Crowd appearance affects player performance in game combat scenarios

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Figure 1: *The two visual appearances of enemy crowds used in our experiment: small green-coloured characters carrying no armour (left) and large red-coloured characters with lots of armour (right). The crowd appearances were designed to elicit different levels of aggression.*

Abstract

The aim of this study was to investigate the effect of non-player character (NPC) appearance in games - specifically, how a character's appearance affects a player's performance, and their perception of the game. We ran an experiment where participants played a mobile game on a 9.7" tablet, the goal of which was to kill all of the enemy characters in the game. The visual appearance of the enemy characters varied in the level of aggression in appearance. One crowd had small, green characters with no weapons and minimal armour. The other crowd had red characters that were large and wearing both weapons and armour. Both crowds had the same level of aggression in behaviour, stance and animations, as well as the same intersection-test capsule to ensure the gameplay was balanced and both crowds were equally difficult to kill. As expected, the second crowd was perceived as highly aggressive and less friendly than the first crowd. We found no differences in the enjoyment levels of the game but interestingly, we found that the visual appearance of the crowd had a direct effect on the player performance in combat. In contrast to our hypothesis, players performed worse (i.e., were killed more often) when in combat against the characters with the less-aggressive appearance.

Keywords: crowds, perception, game

Concepts: •**Computing methodologies** → **Perception;**

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1 Introduction

Recent advances in rendering and processing power have allowed crowd simulation to gain mainstream use in real-time digital video games, both on console and even mobile devices (e.g., Warhammer: End Times - Vermintide (2015), BERSERK (2016), Days Gone (2016)). Crowds of characters or creatures are often used as non-player characters (NPCs) with little function other than to populate a building, or city, and avoid a feeling of emptiness. More recent games are being more creative and using crowds as an integral part of the gameplay, with the player being allowed to interact with and even fight against them. This opens up many possibilities in terms of game-play, but there is little in terms of research on how we perceive these NPCs, and their effect on gameplay and enjoyment.

Human perception is a well documented and explored topic, and gives a strong basis for the field of perception of virtual characters. There has been a lot of previous research conducted around the psychology of how a player is affected by the type of character they play. For example, if a player sees themselves as big and strong, they will act more confidently or if a player is small and unappealing, they are less likely to interact intimately with other players (e.g., [Yee and Bailenson 2007]). These studies indicate that a player's perception is very influenced by the visual appearance of their game character. It is not yet clear, however, if the visual appearance of other characters in the game can influence behaviour. In this study, we are interested in investigating the perception of aggressive crowds of enemy characters, and how a player responds to them. It may be the case that an aggressive visual appearance is enough to change the strategy or performance of the player, or perhaps the behaviour of the crowds is more important and overwrites the effect of their appearance.

We explore these issues in the context of a prototype mobile game set in a fantasy forest. The player is forced into a combat situation, where they are required to kill all of the characters in a crowd, us-

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ing spells and arrows. In our experiment, we alter only the visual appearance of the crowd of characters, and determine its effect on gameplay. We find that even though all other aspects are the same (size of crowds, behaviours, animations, etc.), the visual appearance is enough to cause differences in the players' reactions. These results are important for effective game design, as understanding how a player will react to crowds of characters is crucial when creating an interactive virtual world.

2 Related Work

Social psychology has discussed the effect of player identification with the player character on the enjoyment of a video game [Christoph et al. 2009; Hefner et al. 2007]. Both Christoph et al. and Hefner et al. discuss escapism as a reason for enjoyment of video games, allowing the player to experience an idealised version of themselves in an interesting world (e.g. players playing a warrior character in order to experience being a more courageous or dominant person). In a study by Happ et al. [2013], it was shown that players, when given a character that was inherently good (Superman), were more likely to exhibit prosocial behaviour, compared to players who played a character who was inherently bad (The Joker). Furthermore, when given a background of their character to induce empathy for that character, players who empathised with Superman were less likely to perceive a neutral face as hostile, and players who empathised with The Joker were more likely to perceive a neutral face as hostile, when compared to players who read a neutral background text for their respective characters. There have also been studies on games that are designed to elicit empathy, for example by making the player play a certain character so they can empathise with that character's situation, or by forcing the player to make choices that affect other characters in the game ([Belman and Flanagan 2010]) and telling the player about the consequences of those choices.

The Proteus Effect is a phenomenon seen in digital environments whereby an individual conforms to their digital self-representation, their avatar's appearance, regardless of how others perceive them [Yee and Bailenson 2007]. This study shows the instantaneous effects on people's actions depending on the avatar assigned to them. For example, participants who were assigned taller avatars were more likely to act confidently in negotiation scenarios. This study posits the possibility that a person's real-world attitude would be affected after playing with an avatar and experiencing the Proteus Effect, an assumption which is later confirmed [Madigan 2013]. Madigan discusses how players, when choosing and customising an avatar to represent them, will often make an idealised version of themselves, and states that a player will become more immersed and will benefit more from a game where their avatar can closely match their ideal self. The study gives an example of a fitness demonstration, where participants were given avatars in a virtual environment and told to perform certain exercises. The participants with avatars that resembled themselves worked out for longer and even reported going to the gym after the experiment.

Players can also be affected by their own emotions, as it has been shown that a person's emotion affects their perception [Zadra and Clore 2011]. Similarly, players could be affected by the emotions of the characters around them. It has been shown that, if a person perceives an angry face, they will mimic that emotion and feel angry [Dimberg 1982; Dimberg et al. 2000; Lundqvist and Dimberg 1995]. In relation to our work, if a character's appearance evokes a certain emotion, that could then affect how the player perceives and experiences the game as a whole.

In terms of crowd emotion perception, we must consider the perception of the enemy crowd as a whole, rather than a collection of individuals. In crowds, the interaction between members of the crowd elicits anticipatory and action preparation activity in the brain, as opposed to a crowd of individually acting members, which the brain is less sensitive to [Huis in 't Veld and de Gelder 2015]. A much stronger emotional response can be produced by introducing the player to interacting crowds of NPCs, rather than groups of singly-acting individuals.

Previous research on virtual crowds has mainly focussed on simulation of realistic crowd behaviour and navigation (e.g., [Ondřej et al. 2010]). There has been some work on the perception of crowds and crowd appearance, but with the focus of creating the illusion of variety in the appearance [McDonnell et al. 2008; Maïm et al. 2009] and creating more realistic crowd animations [Hoyet et al. 2016]. More closely related to our work, Bruneau et al. [Bruneau et al. 2015] assessed the impact of crowd visual appearance on the avoidance decision of users in Virtual Reality. They used crowds of ordinary humans, soldiers and zombies to determine if the crowd appearance elicited different behaviours from the participant (either a repulsive reaction or joining of the group). They found that the strategy of the user was influenced by the visual appearance of the crowd, where they tended to walk around and avoid the group of soldiers. Surprisingly, there was no difference in how users reacted to the zombies and ordinary groups. To our knowledge, our study is the first that addresses the topic of the effect of visual appearance of a crowd on player performance in combat.

3 Experiment

The goal of this experiment was to better understand the effect of crowd appearance on a player's experience of a video game. We used both direct and indirect measures to assess enjoyment and performance. For the direct measures, we used a standardised questionnaire designed to predict the enjoyment of the participants during the gameplay, and we designed additional questions to assess the direct impression of the appearance of the crowd on the participant. For the indirect measures, we recorded game performance metrics during the session, including the amount of time it took them to complete the game (indicating difficulty), and the number of times that they died and had to be respawned (indicating their ability in the combat situation).

In order to alter the visual appearance of the crowds, we chose differing levels of aggression as the parameter, in order to fit with the context of the game (crowds were behaving aggressively). A highly-aggressive crowd and a less-aggressive, friendly crowd were created. We hypothesised that the visual appearance of the crowd would directly influence the players' ability to perform the task, and would also alter their level of enjoyment of the game. In particular, we expected that a more aggressive crowd would cause players to become more frightened, which would cause them to make more errors. We also hypothesised that the crowd appearance would have an effect on the overall game experience in terms of enjoyment, frustration, control, etc.

3.1 Stimuli

This research was conducted as part of an EU project called POPULATE[1]. The prototype game was created in Unity by AMA Studios[2] using Golaem[3] crowds technology to generate the behaviours of the crowds. For the purposes of this research, three versions of the game were created, where the only variable was the appearance of the enemy characters. All other factors in the game remained

[1] http://www.populateproject.eu/
[2] http://ama-studios.com/
[3] http://golaem.com/

constant - the behaviours and animations of the crowds, the appearance of the player character, game mechanics, etc. In particular, it was ensured that the intersection-test capsule around the crowd characters remained the same size for all versions, ensuring that the difficulty level for killing all characters was equal. The capsule size was chosen to fit the largest character.

The enemy appearance in the first version was neutral (non-humanoid, white capsule-shaped models). We created this as a training condition in order to ensure that the training enemies' appearance had no influence on the players and that they would have no expectation of the appearance of the other crowds. The data for the training version was not recorded. The aim of the second version was to create a highly aggressive-looking crowd (*Red* crowd). To do this, we altered the colour, size, and armour of the enemies in order to increase the aggressiveness of their appearance (Figure 2). We chose a red colour which has been shown to be associated with aggression [Valdez and Mehrabian 1994], we attached a lot of armour to these characters, and we made them appear larger than the player. The height of the character was increased in order for the player to feel intimidated as studies have shown taller people to be perceived as more dominant [Blaker et al. 2013] and the player's relatively short avatar should make them less confident [Yee and Bailenson 2007]. The enemies in the final version were intended to appear less aggressive and more friendly. For these enemies (*Green* crowd), we chose a green colour, which is meant to have positive attributions [Kaya and Epps 2004]. The characters were smaller in size to the player character in order for the player to feel less threatened by them, and they carried less armour in order to appear less aggressive.

3.2 Participants and Procedure

There were 21 participants, 6 female and 15 male (mean age: 25.7 ± 4.3). 14 had a high experience with games, 5 medium and 2 low. The game was presented on a Samsung Galaxy Tab S2, with 9.7" (245.8mm) display of resolution 2048x1536.

The game began with a small conversation to set the scene for the player. The game was set in a fantasy forest. The players played an explorer who had chosen to defy a god by destroying the god's altar, which was protected by small crowds of enemy "minions". For the purposes of the experiment, we restricted the gameplay and asked the participants just to kill all the minions (50 in total), at which point the game ended.

The game took place in an arena with the altar in the middle, surrounded by groups of enemies. If the player got too close to any group, or attacked any group, that group would become aggressive and attack the player. The player could run away, and the enemies would stop following once the player was a certain distance away.

The player had multiple methods of attack: they could shoot arrows by looking in the direction of an enemy and tapping on the screen, or they could use their skills. The player had three skills: *Gung Ho*, *Oneness*, and *Void*. *Gung Ho* powered up the player so they could shoot arrows with infinite speed for a few seconds, *Oneness* drew health from all of the enemies in an area around the player and increased the players health, and *Void* was a magical explosion which injured everyone in an area, including the player. The players could aim the explosion by dragging from the skill icon to somewhere on the ground. Each skill had a cast time.

The experiment was split into three blocks, with two playthroughs of the game in each block to account for variation. In the first block, participants were asked to play the training scenario with the neutral crowd. This was intended to get the players used to the controls and the game, using a neutral crowd with no aggressive properties. Participants had the controls and gameplay mechanics explained to them during their first playthrough. The second block contained either the Red or Green crowds, and the third block contained the remaining crowd. The order of the stimuli shown in the second and third blocks was randomised between participants. The experiment lasted 40 minutes and the participants were given a €5 book voucher for their time.

Figure 2: *The player being attacked by the Red crowd while using a skill*

3.3 Data Recording

Two types of data were recorded from the experiment: questionnaire data and game performance metrics. Participants answered the questionnaire once after each block of the experiment (excluding the training session) and game performance metrics were measured for each playthrough.

The questionnaire was composed of questions designed by ourselves (Appearance Questionnaire) and a standardised Core Elements of the Gaming Experience Questionnaire (CEGEQ) [Bernhaupt and Mueller 2016]. The Appearance Questionnaire was designed to ensure that participants perceived our character manipulations as expected, and can be seen in Table 1. The CEGEQ is a standardised questionnaire to measure the experience of a game. It provides a comprehensive list of questions and gives results that allow for comparison with other papers that rate common metrics such as enjoyment, frustration and feeling of control. We found the metrics measured by the CEGEQ to be the most appropriate for our study, compared to other popular questionnaires such as the Game Engagement Questionnaire [Brockmyer et al. 2009], which measures engagement, or the Intrinsic Motivation Inventory [McAuley et al. 1989], which measures motivation. Participants were asked to rate the questionnaire statements on a scale from 1 to 7, with 1 meaning they did not agree at all, and 7 meaning they agreed extremely.

The game performance metrics recorded the duration of the game and the number of times the player died and had to be respawned. These metrics were intended to provide us with information on the performance of the player and how difficult they found the enemies to kill.

4 Results

To analyse the results, we first combined the CEGEQ results into their respective groups as described in [Bernhaupt and Mueller 2016]. The questionnaire itself is 38 questions long, however we removed four questions regarding game audio and sound effects as

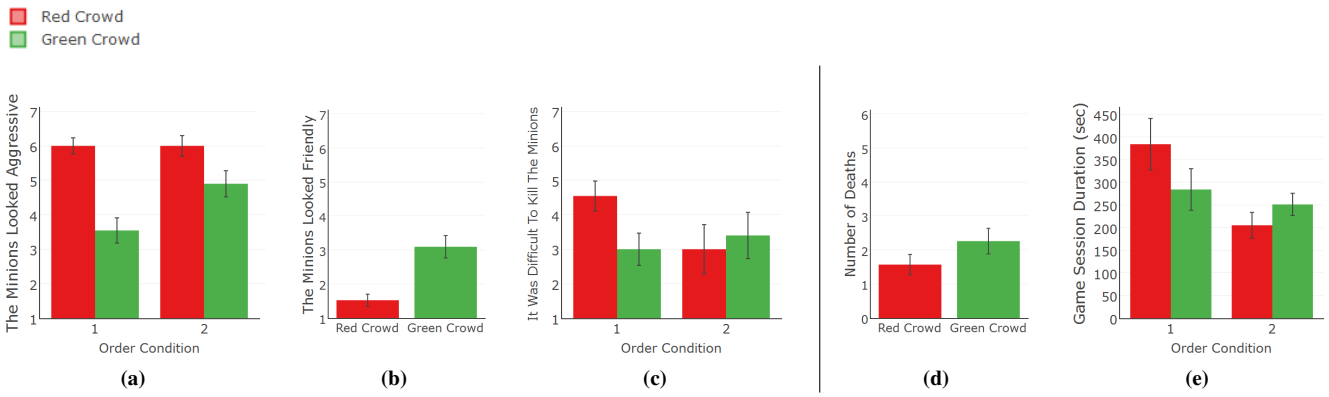

Figure 3: *Main effects and interactions from the Appearance Questionnaire (a-c) and Game Performance Metrics (d-e) results. Order 1 refers to when the participant saw the Red block first and Order 2 refers to when they saw the Green block first. The graphs show the mean ratings and standard error bars for each condition.*

1	The appearance of the minions was appealing.
2	The minions looked aggressive.
3	The minions looked friendly.
4	It was difficult to kill the minions.
5	The minions were intelligent.

Table 1: *Appearance Questionnaire: Questionnaire regarding the players' perception of the appearance of the enemy crowds, or "minions".*

they weren't relevant to our experiment. The questionnaire groups are Enjoyment, Frustration and CEGE. CEGE is split into subgroups of Puppetry and Video Game. Puppetry is further split into subgroups of Control, Facilitators and Ownership; while Video Game is further split into Environment and Game Play. Using these results, the appearance questionnaire results, as well as the game performance metrics, we ran 2-way ANOVAs using the Crowd Appearance as a within subjects factor, and Order as a between subjects factor. Order indicated whether participants saw the Red or Green block first. We did not test for gender as our participant pool was imbalanced for gender. All post-hoc tests were conducted using Newman Keuls comparison of means and only those that were significant are reported. For significant differences, estimates of effect size are reported using partial eta-squared.

4.1 Appearance Questionnaire

We first tested our Appearance Questionnaire answers, in order to determine if we had achieved the goal of creating a highly-aggressive looking crowd using the colour, height, and armour variations.

We found a main effect of Crowd Appearance for the Aggressive (i.e., *The minions looked aggressive*) scale. The Red crowd was perceived as highly aggressive (average rating: 6 ± 0.8) and significantly more aggressive than the Green ($F(1,19) = 45.5, p = 0.00, \eta_p^2 = 0.705$). An interaction between Crowd Appearance and Order ($F(1,19) = 6.6, p < 0.02, \eta_p^2 = 0.258$) also occurred for the Aggressive scale (Figure 3 (a)). Post hoc tests showed that when participants played the Red block first, they subsequently rated the Green characters as much less aggressive than the Red ($p < 0.0002$). When participants played the Green block first, they rated the Green characters as equally aggressive as the Red, and significantly more aggressive ($p < 0.03$) than the ratings for the Green characters when the Red block was seen first. This implies that participants did find the Green crowds to appear aggressive, but much less so when they had already viewed the Red and could compare the two.

Neither of the crowds had high ratings on the Friendly scale (*The minions looked friendly*), however the Green was perceived as significantly more friendly than the Red ($F(1,19) = 32.5, p = 0.00, \eta_p^2 = 0.631$), see Figure 3 (b). This implies that we successfully presented participants with crowds of differing levels of aggression and friendliness, using our appearance alterations. No ordering effects or interactions occurred on this scale.

A main effect of Crowd Appearance ($F(1,19) = 4.8, p < 0.05, \eta_p^2 = 0.202$) was also found for the scale which measured perception of difficulty (*It was difficult to kill the minions*). The Red crowd was perceived as significantly more difficult to kill than the Green. An interaction also occurred between Crowd Appearance and Order ($F(1,19) = 13.886, p < 0.002, \eta_p^2 = 0.422$), which showed that this was the case only when the order of the blocks showed the Red crowd first (Figure 3 (c)). This implies that seeing the Red crowd first gave a stronger impression of their difficulty to kill.

There were no other main effects or interactions for the remaining perceptual questions, which dealt with how appealing the minions were (average rating: 4.5 ± 1.5), and how intelligent they appeared (1.9 ± 1.1).

4.2 CEGE Questionnaire

The results from the CEGE Questionnaire can be seen in Figure 4. The graph shows the results of both Red and Green versions as ANOVA showed no main effect of Crowd Appearance on any of the scales, indicating that the different levels of aggressive-appearance did not change participant's overall perception or experience of the game.

We did not get a particularly high result for either Enjoyment (mean = 3.2 ± 1.6) or Frustration (mean = 3.7 ± 1.8), indicating that the participants did not have strong positive or negative feelings about the game in the experiment. We expected a possible difference in Enjoyment, as it may feel more natural to be in a combat situation with large, armed characters as opposed to small, unarmed ones; but our results did not show a difference.

The remaining scales are CEGE, and the component scales of CEGE. We did not expect to see a difference in these scales as they

measure such factors as the controls or rules of a game - elements that are inherent to gameplay and not perception. The CEGE scale itself measures the overall experience of the player, and an absence of CEGE (a low score) would suggests a definite negative experience. The presence of CEGE, however, does not guarantee that the experience will be positive, only that it will not be negative - which is what our CEGE (mean = 4.3 ± 0.6) and middling results for Enjoyment and Frustration show.

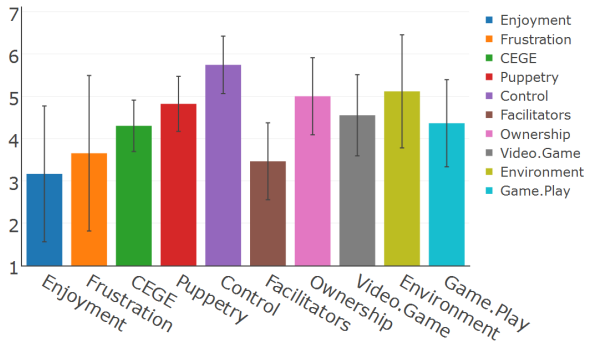

Figure 4: *Results from the CEGE Questionnaire, showing the mean ratings over the Red and Green crowds, and standard error bars.*

4.3 Game Performance Metrics

The game performance metrics were then assessed in order to determine if the difference in appearance of the crowds had an effect on the player's ability during combat.

Interestingly, we found a significant difference in the amount of times the players died and respawned in each condition ($F(1,20) = 8.094, p = 0.010, \eta_p^2 = 0.287$). Contrary to our hypothesis, it was against the Green crowds that the players died more often, see Figure 3 (d). This implies that the players were less effective at killing the Green crowds than the Red. There was no effect of order or interaction on this metric.

For the game session duration, we found no main effects but an interaction between Crowd Appearance and Order ($F(1,19) = 8.7, p < 0.008, \eta_p^2 = 0.315$). Post hoc analysis showed that when participants played the Red block first, they played for longer with the Red than the Green character ($p < 0.04$) (Figure 3 (e)), implying some training effects existed in this case.

5 Discussion and Future Work

In this paper, we made a first attempt to investigate the perception of crowd appearance and its effect on gameplay. Since we were interested in combat, we changed the level of aggression of the enemy crowds to determine its effect. Our results indicate that players of the game correctly perceived our Red characters as highly aggressive and not friendly, while the Green characters were perceived as less aggressive and more friendly. We believe that this factor influenced their ability to play the game, since they performed worse (died more often) when they were fighting the less aggressive, friendlier-looking crowds. This result is interesting, especially since the character behaviours were not altered, just their appearance. Another interesting point is the fact that the players also perceived the aggressive-looking characters as being more difficult to kill, which is contradicted by their performance. These results imply that the aggressive-looking characters created a sense of fear in the players, causing them to perceive the characters as difficult to kill and heightening their combat awareness, allowing them to survive more successfully. The appearance of the friendlier-looking crowds possibly caused players to underestimate their abilities, which is shown by their decreased ability to survive.

This result has implications for the design of non-player crowds in combat games. However, this is just a first study and more research will be needed to understand the specific parameters that caused this effect. Firstly, we purposely manipulated three aspects of the appearance of the characters (colour, size, and armour) in order to create two contrasting enemy characters. Further investigation will be necessary to understand the individual contributions of each of these attributes, which of these attributes was most important, or if a combination was indeed necessary. In particular, the size attribute would need further investigation. Even though we ensured that the intersection-test capsule surrounding the characters was the same in all cases (i.e., they were equally difficult to kill), it is possible that the smaller size of the friendlier-looking characters may have made the perception of the task more difficult, as players may have felt the need to aim more accurately at the smaller models. On the other hand, since the intersection-test capsule fit the largest character, it is also possible that a poor aim at the smaller characters could have resulted in more kills. More controlled experiments would be needed to investigate the manipulation of these attributes in detail.

There has been much previous research on the perception of self-avatars in games and how their appearance affects players reactions and behaviours. In our study, the player character was a boy with minimal armour (Figure 5). It is possible that the contrast between the player character appearance and the appearance of the crowds also had an effect on the result. In particular, the fact that the boy explorer was smaller in size and had less armour than the aggressive-looking characters. It is possible that if the player character was more aggressive-looking, that participants would underestimate even the more aggressive-crowd (i.e., the Proteus Effect [Yee and Bailenson 2007]). The effect of the contrast between how aggressive the player and crowd characters appear will be investigated in future work. The importance of the background of the character could also be important. In this case, the player was told that the player character was an explorer and that his task was to defy a God by destroying an altar. Previous research (e.g., [Happ et al. 2013]) has found that the back-story can effect the players' decisions in a game, so it would be interesting to investigate how this factor affects the perception of crowd appearance in future work.

Figure 5: *The explorer character used in the game - a young boy with minimal armour.*

In our study, we chose to keep the level of aggression in animation and behaviour of both crowds the same. We did not test players perception of the aggression in behaviour but this would be an interesting point for future exploration. For the friendly-looking characters

in our study, there was a mismatch in appearance and behaviour which may have been the reason for the participants' underestimation of their aggressiveness. Based on our result, game character designers should ensure that there is a consistency between the appearance and behaviour of their characters to avoid underestimation. The level of mismatches will be explored in future work to determine at what point the appearance or behaviour is more important.

Our study relied on questionnaire responses and game data to form our conclusions, however it would be interesting to include physiological measures in future research to determine if our conclusion that a sense of fear of the aggressive-looking characters made participants react the way they did is supported. Testing skin conductance or heart rate would potentially give an indication of the emotions evoked by the enemy crowd appearance. Additionally, we did not record the strategy used (skills selected) by the players at killing the crowds. This could be an important metric to include in future studies in order to determine if it was in fact a difference in strategy that caused the difference in performance for the two crowd appearances.

Further research could investigate the effect of character appearance in combat with different numbers of enemies (ranging from one-on-one fights to crowd interactions), in order to determine more accurately the effect of the size of the crowd. Finally, it would be interesting to test the perception of characters in scenarios other than combat. Although violence is prevalent in games, there are a number of other key types of gameplay and character interactions that would be interesting and beneficial to investigate. Players often have to complete quests for characters, so altering the quest-giving character's appearance could be an interesting start-point for future experiments. An aggressive-looking character giving out friendly advice might not be interpreted in the same way as a friendly NPC.

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