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Analyzing the Impact of Character Animations on Gameplay Styles and Player Perception

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Bachelor’s Thesis | Abstract

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Analyzing the Impact of Character Animations on Gameplay Styles and Player Perception

The gaming industry is in a constant state of evolution, yet a limited number of studies have explored the impact of character animations on shaping users' interpretation of a character's personality. Perceived character personalities can be crucial in eliciting emotional connections with players. This research delves into the effect of character animations on players’ perception of personality traits and their impact on play styles. The study involved 22 participants and utilized the Big Five TIPI test to assign participants to characters with congruent personality traits. The findings from the Wilcoxon Signed Rank and Mann-Whitney U tests demonstrated that character animations do not impact a player’s gameplay style. Yet, the results suggest that character animations have an impact on personality perception and gameplay enjoyment, especially for extroverts. Despite that, the absence of homogeneity and the characters’ appearance might have contributed to biased results. Further research with an unadorned character is required to investigate potential confounding factors, including a randomized sample while establishing participants’ baseline before the experiment to control aspects that could influence the outcomes.

Keywords:

Character animations, personality, perception, gameplay styles, introverted, extroverted, TIPI

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List of abbreviations

2D	Two-dimensional
3D	Three-dimensional
High-poly	High-polygon
Low-poly	Low-polygon
Quad	Quadrilateral
TIPI	Ten-Item Personality Inventory
UV	XYZ Texture Coordinates

1 Introduction

The video game industry has experienced consistent growth, attracting more players and developers in recent years (Sobota, 2022). As the gaming industry has financially surpassed other forms of entertainment worldwide (Baltezarević et al., 2018), video game character design and animation techniques become even more significant. These components elicit strong emotions and reactions from players by developing captivating characters that resonate with the audience. However, although numerous studies have examined the visual aspects of character design, fewer have thoroughly investigated the impact of how character animation can shape the users' interpretation of a character's personality.

This study outlines character creation and 3D animation processes to analyze two sets of animations for two humanoid deer characters. Both characters' animations were crafted to imbue them with unique personalities - one displaying confidence and happiness, while the other exhibits insecurity and shyness. In addition, the characters were, apart from their animations, visually identical to eliminate any bias due to character design elements.

Gameplay took place in a basic Unity3D level featuring a platform with grey obstacles to minimize distractions from background colors and allow participants to focus solely on the characters' animations. The game mechanics and third-person perspective were consistent across both characters, providing each with identical game actions during separate gameplay sessions.

Before the testing phase, participants were required to complete the Ten-Item Personality Inventory (TIPI), based on the Big Five (Five-Factor Model) of personality (Gosling et al., 2003), to evaluate participants' personality traits. The primary objective of administering the latter was to ascertain each participant's personality traits and determine their potential inclinations toward specific gameplay styles. The Big-Five framework organizes personality traits into five broad dimensions: Extraversion, Agreeableness, Conscientiousness, Neuroticism, and Openness to Experience. These factors provide a general overview of an individual's personality traits derived from empirical research (Gosling et al., 2003). Therefore, the Big Five framework provides a reasonable approach to classifying various traits that form an individual's personality. Moreover, the TIPI instrument is a viable option that consists of ten brief items designed to capture the five dimensions of the Big Five personality traits (Gosling et al., 2003).

Following the TIPI test, participants were assigned to the gameplay group with their respective characters designed to be congruent, meaning compatible, with their extroverted or introverted personality traits. Gameplay styles and in-game actions were observed and documented to determine whether distinct behaviors emerged based on players' character animations, focusing on examining the extent to which their playing styles altered regarding the personalities of their assigned characters. Subsequently, participants completed a questionnaire to assess their viewpoints during gameplay. This research specifically addressed the question, "How do character animations affect play styles during gameplay and vary based on players' personality traits?". A mixed-methods research design was employed to investigate the research question, combining qualitative and quantitative approaches. The study observed and documented participants' in-game actions and gameplay styles, emphasizing the impact of character animations on player behavior.

In this thesis, the organization of the content is as follows: Chapter 2 presents a comprehensive literature review, encompassing relevant studies and existing knowledge related to the topic at hand. Chapter 3 describes the research prototype.

In Chapter 4, the character design process is thoroughly discussed, covering every stage of development from the initial concept art to the final animation. This chapter specifically covers the following stages: concept art creation, sculpting, retopology, UV mapping, texturing, rigging, and animating, providing a thorough understanding of the complexities of crafting a fully developed character for the study.

Chapter 5 elaborates on the research methodology. Chapter 6 presents the results, followed by a discussion of their implications in Chapter 7. Finally, Chapter 8 serves as the closing chapter, summarizing the findings and offering suggestions for future research.

Key terms: Blender3D, Clip Studio Paint, Sculpting, Retopology, UV Mapping, Texturing, Rigging, Weight Painting, Animation, Low-polygon, High-polygon, Mesh, Add-on, Edit mode

2 State-of-the-Art in Character Animation

Animations can convey emotions and personality traits, even without verbal communication (Thomas et al., 2022). Therefore, a character's personality is communicated not only through their background, appearance, or speech but also through animations that bring them to life and enhance the player's experience during gameplay.

2.1 Character design workflow

The character design workflow (Figure 1) employed in this study was optimized through the combined use of Clip Studio Paint and Blender 3D. Each offered unique strengths and functionalities essential for the character design process. Clip Studio Paint, a versatile digital art software known for accommodating various types of illustrations, is widely used for designing adaptable visuals (Yuliani, 2020). This software served as visual groundwork for the character's appearance. Meanwhile, Blender3D, a comprehensive open-source 3D graphics software and animation, was used for the subsequent workflow stages, including sculpting, retopology, UV mapping, texturing, rigging, weight painting, and animation (Baechler, 2020). In addition, Blender3D incorporates various add-ons, which are supplementary tools that extend the software's functionality (Blender Documentation Team, 2023) and augment user engagement.

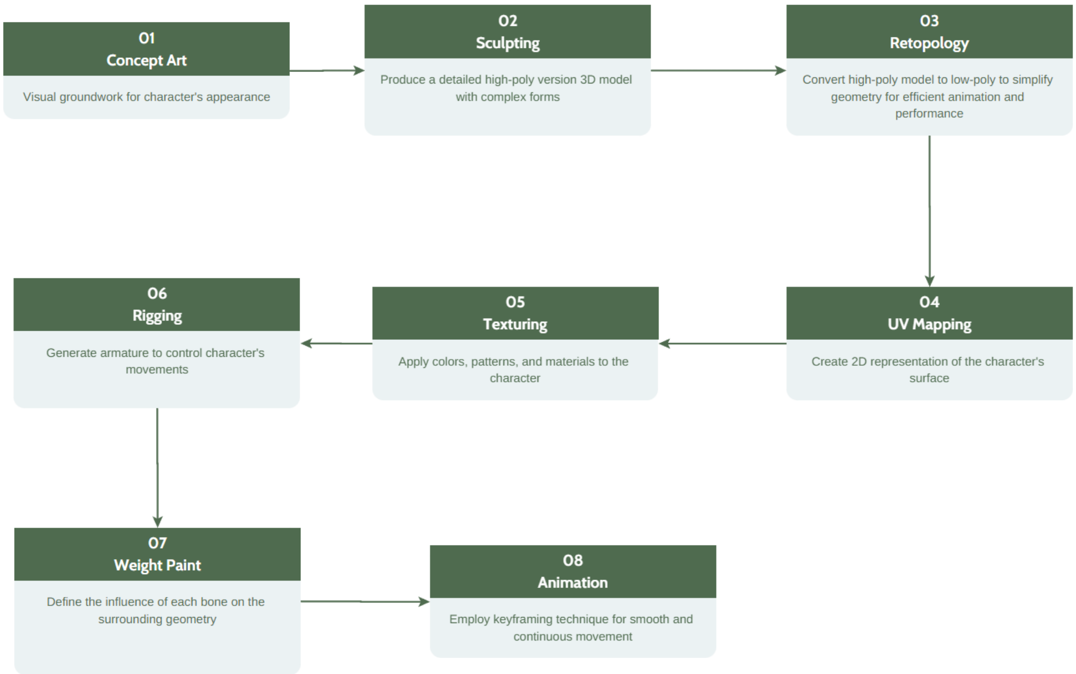

Figure 1. Character design workflow diagram.

The sculpting phase in Blender3D was intended to build the 3D deer character and incorporate details, resulting in an elaborate, high-poly mesh. High-polygon (high-poly) meshes are high-resolution geometry with many polygons that capture complex shapes (Baechler, 2020). A polygon is a flat, closed shape formed by connecting three or more points in a mesh, i. e., a 3D object (Van Gumster, 2020). These polygons, also known as faces, define the structure and appearance of objects in computer graphics. However, the high-poly mesh was converted into a more manageable, low-poly version to ensure efficient animation and performance through retopology. Low-polygon (low-poly) meshes have simplified geometry and fewer polygons, making them more suitable for animation (Baechler, 2020).

The rigging process was performed in Edit mode, which enabled the selection and editing of the 3D model's geometry for specific changes to the model's shape and form (Baechler, 2020). The latter involved creating an armature, or skeleton, that provided precise control over the character's movements and allowed for the deformation of its model. During the animation, the armature was manipulated to create movement in the 3D character, which deforms the mesh, the outer surface of the 3D object. The purpose of the latter was to achieve a natural-looking motion. Weight painting further defined the extent to which each bone influenced the surrounding surfaces, ensuring natural deformations throughout the animation process.

Finally, keyframing was employed, a fundamental technique in animation that involves specifying the character's poses at distinct points in time. The software interpolates the motion between these keyframes, generating smooth and continuous movement (Blender Development Team, 2023).

2.2 Literature Review

Character animations can significantly impact player awareness, cognition, and emotional responses (Praveen & Srinivasan, 2022; Plass et al., 2023). Nonetheless, there are challenges in ensuring that the animations effectively convey the intended personality traits. Past studies have emphasized character animation's effectiveness in transmitting emotional authenticity (Anasingaraju et al., 2020) and demonstrated that animations can communicate emotions and personality traits without verbal cues (Thomas et al., 2022), which in digital characters enhance expressiveness and communication (Wang & Ruiz, 2021).

Recent research highlights the importance of psychological factors in creating and interpreting 3D animation. Creators can use their psychological knowledge of the audience's preferences, emotional reactions, and interpretation of a character’s personalities and actions to design meaningful animations beyond their commercial value (Wang & Hao, 2023). By doing so, creators can develop more effective and impactful character animations that resonate with the audience, resulting in improved emotional responses and a more immersive game-based learning experience (Plass et al., 2023).

In order to address the research gap in understanding the relationship between character design, animation, and player preferences, this study aimed to investigate the impact of character animations in conveying personality traits and their influence on gameplay styles. Despite the increasing importance of character design and animation in the video game world, it remains to be seen how to tailor these elements best to suit the unique preferences of players with different personality traits. Therefore, two animation sets representing introvert and extrovert traits were developed and tested on players, with participants' in-game actions being recorded to assess the relationship between character animations, personality conveyance, and gameplay styles. By examining the effects of character animations on gameplay and considering the potential role of personality traits, this study sheds light on this new aspect of video game design. Furthermore, it contributes to a better understanding of how to customize animations to satisfy a diverse range of players.

3 Prototype Description

In this study, the development of the prototype involved using Blender3D to create two sets of character animations (Figure 2): Animation A, representing introverted personality traits, and Animation B, representing extroverted traits. These animations were assigned to virtual characters based on participants' TIPI results.

Figure 2. Final version of Animation A (left) and Animation B (right) in Unity.

Unity3D was used to create a virtual game environment that minimized distractions. The Etra's StarterAssets package provided digital assets, such as 3D models, textures, animations, and scripts (Technologies, 2023), which were imported into the Unity project to expedite development. Etra's Character Creator menu generated a platform with a third-person perspective, enabling clear visibility of the animations, and offered a range of character abilities, including jump, dash, sprint, and crouch. The study replaced the default character with the 3D deer. In addition, the platform's color scheme was modified to grey. Various-sized pillars and a tunnel for the virtual environment were employed as well.

Both characters had consistent game design and actions during separate gameplay sessions. The 3D deer animations were imported into Unity3D and integrated into the Animator Controller, which controlled character movements based on player input through animation states, transitions, and conditions.

The game recorded in-game actions, providing quantitative data for gameplay style analysis. The former was achieved by integrating custom code into each ability script, ensuring recorded data would appear in the bottom-left corner of the gameplay interface without obstructing the player's field of view. The custom code, embedded within the corresponding ability scripts, counted the number of times the player performed actions such as crouching, jumping, sprinting, or dashing. This information was displayed on the screen, facilitating observational analysis.

4 Character Design

The process of creating a 3D humanoid deer character begins with concept art creation and sculpting the 3D model. Next, the character undergoes retopology and UV mapping to prepare it for texture painting, which gives the character its distinctive appearance.

Once the character was graphically complete, it moved on to the rigging process, where a skeletal framework provided control of the character's movements. After rigging, the weight painting stage determined the influence of bones on the character's mesh. Finally, the character is animated in Blender3D, breathing life into the model by providing a range of actions that reflect its personality.

Each stage is thoroughly explained in the subsequent subchapters, detailing the specific tools and techniques employed throughout the character design process.

4.1 Concept Art

Multiple sketches were designed to explore various concepts during the early stages of the 3D humanoid deer design. Subsequently, Clip Studio Paint was selected to produce a detailed digital painting with layers for enhanced control and flexibility. The approach encouraged forming and modifying specific parts of digital art without affecting other elements. The process was initiated with a blank canvas. Each layer represented a transparent sheet containing line art, color, sketch, and paper layers, which were incorporated in a top-to-bottom sequence. This feature facilitated adjustments and revisions to the artwork.

Furthermore, the preliminary step involved the formation of a sketch (Figure 3), which consisted of basic shapes representing the deer's fundamental structure. As the design progressed, finer details were incremented to allow for the gradual refinement and development of the character. Throughout this procedure, careful consideration was given to maintaining harmonious proportions of the character's form.

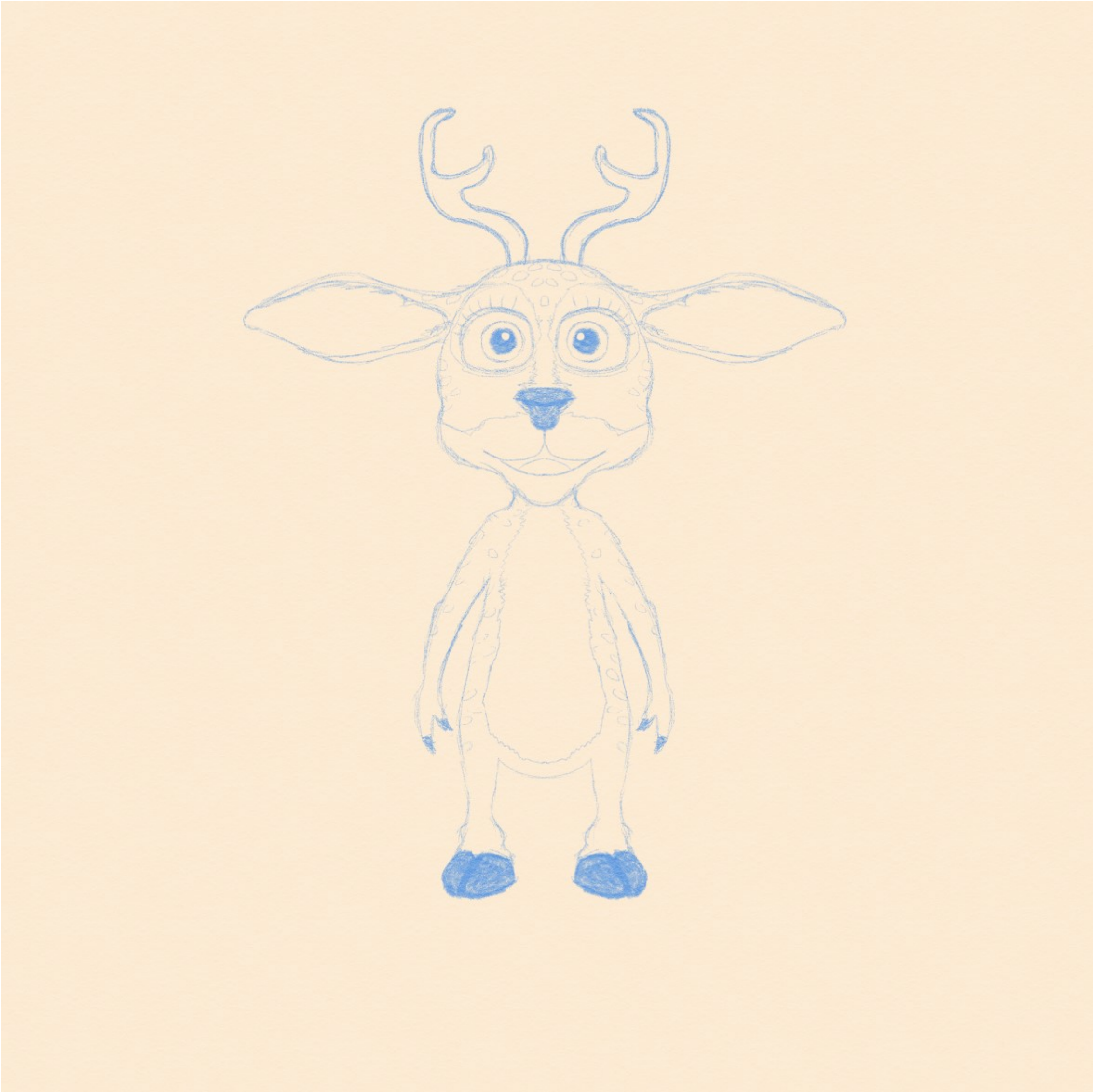

Figure 3. Sketch layer for the 3D character.

Concurrently, a Wacom digitizer tablet was utilized for the sketching layer to test and calibrate pencil strokes, ensuring precise control throughout the design process. Additionally, the graphics pen tablet simplified the development of the character's concept art, which was further refined in the line art layer.

Upon completion of the sketch, adjustments to the layer settings were made to simplify the outlining process in the subsequent line art layer (Figure 4). Specifically, the color of the sketch layer was altered to blue to differentiate it from the line art layer, and its opacity was reduced by 50% to ensure visibility during the outlining process.

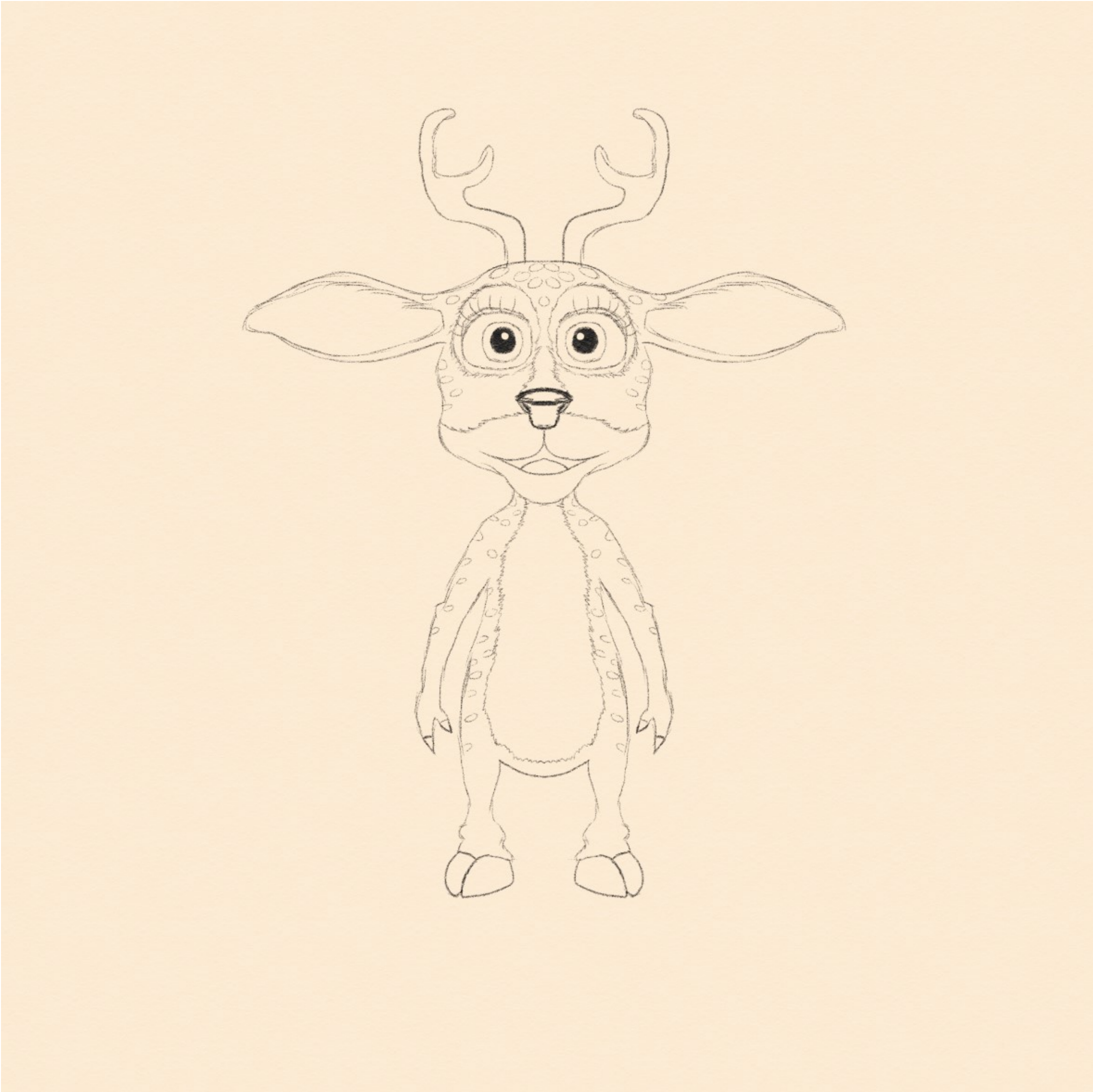

Figure 4. Line art layer.

Once the line art layer was finished, the sketch layer was hidden, and the color application began on the color layer (Figure 5). Shades of dark brown were applied to the antlers, eyes, and hooves, while a lighter brown hue was applied to the fur. Light spots were strategically incorporated into the fur to accentuate the character's youthful appearance, and a light beige patch was added to represent the abdominal region. In addition, selecting an appropriate color palette was crucial in expressing the character's age. Chosen colors were carefully considered to ensure they reflected the juvenile appearance, contributing to a youthful demeanor irrespective of personality traits.

Figure 5. Final concept art with the color layer application.

Concept art supported visualization and communication of ideas before crafting the 3D sculpture, promoting consistency and cohesiveness in the character's design elements. As a result, assessing the character's overall appearance led to modifications based on feedback. For instance, adjustments were made to the character's cheekbones, antlers, and ears to appear less protruding, and the head was rounded for a more innocent look.

Despite challenges during the concept art phase, such as finding the right visual balance between real-life deer and cartoon aesthetics, exploring various artistic influences led to suitable layout decisions.

The successful implementation of concept art in the design process and the exploration of artistic influences highlighted the importance of establishing a solid visual groundwork to streamline subsequent stages of character creation, including the transition to 3D modeling and animation.

4.2 Sculpting

Following the concept art phase, the next step in the character creation process involved the production of a 3D humanoid using Blender3D. This phase comprised building upon the ideas and visual designs established during the concept art to represent the character's overall shape and appearance. However, while the concept art served as a guide to visualize ideas, adjustments were made during the 3D modeling process, resulting in a final sculpture that diverged from the initial artwork.

The default sphere was the basis for developing the cervine model in sculpting. The manipulation of specific mesh sections was achieved by utilizing the grab brush. This tool was used to select and modify the model's face by causing a protrusion with the brush size and strength. The increase in brush size corresponds to a more prominent affected area, while a higher brush strength results in a more pronounced grab effect on the selected region. The techniques mentioned above were employed in diverse regions of the face, including the head, jaw, cheeks, chin, nose, and forehead. Therefore, an appropriate cartoon-looking head with gentle physiognomy while maintaining a balanced shape to the deer's face.

Consequently, the ears and antlers were shaped and extruded using the masking brush. The approach involved applying pressure to the area targeted for modification with the masking brush, allowing extraction and subsequent mesh shaping to achieve the desired effects. In this instance, the ears and antlers were elongated to maintain the deer's juvenile appearance while simultaneously carrying a sense of maturity, befitting the character's image. As previously mentioned, the masking technique was similarly employed for the entirety of the body, including arms, torso, legs, and tail. On the other hand, the eye sockets were formed utilizing the clay strip brush. Rather than applying clay strips, the brush was used to remove material in circular motions, simulating the appearance of eye sockets. The eyes were then integrated into the sockets to complete the character's facial features.

Utilizing the sculpting tools within Blender3D, the model underwent a process of refinement and iteration to reach a satisfactory level. The former was accomplished by carefully considering and incorporating a few deer features from the concept art (Figure 6).

Figure 6. Deer character sculpted in Blender3D.

4.3 Retopology

Before commencing the sculpted character retopology, it was necessary to enable specific add-ons within the Blender software, including F2, LoopTools, and BSurfaces GPL Edition. These add-ons played a crucial role in the retopology stage, enhancing workflow performance. For instance, F2 assisted with the creation and extension of polygonal faces, LoopTools provided a collection of mesh editing tools that were utilized to improve edge loops and faces, and BSurfaces specialized in creating complex structures with optimal topology. By navigating to Edit > Preferences > Add-ons within Blender3D, the corresponding checkbox was selected to enable the add-ons mentioned above.

The sculpted deer model was selected to utilize the BSurfaces add-on. After activating the add-on, an empty object was generated, and the required retopology settings were configured. The mirror modifier was added through the BSurfaces add-on to create a symmetrical mesh on the opposite side, simultaneously allowing retopology on both sides. In addition, the BSurfaces add-on enabled the annotate tool, which allowed drawing on top of the 3D character to generate a new surface. The add-on settings were also modified to apply or remove the polygons as required, resulting in more aligned and appropriately sized faces.

A critical aspect of retopology was establishing essential loops (Figure 7) in regions where animation and deformation would occur. The procedure commenced with facial retopology, generating vital loops around the jaw, eyes, mouth, cheeks, and ears. Additionally, essential loops were created for hinge joints, which typically encounter most deformations. In the case of the humanoid deer, these included the neck, elbows, wrists, and ankles, as these areas undergo significant twisting motions. Consequently, three loops per hinge or joint were incorporated to ensure efficient and smooth deformations with sufficient polygons.

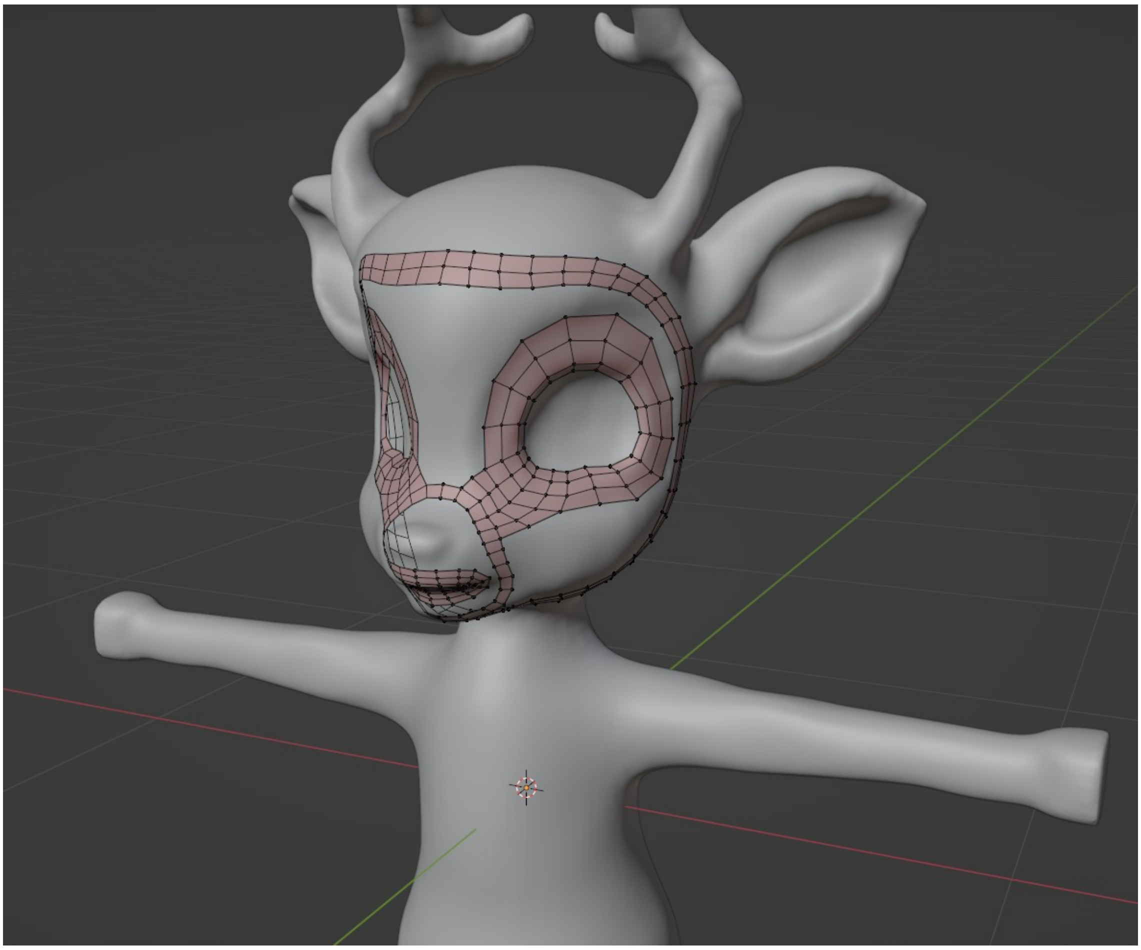

Figure 7. Essential loops around the sculpted deer's face.

Full loops were strategically positioned around the elbows, defined as uninterrupted edge loops encircling a specific area and forming a complete circuit without breaks. The latter granted proper articulation and an even geometry distribution, yielding more natural and realistic movements in the final animation (Aleknavitsjus, 2022). In addition, integrating full loops around the elbows enhanced character rigging and animation outcomes.

Following the formation of essential loops, these were connected by generating new faces between them. The F2 add-on proved beneficial for this task during the connection of polygons through new face creation by selecting a vertex and pressing the F key bind. Moreover, an even distribution of edges was attained by utilizing the CTRL + R shortcut, while the conversion of triangles into quad was enabled with the knife tool. As a result, triangles have three vertices and edges, while quads have four vertices and edges, providing more flexibility and control during rigging and animation. Finally, the knife tool was activated via the K key bind to assist in the creation of necessary lines connecting corresponding edges, effectively transforming triangles into quads.

The newly created topology (Figure 8) was evened out with the sculpting's smooth brush at a reduced strength. In addition, the subdivision surface was applied, yielding a polished polygon surface.

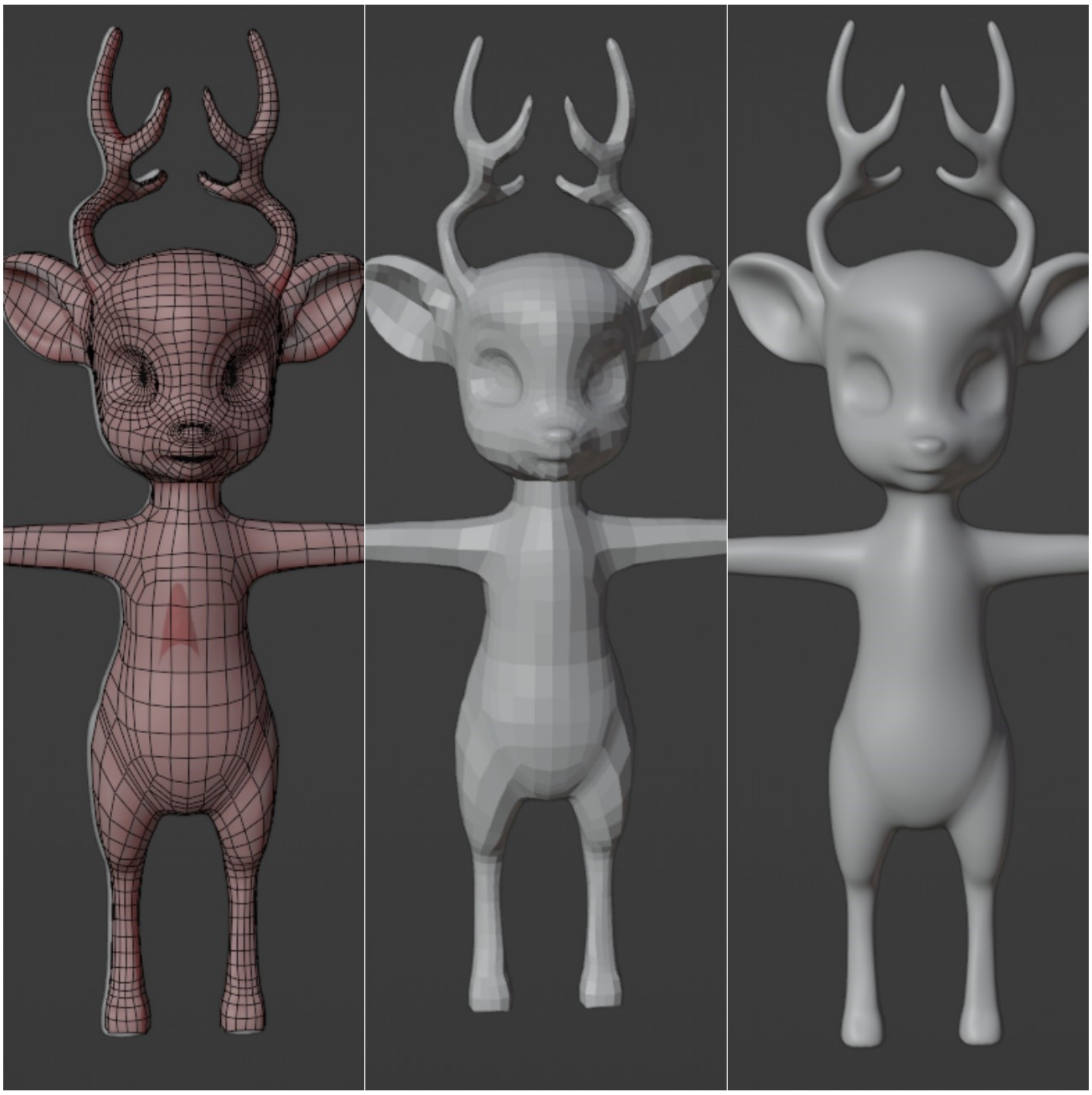

Figure 8. Final retopology (left) or low-poly version (middle) of the sculpted deer with subdivision surface modifier (right).

4.4 UV Mapping

Following retopology, UV mapping is performed in Edit mode to generate a 2D representation of the character's surface through the placement of seams. Seams are marked edges to indicate where the mesh should be split apart to create individual UV islands, i.e., the separated pieces. The previously mentioned is essential for the texture painting phase, where colors and details are directly applied to the 3D object. Thus, UV mapping is achieved using the Unwrap tool, which flattens the 3D mesh onto a 2D plane for texturing purposes (Lotter, 2022).

The identified areas for separation during UV mapping in the humanoid deer model were marked with seams in the Edit mode, strategically placed on the mesh to define UV islands using the "Mark Seam" option in the Edge menu (Ctrl + E).

Seams were placed along the back of the head, ears and antlers, extending from the top and continuing down the center to the base and sides of the neck towards the shoulders. Seams were created around the eyes, nose, and mouth for the face. Seams were also introduced along the inside of the arms, connecting from the armpit to the wrist, around the shoulders and armpits. Additionally, more seams were placed along the sides of the torso, reaching from the armpit to the hips and circulating the groin area, separating the front and back torso UV islands while placing seams in less visible areas.

The model also featured hooves, where seams were placed around the top, connected to the back of the legs and the arms, connecting to the hooves. Around the hooves' bottom edge, seams were placed to separate the sole from the hooves and minimize stretching during texture painting. An additional seam was placed around the bottom of the tail.

After all the seams are carefully placed (Figure 9), the 3D deer model is selected in Edit mode, and the user can access the UV unwrapping options by pressing the U key. Selecting "Unwrap" from this menu initiates the automatic UV unwrapping process in Blender3D. As demonstrated in Figure 10, the process generates a 2D layout of the model based on the previously marked seams. The margin parameter is adjusted to 0.50 to provide a wider distance between the UV islands to prevent the colors and details from bleeding into each other during texture painting. This step ensures that each UV island has enough space to accommodate the necessary textures.

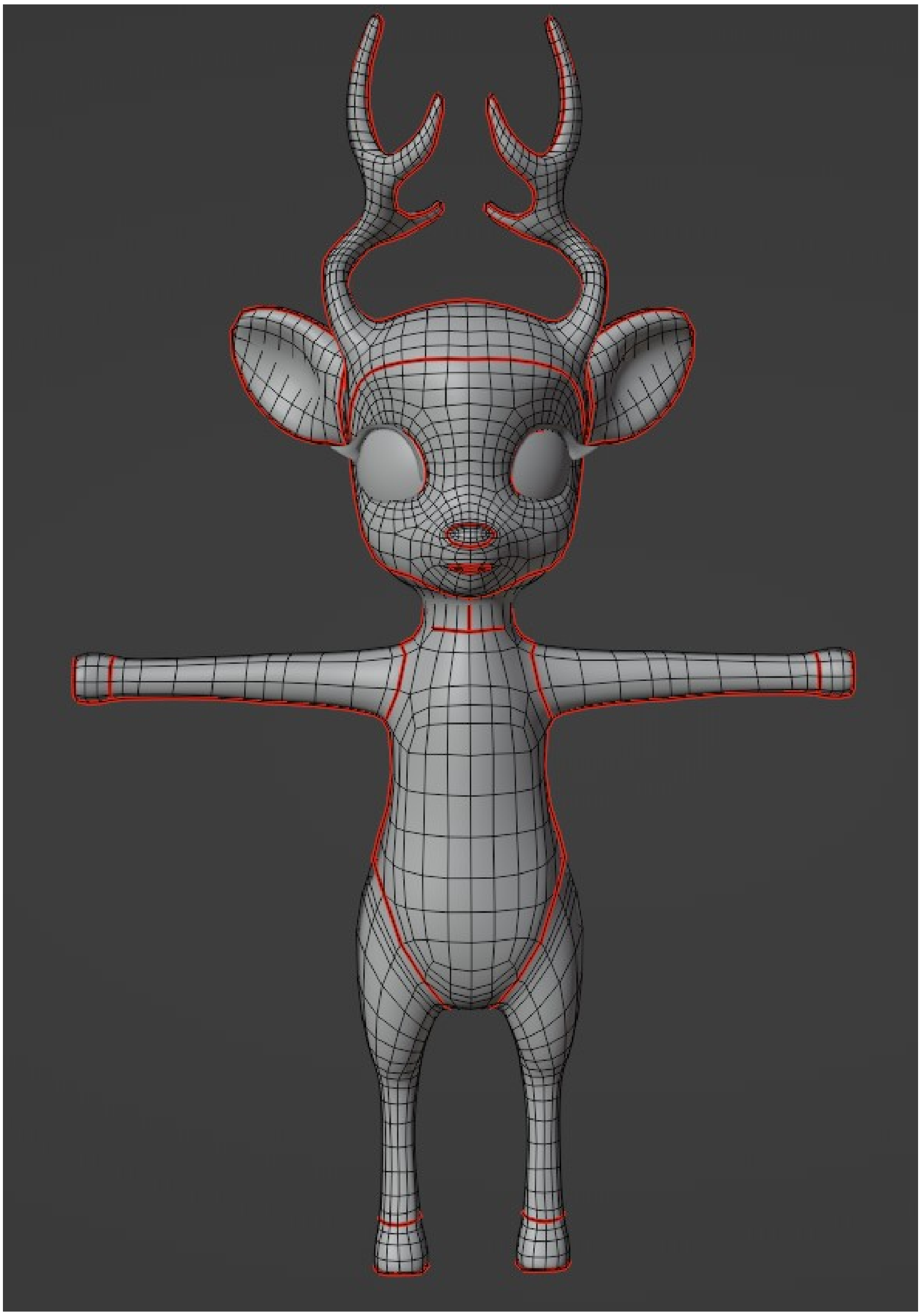

Figure 9. Seams (red lines) applied for UV unwrapping.

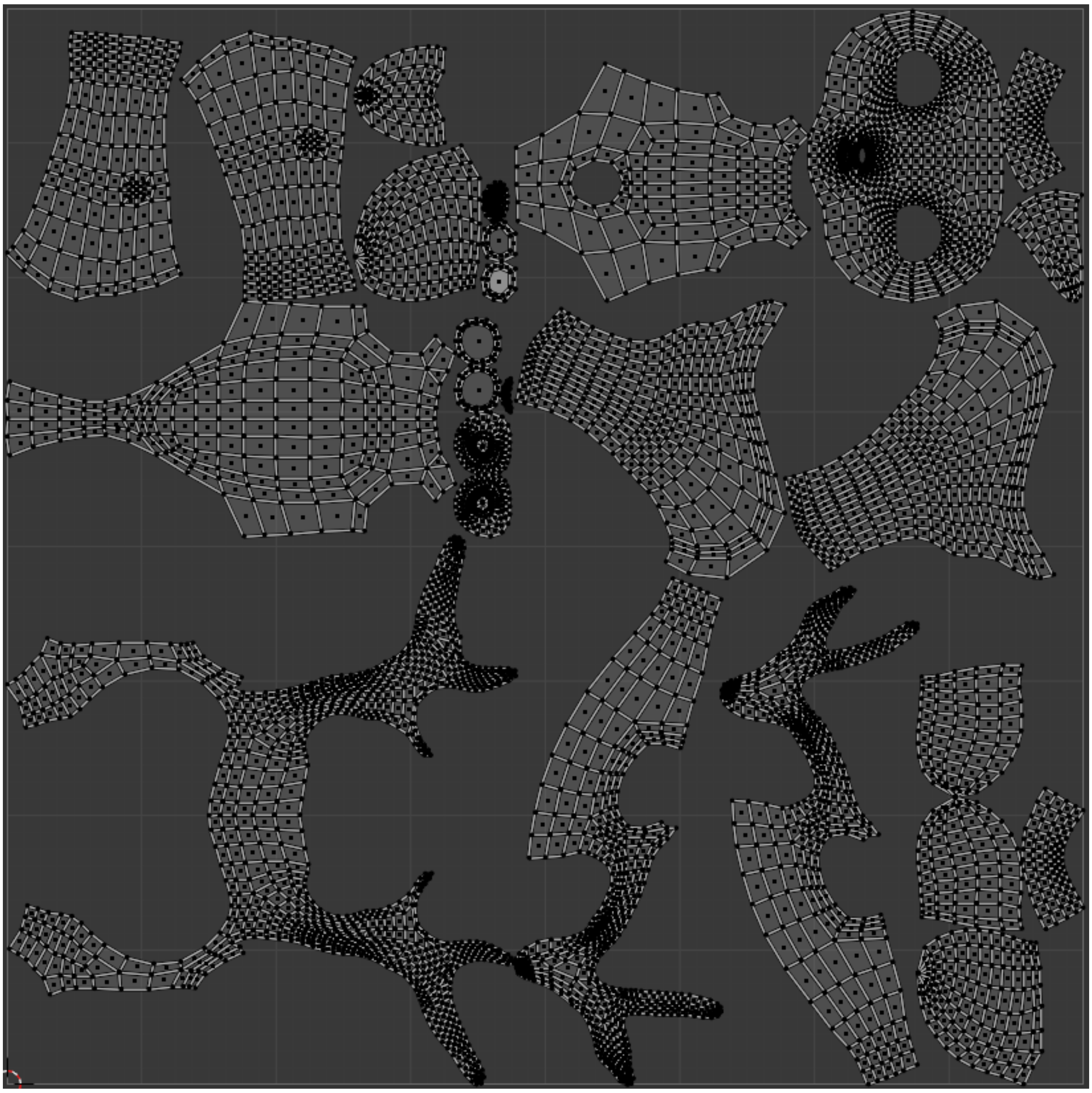

Figure 10. 3D deer UV unwrapped.

4.5 Texture Painting

A thoughtfully selected color palette ensured a harmonious color composition for the character. A new texture paint slot with a 2048x2048 resolution was added to the Texture Paint workspace. This resolution offered a more detailed texture, which enabled sharper and more complex patterns, colors, and nuances within the texture.

A light brown base color texture was applied to the humanoid deer using the Fill brush that covered the model's entirety. The Smear brush tool was used to modify the texture mask to mimic fur streaks. The texture mask is a grayscale image that is used to influence the appearance of the paint being applied. By modifying the texture mask, the Smear brush tool created the appearance of fur streaks in the texture painting. This addition of detail allowed for greater control and customization over the fur pattern effect.

Additional details, such as streaks of a slightly darker brown, were painted directly onto the base color using the Draw brush. To add depth and create the appearance of fur, the dark shade of brown was blended with the base color using the Smear brush. These colors were manipulated to create a natural-looking transition for the fur pattern effect and were smoothed out to maintain a softer and more gradual transition between colors.

The gradient pink in the inner ears and the mouth region added a subtle touch of vibrancy to the character. The eyes, antlers and hooves were painted dark brown, contributing to a visually appealing contrast with the lighter shades. The upper region of the head, the posterior side of the ears, the top of the nose bridge, and the area extending from the rear towards the tail were adorned with a medium brown tint. This choice of coloration created a smooth transition, using the Smear brush, between the lighter and darker shades.

Particular areas of the deer, such as the region adjacent to the eyes, the outer portion of the ears, and extending from the frontal torso downwards, the areas beneath the tail and upwards towards the mouth and cheeks, were adorned with white markings. Additionally, medium-sized white spots were added to the rear.

After the texture painting process was completed, the resulting 2D layout image was saved on the computer for future use in the Unity3D game engine (Figure 11).

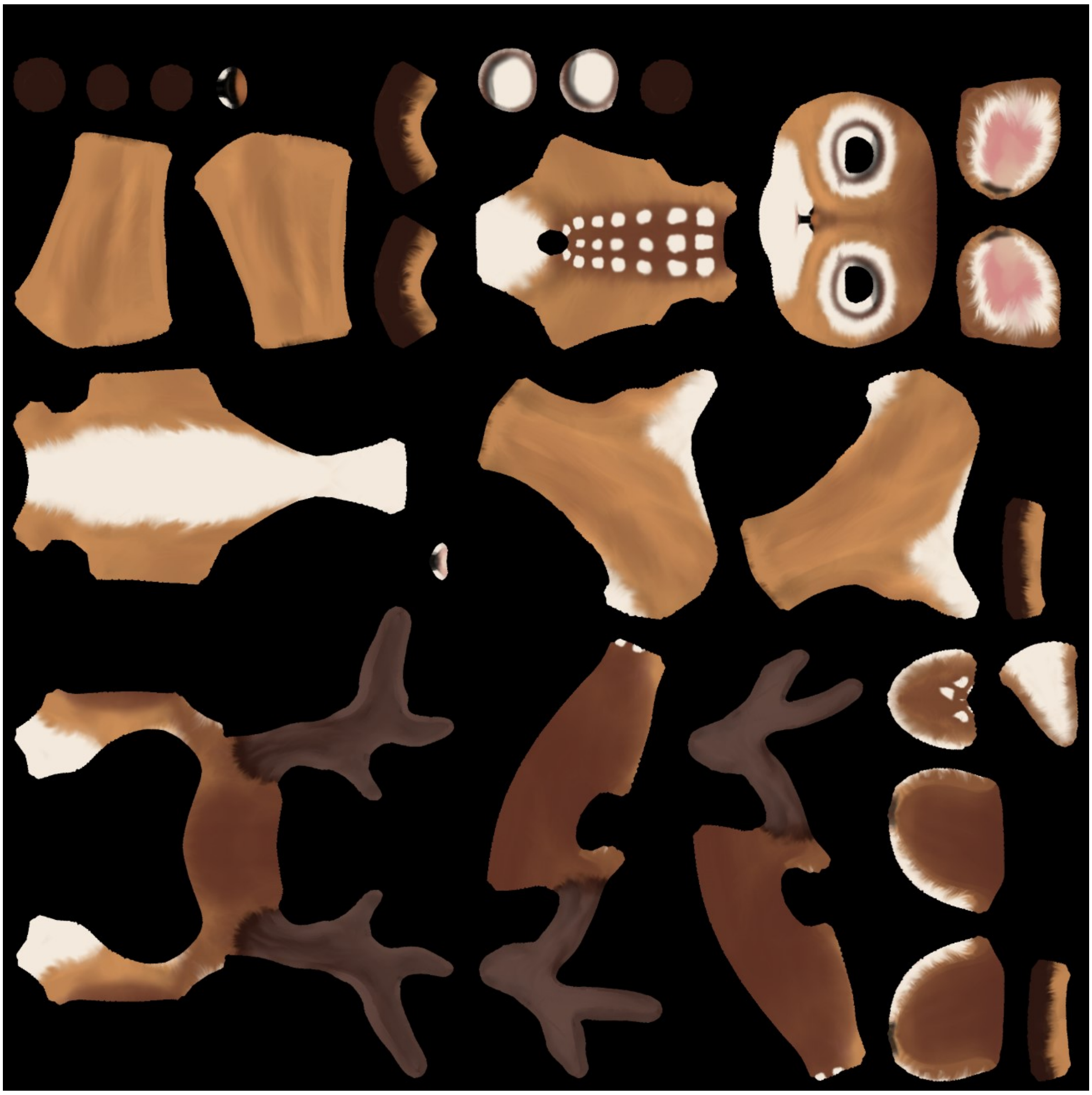

Figure 11. Deer's texture image.

4.6 Rigging

Rigging is building an armature, a skeleton-like structure with articulation points known as joints. These joints are connected by bones, which control how the character's outer surface, or mesh, changes shape during animation (Baechler, 2020). Rigify, a user-friendly add-on, was installed to assist with rigging by offering a collection of pre-built bone components. The former can be customized and combined to create a unique armature for a 3D model, such as the 3D deer.

In addition, the various preconfigured rigs are designed for different body parts, ensuring a versatile and adaptable rigging process.

For the lower body, leg presets are added by navigating to the Armature Tab > Rigify Buttons and searching for the appropriate preset. Bones were adjusted to align with the humanoid's limbs. Similarly, a primary spine preset was incorporated to match the character's torso, and arm presets were added to accommodate the hooves and enable wrist movement. Lastly, a super head preset included the necessary neck bones in the armature.

In addition, the ears were given new bones with the tentacle preset, which provided a flexible structure. The tentacle preset was also applied to the tail to allow for a smooth range of motion. Bones were added to the pelvis and shoulder areas to support other bones and prevent deformation in those regions. Similarly, bones were applied to the skull to prevent manipulation from the ear bones.

The skeletal structure was extended to the deer's facial region after incorporating bones throughout the body. The bones were strategically placed in critical areas such as the forehead, nasal region, cheeks, temples, and the region encompassing the eyes.

Subsequently, the ear bones were linked, or parented, to the skull bones, which in turn were attached to the head bone. Similarly, the neck and shoulder bones were parented to the top spine bone, allowing for more natural upper body movement. Parenting or attaching refers to connecting bones to create a hierarchical relationship, which allows for coordinated animations since the movement of the root bone will affect other bones.

Once all the bones were in place, the "Generate Rig" button was selected in the armature tab, which generated a Rigify rig for smoother animations and easy functionality. The original armature was then hidden to prevent interference while animating. Next, the character was selected, followed by the rig, and CTRL+P was pressed to display the "Set parent to..." menu to attach the newly generated Rigify rig. In this menu "Armature deform" option was chosen, explicitly selecting "with automatic weights", which established the connection between the character's mesh and the rig. Subsequently, the software automatically calculated the influence of bones on the character's mesh, enabling the character to move naturally and efficiently using the controls provided by the Rigify rig, which originated from the armature.

In this manner, the use of Rigify and its customizable presets assisted the rigging process (Figure 12), ensuring that the deer character had a suitable armature for natural and seamless movement during the animation stage.

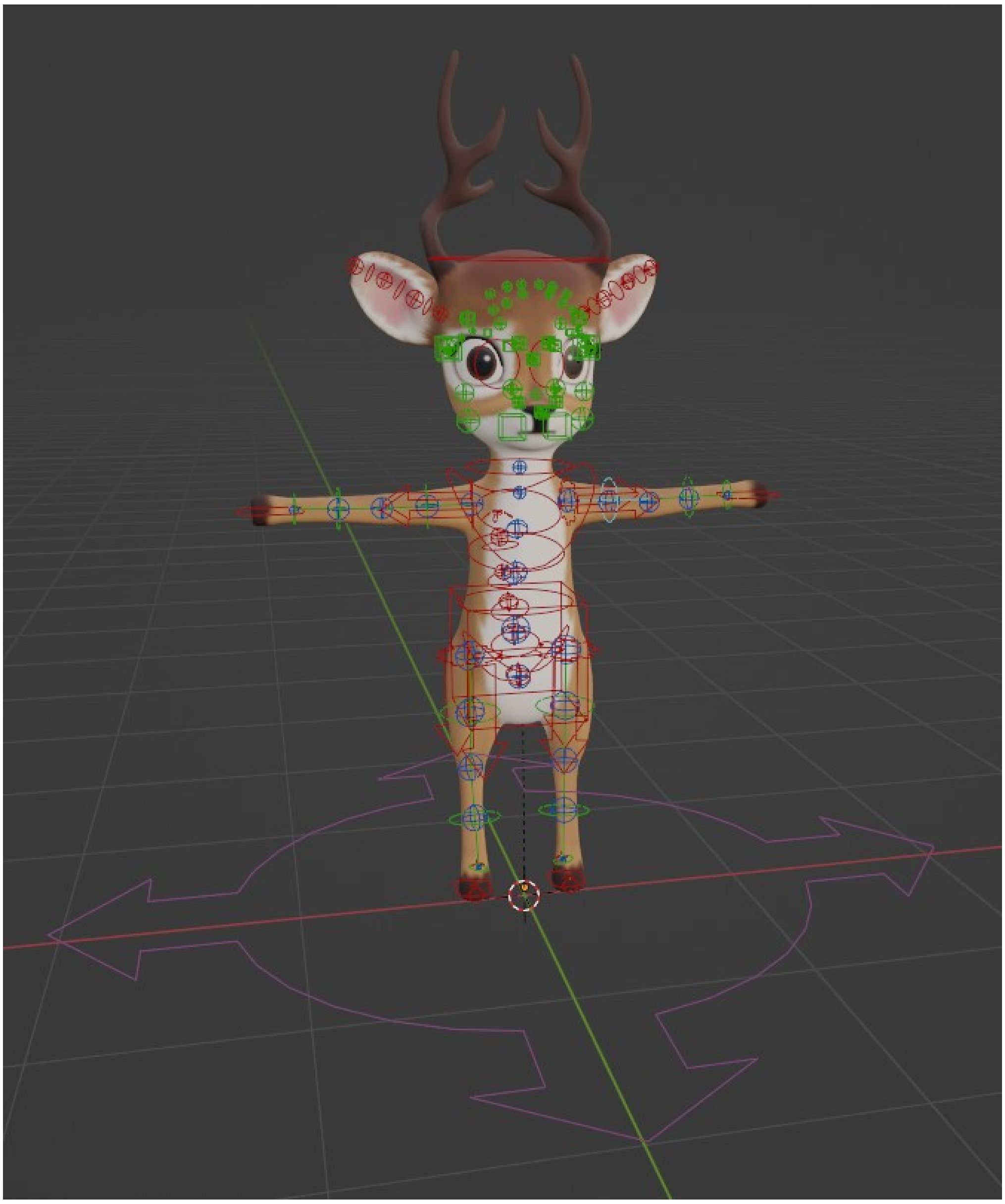

Figure 12. Rigify armature on top of the 3D deer.

4.7 Weight Paint

Weight painting is a technique used to define the influence of each bone on the character's mesh as it moves and animates. The deer model was posed in a neutral T-pose, extending their arms horizontally, forming a "T" shape with the body. The T-pose is a standard starting point for rigging, animating, and adjusting the weight influence. The weight painting was then refined to limit its influence on the intended areas, preventing unwanted movements as the animation progressed. Although the Rigify add-on assisted in setting up the initial bone weights, weight painting was crucial in adjusting the weight influence to achieve the desired animation results. By painting directly on the mesh using the weight painting brush, the weights associated with certain bones were modified to control the degree to which the mesh would be affected by their movement. Weight Paint mode displays a heatmap representation of the weights assigned to the selected bone, with colors raging from blue (no influence) to red (full influence) and to gradient colors representing varying degrees of influence.

The weight influence was adjusted to the ears to limit the effect only to the area encircling them and not other parts of the model (Figure 13). By adjusting the weight influence on the area encircling the ears, these could move freely and independently as the animation was being crafted. To prevent unwanted movements, the bone's influence on the mesh was removed in the surrounding areas, such as the antlers, allowing for more precise and accurate animation. The tip of the head weight influence was also removed to ensure that there would not be deformations in unwanted places.

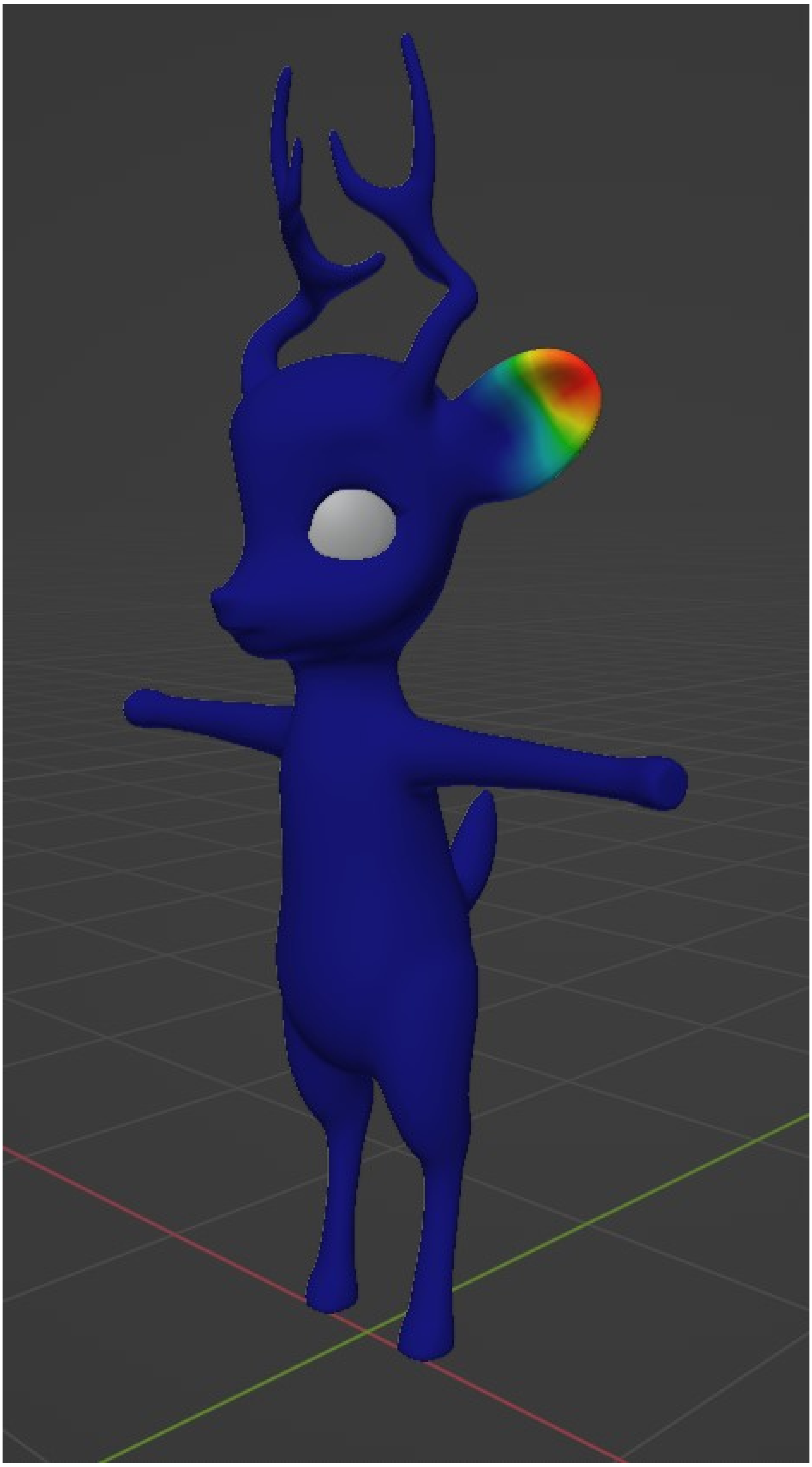

Figure 13. Example of weight paint influence on the deformation of the ears.

The weights were refined in areas where multiple bones influenced the same part of the mesh, such as the joints or areas where the body parts were connected.

4.8 Animation

The character animation process was conducted in Blender3D, utilizing keyframe animation techniques due to familiarity with the method. Pose-to-Pose and Straight-Ahead Animation were employed to achieve the desired results. Pose-to-pose animation involves creating key poses first and filling in the in-between frames, allowing for better control over timing and poses. On the other hand, straight-ahead animation sequentially involves animating frame by frame, resulting in more fluid and spontaneous motion. The assembled animations included Idle, Walk, Sprint, Crouch, and Dash.

Character A's expressions and body language displayed insecurity and shyness, with lowered shoulders, drooping ears and tail, and a facial expression to appear timid. In contrast, Character A's expressions were designed to convey confidence and joy, as evidenced by a straight head, a smile, straight shoulders, and an upward-pointing tail.

The Action Editor in the Animation workspace granted the creation of new actions for individual animation for the deer character. In Blender, actions represent a series of keyframed transformations or deformations constituting an animation sequence. For the deer character, alterations in its properties, including location, rotation, and scale, were made over a specified duration to create dynamic movements and actions.

The character was brought to life through a methodical process that involved selecting the *rig* and opting for pose mode, which permitted the manipulation of bones to achieve the desired positioning. A *rig* refers to the virtual skeleton used to control the character's movements, consisting of a series of interconnected bones and joints that provide a hierarchical structure simulating the anatomical structure of the character. *Pose mode* is a specific mode within the animation software that enables the manipulation of the character's rig to create various poses and movements.

In *Pose mode*, the bones and joints were manipulated to generate various poses and expressions. These poses were then used as keyframes within the animation timeline, as snapshots of the character's position and orientation at specific moments.

5 Methodology

The study employed a mixed-methods research design, incorporating observational, qualitative data and quantitative measurements of in-game actions. Through random sampling of individuals, 22 participants with experience in video games were recruited via online platforms, social media, and interpersonal communication. Data collection was conducted using Google Forms.

Before the testing phase, the Ten-Item Personality Inventory (TIPI), based on the Big Five (Five-Factor Model) of personality, was administered to assess participants' personality traits. The Big Five model is a widely utilized psychological framework that consists of five dimensions of personality: Extraversion, Agreeableness, Conscientiousness, Emotional Stability, and Openness to Experience (Gosling et al., 2003). The TIPI consists of 10 items, with two items for each Big Five trait. Participants rate their agreement with each item on a scale from 1 (strongly disagree) to 7 (strongly agree) (Appendix 1).

Based on TIPI results, participants were divided into extroverted and introverted groups and assigned virtual characters with congruent personality traits. During gameplay, in-game actions such as jumping, crouching, sprinting, and dashing were recorded to evaluate gameplay styles quantitatively.

The experimental setup involved observing and assessing participants' in-game actions while they engaged in gameplay. Subsequently, players completed a questionnaire addressing their perceptions of character animations and their influence on gameplay style. The observational analysis evaluated five gameplay style dimensions: aggressiveness, cautiousness, exploration, adaptability, and precision. The dimensions were assessed by observing how players navigated the level and analyzing the recorded in-game actions.

Two sets of hypotheses were formulated:

$H0_1$: Players are able to identify 3D character personality traits from the character's animation.

Ha_1: Players are not able to identify 3D character personality traits from the character's animation.

$H0_2$: There is no significant difference in the perceived gameplay style between participants experiencing Animation A (introvert) and those experiencing Animation B (extrovert).

Ha_2: There is a significant difference in the perceived gameplay style between participants experiencing Animation A (introvert) and those experiencing Animation B (extrovert).

By combining observational, quantitative, and qualitative data analysis methods, this study aims to understand how character animations influence gameplay styles and the factors contributing to this relationship.

6 Results

A dataset of 22 samples was assessed through the Big Five personality TIPI test before character testing and answering the post-test questionnaire to determine whether character animations influence play styles and differ according to players' personality traits. Figure 14 illustrates the Big Five personality traits scores, specifically among players assigned to the introvert and extrovert characters. Particularly, the chart highlights an absence of homogeneity for extraversion.

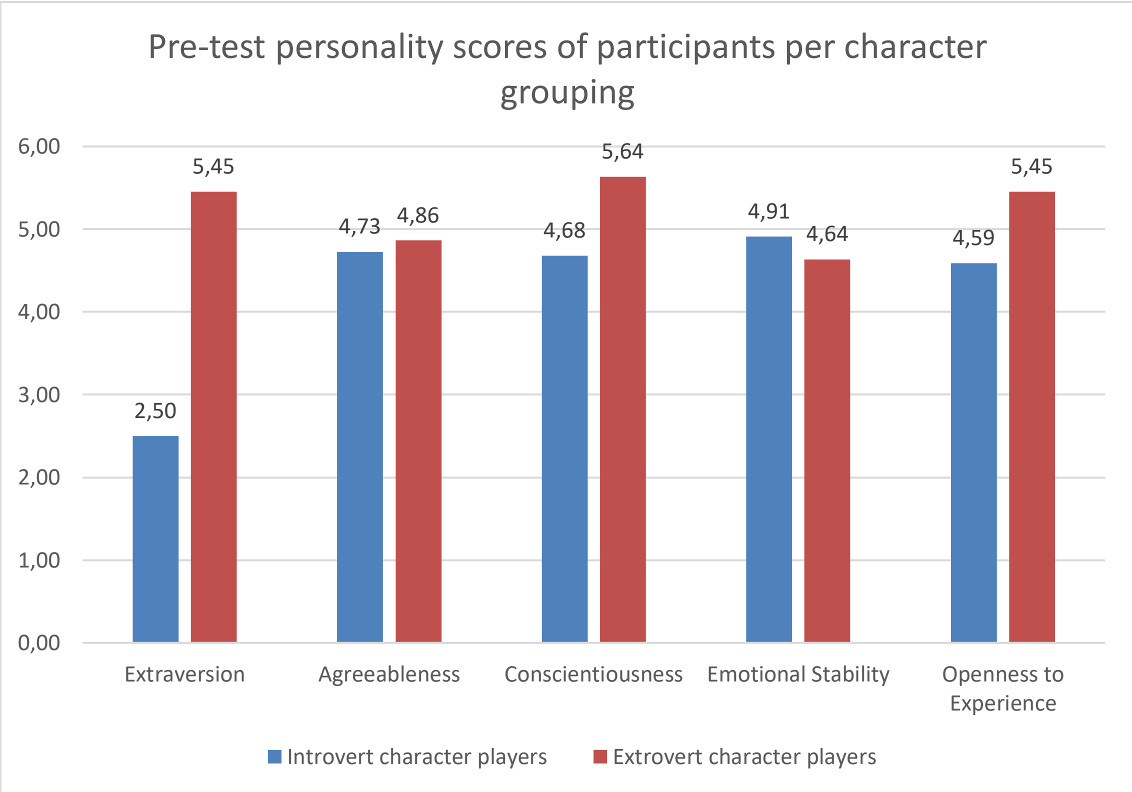

Figure 14. Big Five TIPI scores.

Subsequently, a two-tailed Wilcoxon Signed Rank Test was conducted on the equally distributed introverted and extroverted groups, with a sample size of N = 11. The analysis resulted in a W-value of 5, exceeding the critical value of 0 at an alpha level of 0.05. The null hypothesis was retained since the test indicated that introvert and extrovert participants were equally proficient in identifying the personality traits associated with their respective characters. Additionally, a right-tailed test was conducted to determine if the introverted group had higher scores than the extroverted group. The result was not statistically significant at an alpha level of 0.05, with a p-value of 0.25, meaning it failed to reject the null hypothesis.

Furthermore, Mann-Whitney U tests were performed on individual personality traits across introvert and extrovert groups to validate the Wilcoxon Signed Rank results. The results indicated insufficient evidence to reject the null hypothesis in identifying the cooperative trait between groups. This means the introverted group perceived their character as cooperative.

The groups showed notable variances in their capacity to recognize alternative personality traits (with a U score below 30), indicating their capability in identifying the assigned characters' personality traits. A critical value of 30 was determined at an alpha level of 0.05 for the perception of introverted, happy, down-to-earth, skeptical, careful, outgoing, confident, shy, imaginative, daring, and insecure traits between introvert and extrovert groups (Table 1). U values for each trait were compared to the critical value to assess significant differences between the groups, leading to rejecting the null hypothesis.

Table 1 Mann-Whitney U tests results for each trait.

Trait	**U Value** (critical value = 30)	**P Value** (α=0.05)
Cooperative	35	0.094
Introverted	0	0.0000711
Happy	8	0.00057
Down-to-earth	0,96	0.015
Skeptical	1,05	0.022
Careful	0	0.0000711
Outgoing	0,38	0.00081
Confident	0,295	0.000501
Shy	1	0.000093
Imaginative	0,63	0.0031
Daring	3	0.00016
Insecure	0	0.000071

The statistical test (right-tailed) results revealed significant discrepancies in the impact of character animations on gameplay style (U = 32.5, p = 0.033) and overall gameplay enjoyment (U = 31, p = 0.026) between the introvert and extrovert groups. Since the p-values are both less than the chosen significance level (alpha = 0.05), it implies that the character's animations positively impacted the extrovert group in terms of gameplay style. Therefore, the null hypothesis was rejected.

To further validate the former results, Figure 15 displays the participants' evaluations of character animations for the introvert and extrovert groups, corroborating that the implemented animations represented the characters' intended personality traits.

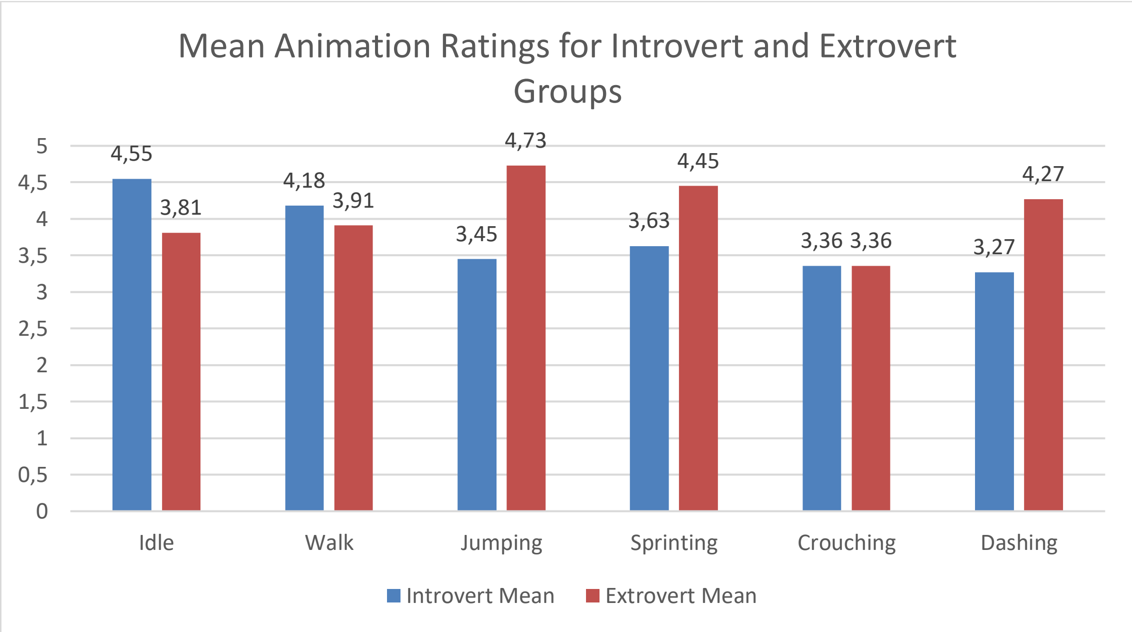

Figure 15. Question 1 bar chart results.

Additionally, the results for the in-game actions across introvert and extrovert groups (Table 2) revealed no significant differences for jumping (U = 48.5, p = 0.431), sprinting (U = 43.5, p = 0.264), crouching (U = 36.5, p = 0.115) and dashing (U = 47.5, p = 0.393) indicating that these actions were similarly used by introvert and extrovert players.

Table 2. Mann-Whitney U in-game actions test results.

In-Game Actions	**U Stat** (critical value = 30)	**P-value** (α = 0.05)
Jump	48,5	0,431
Crouch	36,5	0,115
Sprint	43,5	0,264
Dash	47,5	0,393

Moreover, Figure 16 visually represents the participants' perception of character animations concerning introverted and extroverted personalities. In the introvert group, the most frequently selected animations were idle, walking, and crouching, indicating that these animations are associated with introverted characteristics. In contrast, the extrovert group preferred sprinting, jumping, and dashing animations, suggesting that these animations were perceived as extroverted characteristics.

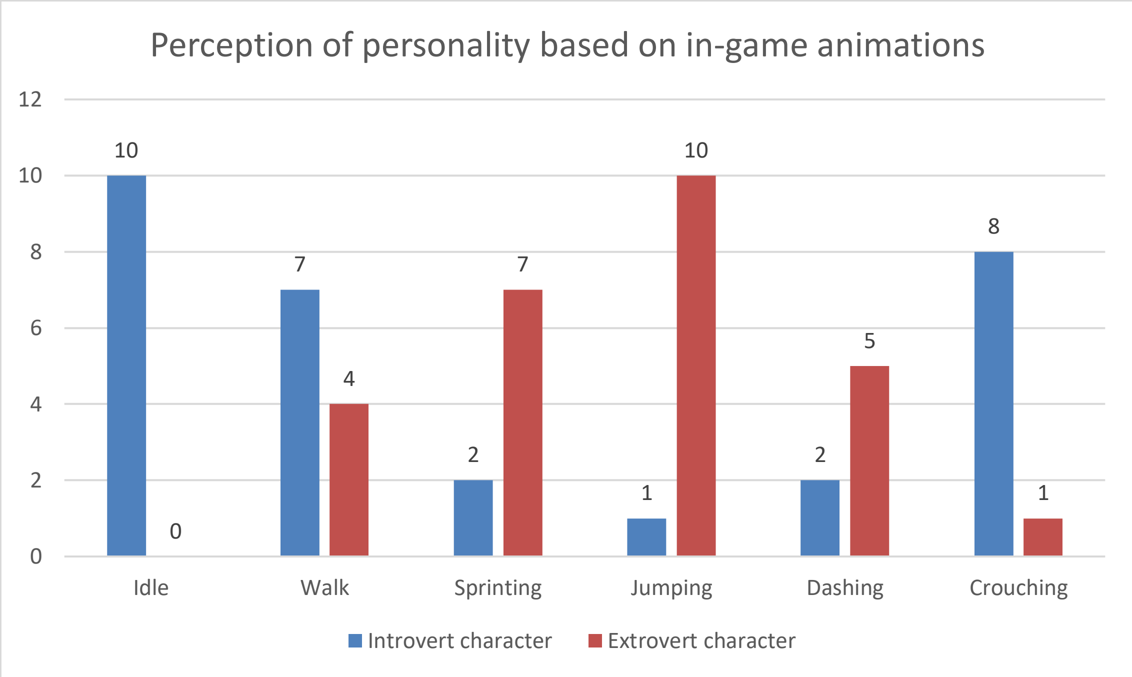

Figure 16. Question 2 results.

Regarding observational data, comparisons of gameplay styles between introvert and extrovert groups revealed equality for aggressive gameplay style (U = 38, p = 0.140), cautious (U = 48, p = 0.412), exploratory (U = 48.5, p = 0.431), strategic (U = 54.5, p = 0.694), and precise (U = 35.5, p = 0.101) gameplay styles. Therefore, the null hypothesis was retained since no substantial discrepancies (U > 30) in gameplay styles existed.

7 Discussion

The Wilcoxon Signed Rank test results were consistent with expectations, revealing no notable differences between the groups in their perception of personality traits. In addition, participants could identify the perceived personality traits of their assigned characters. Therefore, the animations and visual cues conveyed the intended personality of the characters.

Moreover, the cooperative trait had equivalent outcomes for the introvert and extrovert groups by analyzing the Mann-Whitney U test results for all traits across groups. In addition, the cooperative trait is usually associated with extroversion, but it may not always be strongly correlated with it. The results also imply that cooperative behaviors can be perceived by introverts and extroverts differently, which means that there is a complexity and diversity of personality traits in individuals who have other underlying factors such as cultural influences or personal experiences.

Character animations like crouching, idle and walking appear to create a perception of introversion in characters. On the other hand, animations like sprinting, jumping, and dashing contributed to a perception of extroversion. If the aim is to portray a character as introverted, focusing on animations related to idle, crouching, and walking would be beneficial. Similarly, for an extroverted character, emphasis can be placed on animations associated with jumping, sprinting, and dashing.

According to the in-game actions and observational data comparing gameplay styles, the results indicate that the players' introverted or extroverted personality traits do not necessarily influence play styles. In this case, it may signify that participants in both groups already have their preferred play style, which might not directly relate to their personality type. Despite that, underlying factors not considered in the study could also have impacted participants' play styles. The factors may encompass individual gaming preferences, previous gaming experience, the specific game being played, mood, environment, and, most significantly, the deer character played. Since the 3D deer possesses a youthful and juvenile appearance, it could have also influenced the study. The character could have been more appealing and relatable to specific participants or irrelevant and unlikeable to others. A more neutral and unadorned humanoid character without colors might have been more beneficial to minimize the influence of the characters’ aspect.

As a personality assessment tool, the Big Five TIPI test appears to have provided a limited understanding of participants' personalities due to its brevity and simplicity. Thus, conducting a more in-depth personality assessment might be required to better understand gameplay styles by establishing a baseline for their traits.

Additionally, assigning all extrovert participants to the extrovert character may have contributed to an absence of homogeneity in the extraversion trait scores. Therefore, randomly assigning participants to introverted or extroverted characters could mitigate external factors, regardless of their personality traits. Moreover, since results implied that character animations impacted gameplay enjoyment, introverted players might have enjoyed the gameplay more if they had played with a character with extroverted traits. From here, it is visible that despite players having introverted or extroverted personality traits, they did not impact gameplay style.

Furthermore, developers could enhance character customization by incorporating separate body parts, such as hands, legs, or shoulders, as animation customization options. For instance, players would have a range of animations for each body part to select from that would convey unique personality traits. The broad customization options could empower players to personalize their characters more elaborately while aligning them with their desired perceived personality. This personalized animation experience not only allows players to explore and experiment with customization but also has the potential to impact their overall gameplay enjoyment.

Considering the sample size impacted the findings, replicating the study with a wider and randomized sample could offer further insights into the underlying motivations and preferences in gameplay actions between introverted and extroverted players.

8 Conclusion

This research aimed to explore the impact of character animations on gameplay styles and how they vary based on players' personality traits. The results indicate that participants could identify the perceived personality traits of their assigned characters, demonstrating that the implemented character animations effectively conveyed the intended traits. Although the animations influenced participants' overall enjoyment, particularly for the extrovert group, they did not affect gameplay styles. By incorporating customizable animations for separate body parts, game developers can enhance player customization and create more engaging and personalized gaming experiences. Finally, the findings highlight the importance of character animations in shaping player perceptions and provide paths for future research and development in the gaming industry. Future studies could consider confounding factors and unbiased larger samples.

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Appendix 1

Ten-Item Personality Inventory (TIPI) Test

The Big Five TIPI test was utilized in the study. On a scale from 1 to 7, participants were asked to rate how one characteristic applied more strongly than the other (Gosling et al., 2003).

Disagree strongly	Disagree moderately	Disagree a little	Neither agree nor disagree	Agree a little	Agree moderately	Agree strongly
1	2	3	4	5	6	7

I see myself as:

1. _____ Extraverted, enthusiastic.
2. _____ Critical, quarrelsome.
3. _____ Dependable, self-disciplined.
4. _____ Anxious, easily upset.
5. _____ Open to new experiences, complex.
6. _____ Reserved, quiet.
7. _____ Sympathetic, warm.
8. _____ Disorganized, careless.
9. _____ Calm, emotionally stable.
10. _____ Conventional, uncreative.

TIPI scale scoring ("R" denotes reverse-scored items): Extraversion: 1, 6R; Agreeableness: 2R, 7; Conscientiousness; 3, 8R; Emotional Stability: 4R, 9; Openness to Experiences: 5, 10R.