gloves** (inertial markerless system).
- **Real-time monitoring** during capture sessions ensured detection of any deviations **in sensor performance** or movement execution.
- **Performer observation** of short film and execution of selected movements as instructed by experts.
- Each movement was recorded two or three times to ensure the **highest data quality**.
- Use of **the recorded movement data** for later processing and analysis.

Experimental Study

Motion Editing

Live Performer, performer of short film and avatar



Motion capture data

Recorded Movements (FBX format)

Import

Unity 6 (Unity Technologies, 2024)

Process & Refine

uMotion (Software Interactive, 2024)

Edit

Adobe Premiere Pro (Adobe Inc., 2020)

Finalize

Video clips (Mp4)

3d character/ avatar

Experimental Study

Movements

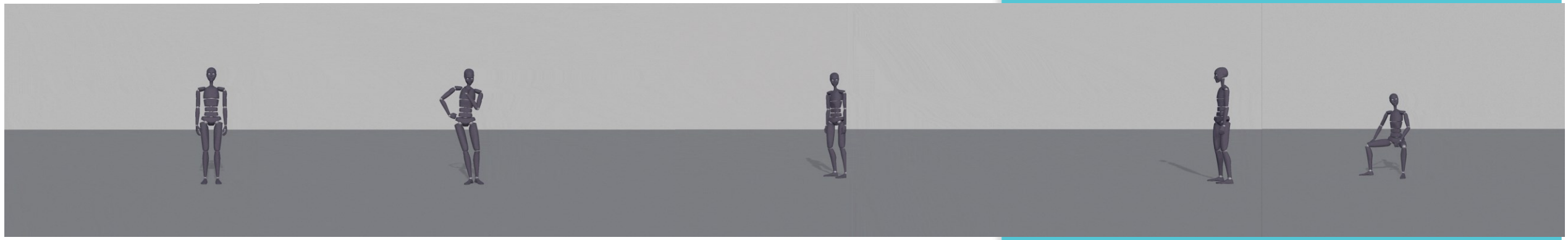
M1: character searching with curiosity

M2: character standing thoughtfully

M3: character walking carefully

M4: character running

M5: character sitting confidently



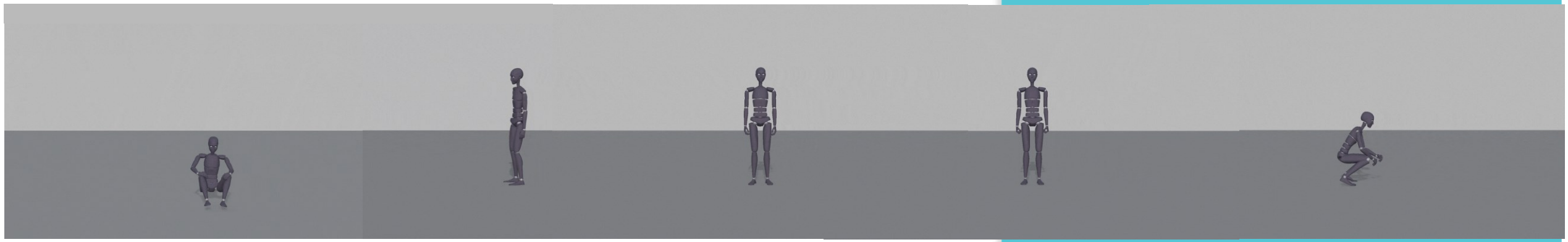
M6: character sitting with concern

M7: character standing relaxed

M8: character jumping happily

M9: character walking nervously

M10: character jumps



Experimental Study

Evaluation

Participants

Total: 20 participants

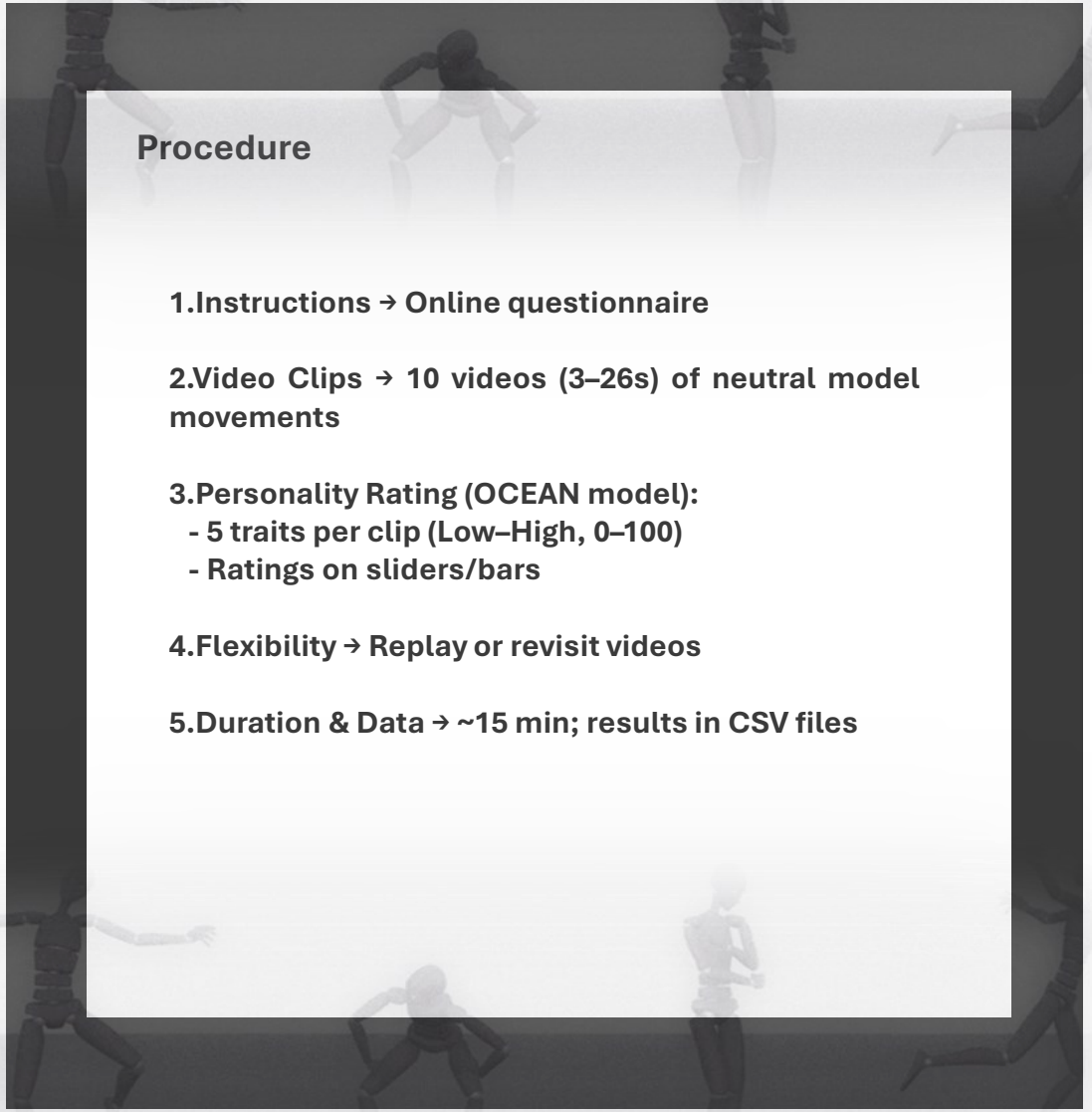
Backgrounds:

10 undergraduates
4 design graduates
3 dancers/performers
2 directors/screenwriters
1 director/performer

Age groups:

18–25: **9**
26–34: **7**
35–44: **2**
45–54: **2**

⚧ **Gender: 11 female & 9 male**



Procedure

1.Instructions → Online questionnaire

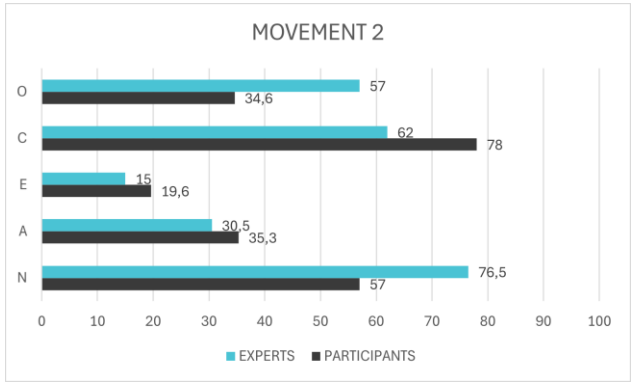
2.Video Clips → 10 videos (3–26s) of neutral model movements

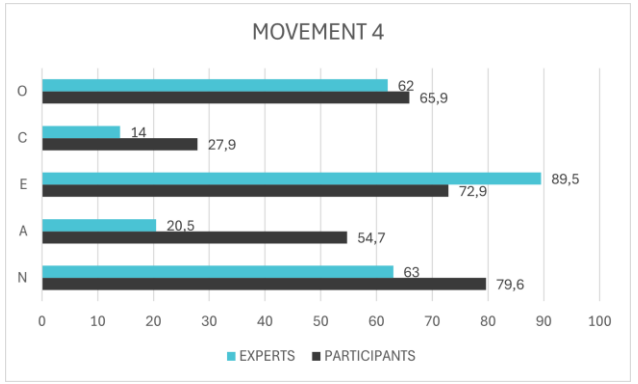
3.Personality Rating (OCEAN model):
- 5 traits per clip (Low–High, 0–100)
- Ratings on sliders/bars

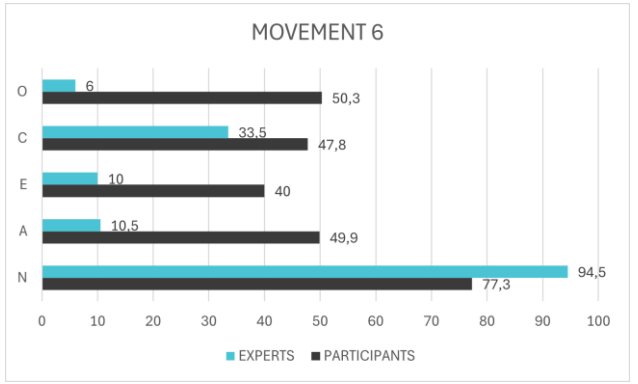
4.Flexibility → Replay or revisit videos

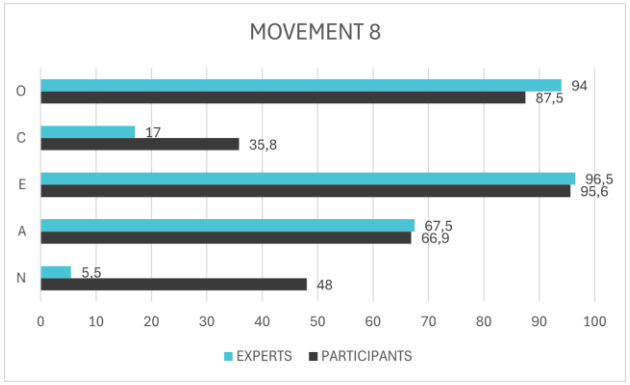
5.Duration & Data → ~15 min; results in CSV files

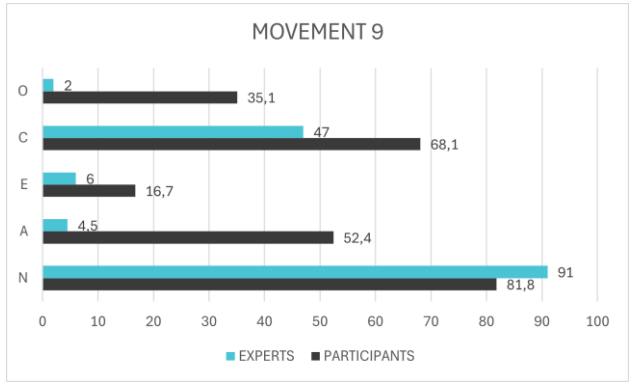
Results

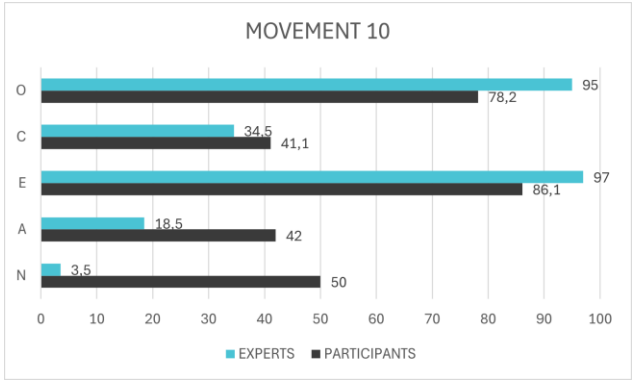












Results showed that between participants 'ratings and expert analysis were a high correlation for the evaluation process personality movement.

The participants rated the five(5) personality traits of the OCEAN model:
Openness the experience(O),Conscientiousness(C),Extraversion(E),Agreeableness(A) and Neuroticism(N)on a scale from 0 to100.

Results

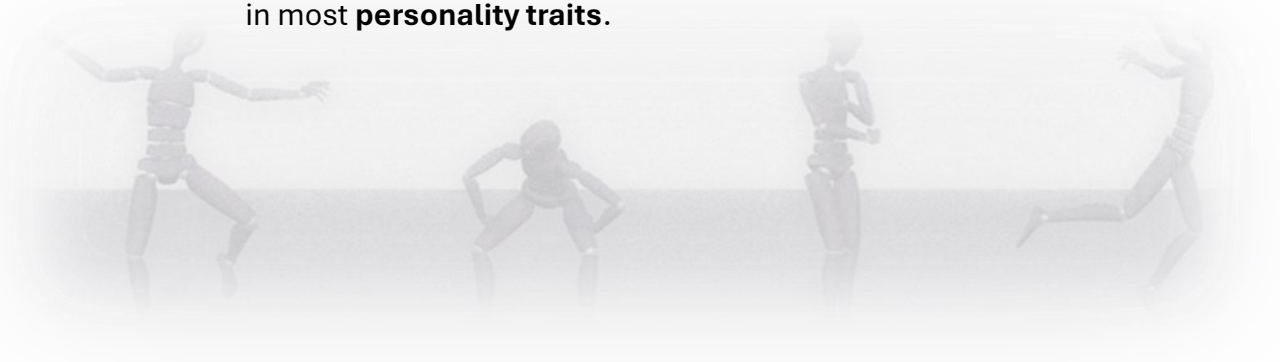
The Table presents the **absolute differences** between the scores of the participants and experts in each personality trait for **ten(10) movements (last column)** and in each **10 movements (last row).**

Movements / Traits	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	AVG
O	14.7	22.4	6.2	3.9	3.6	44.3	29.2	6.5	32.1	16.8	17.97
C	8.2	16.0	33.5	13.9	15.9	14.3	2.7	18.8	21.1	6.6	15.10
E	20.8	4.6	12.0	16.6	45.4	30.0	28.9	0.9	10.7	10.9	18.08
A	22.7	4.8	9.9	34.2	6.2	39.4	14.9	0.6	47.9	23.5	20.41
N	24.4	19.5	9.1	16.6	23.9	17.2	24.7	42.5	9.2	46.5	23.36
AVG	18.16	13.46	14.14	17.04	19.00	29.04	20.08	13.86	24.20	20.86	

In general, most of the participants voted mainly the values that were closest to the middle of the range ~ 50%, so many scores are observed that are characterized by neutrality.

Participants vs Experts

- **Highest** correlation **Openness to experience** (M3,M4,M5,M8)
- **Lowest** mean absolute difference presents **Conscientiousness** (MD:15.1).
- **Extraversion (E)** and **Agreeableness(A)** showed a **moderate score** (MD:10.08 and 20.41)
- **Neuroticism (N)** had the **highest** mean absolute difference among **all traits**.
- Movements 6 **(M6)** and 9 **(M9)** had the **highest** mean difference in most **personality traits**.



Discussion

Openness to experience was most clearly conveyed through movements that included **asymmetrical body posture**, **tilted head in various directions,** and **angular limb positioning** (M1).

Conscientiousness was accurately perceived in movements characterized **by control, symmetry**, and **minimal exaggeration** (M1,M7,M10).

Extraversion was associated with movements with **wide range of motion, fast pace, extended long limbs** (M8,M10), and **straight posture** (M2).

Also, **Extraversion** is often linked to open posture, stretched limbs, broad gestures, and upward head movement; however, overlap with similar cues in **Neuroticism** may have caused participant confusion.

Agreeableness was associated with movements that exhibit traits that present **friendliness, optimism,** and **relaxation** such as **smiling and open body posture** (M5,M8).

Neuroticism has the highest mean absolute difference among all traits, indicating **the most difficult personality trait** for participants to accurately rate based on the movement.

Discussion

In general.....

1.Movements with **an upward** or **centered tilt of head** and **torso** were associated with **self-confidence** and **extraversion**.

2.Opening the arms and **legs with asymmetry** indicates **curiosity** or **creativity**.

3.Symmetrical and **grounded postures** indicate **conscientious behavior**.

4.Smooth and **sustained movement** was associated with control.

5.Rapid and **sudden changes** were sometimes interpreted as **anxiety** and sometimes as **energy**.

6.Contracted and **short postures** and **hyperactive** and **nervous qualities** were associated with **neuroticism**.

7.Scenes with **only gestures and body posture** did not differ in personality trait perception from scenes featuring full body movement.

Conclusions & Future work

We propose....

a **framework** analyzing kinesiological patterns in **actor performance**, applying recorded movement to a **3D model**.

Findings suggest **movement** reflects in **personality expression**.

Limitations....

include **few participants** and motion capture challenges affecting **accuracy and fidelity** in some of the movements.

Future work....

Conduct **additional experiments** exploring how different aspects of character design—such as **appearance, environment, and interaction**—contribute to the perception of **personality in digital characters** in relation to **motion**.

Acknowledgments

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THANK YOU