

1 Paper Analysis

[0] is a study that aims to help animation productions develop convincing and believable characters by converting artists' knowledge into guidelines for 3D characters generation. Since previous studies on 3D characters creation have been done in scopes of rendering style [1], anthropomorphism [2], and 2D filters [3], the author looks at two other main aspects, shapes and materials, which define 3D faces.

Multiple experiments are conducted with different stimuli which are sets of 3D characters with varying combinations of shapes, materials, and facial expressions. The author chooses to use static images instead of videos as stimuli because [1] shows that the information provided by static images is sufficient for people to evaluate virtual characters.

For each experiment, participants are asked to rate different levels of impressions given by each stimulus on Likert scales, as the author argues that this method numericises subjective conditions, such as attitudes, for analytical purposes. The effect of a parameter is then interpreted from its statistical significance calculated from the participants' answers. The author is careful with isolating the test parameters being studied across experiments to ensure the current parameters indeed cause effects.

The final results reveal that shape is the determining factor for the realness of a character. On the other hand, material determines attractiveness. If mild stylisation on material is applied, the realness of the character will not be compromised. However, strong mismatches between shape and material cause the characters to be unappealing and eerie, which is further confirmed by the anthropomorphic guideline provided by [2]. On top of that, the angry expression also makes the character less appealing and eerier. Furthermore, shape stylisation intensifies the expression of a character.

The author points out that predicting appeal cannot be solely based on realness, which is also shown in [1]. This finding does not align with the uncanny theory. The author argues that it might be because participants have difficulty categorising the characters due to their mismatched appearance parameters, which is proposed by [1]. The author also points out that material stylisation reduces the intensity of expressions for realistic shapes. [3] is used to argue that this phenomenon might be explained by the loss of *suspension of disbelief* made by realistic characters.

[2] studies the uncanny effect by changing features and proportions of digital faces, while [0] makes use of global stylisations. [3] studies the perceived realness of a character by simply blurring characters' normal vectors and textures with an image filter (i.e. Gaussian), but [0] uses stylisations created by professional 3D artists and is more in line with the animation industry. Finally, [1] studies how participants perceive characters differently based only on rendering styles, while [0] separates shapes and materials and tests on the combinations of those.

2 Citations Analysis

[0] was cited 81 times on 27th March, 2022 according to Google Scholar. The fields that [0] is involved are mainly human computer interaction (HCI), visualisation & computer graphics (CG), and neuroscience.

The most influential paper that continues the exploration of the effect of realistic characters is [4] in 2018. The paper emphasises studying virtual characters in an *immersive* environment that can present the characters' personalities. Based on the work done by [0], the author explicitly points out that visual realism is not necessarily a predictor of participants' affinity toward the virtual characters. The experiment result confirms this statement by showing rendering styles alone do not make a character unappealing or eerie. Instead, the negative perceptions are caused by both rendering styles and the character's personality.

In the field of neuroscience, the most cited paper [5] in 2017 studies the stylisation effects of 3D characters on the cognitive level. The author conducts experiments to investigate brain responses (N170, EPN, LPP) to the stimuli created by [0] and develop the conclusion about the cause of LPP by comparing LPP measurements from their experiments with the familiarity statistics of [0].

In general, most papers in neuroscience which cited [0] are centred around understanding the uncanny effect, while papers such as [6] in CG use [0] as means to guide their user experience experiments design. As for HCI, ongoing research has gained a deeper understanding of the effects caused by 3D characters in more dimensions.

Since the topic is so broad, some research focuses on the static domain where the participants only observe the characters, while others move the experiment settings to be in virtual environments where the participants can also interact with the characters. The latter approach takes participants' behaviours into account. An example of the former category is [7] in 2016, which targets explicitly the factors for the appeal of female 3D characters, where conclusions given by [0] about how material plays a role come into place. In the immersive domain, for example, [8] finds that participants are more cautious in the virtual environment when they are controlling avatars that resemble themselves. This shows that realistic styling reinforces participants' ownership of characters.

3 Conclusion

There is extensive research that has been done to study the effects of the look of 3D characters on participants, and I believe that for 3D artists, the guidelines for achieving a target effect on appearance are sufficient. However, questions of how to fully realise a believable character of an arbitrary personality in the virtual environment and how to guide participants' behaviours when interacting with the character are yet to be answered. I think this research field still has a long way to go before it can also eventually guide game developers.

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