Enlighten Me: Importance of brightness and shadow for character emotion and appeal

PISUT WISESSING, Trinity College Dublin, Ireland
KATJA ZIBREK, Trinity College Dublin, Ireland
DOUGLAS W. CUNNINGHAM, BTU Cottbus-Senftenberg, Germany
JOHN DINGLIANA, Trinity College Dublin, Ireland
RACHEL MCDONNELL, Trinity College Dublin, Ireland

Lighting has been used to enhance emotion and appeal of characters for centuries, from paintings in the Renaissance to the modern-day digital arts. In VFX and animation studios, lighting is considered as important as modelling, shading or rigging. Most existing work focuses on either empirical best-practice created by artists of the centuries or on lighting perception with basic shapes. In contrast, our work focuses on the effect of lighting on emotional characters. Our study presents an extensive set of novel perceptual experiments designed to investigate the effects of brightness levels (key light brightness) and the proportion of light intensity illuminating the two sides of a character's face (key-to-fill ratio). We are particularly interested in the effect of lighting on the recognition of emotion, emotion intensity and the overall appeal, as these are crucial factors for audience engagement. Our results have implications for artists and developers wishing to increase the appeal and emotional expression of their characters, ranging from cartoon to realistic styles. Our key finding is that lighting can be used to effectively alter the intensity of emotion of a character and that brighter conditions increased appeal across all of our experiments.

SUPPLEMENTARY MATERIAL

Table 1. **Baseline** Experiment: Summary of main effects and interactions with corresponding post–hoc analysis. See Results section for more detail.

Recognition

Effect	F-Test	post–hoc
Emotion	$F(5,56) = 4.07$, $p < 0.006$, $\eta^2 = 0.23$	Anger recognized more than fear ($p < 0.009$).
Character*Emotion	$F^*(2.81, 39.41) = 3.37$, $p^* < 0.031$, $\epsilon = 0.70$, $\eta^2 = 0.19$	For Mery, anger and happiness more recognized than sadness ($p < 0.04$).
Emotion*Brightness	$F(8,112) = 2.71$, $p < 0.01$, $\eta^2 = 0.16$	No interpretable differences in post–hoc tests.
Emotion*Brightness*KTFR	$F(16,224)=2.29$, $p < 0.004$, $\eta^2 = 0.14$	Fear better recognized at 100% brightness, 1:1 KTFR than 25% brightness, 4:1 KTFR ($p < 0.02$).

Intensity

Effect	F-Test	post–hoc
Emotion	$F(3,42) = 28.03$, $p < 0.0001$, $\eta^2 = 0.67$	Anger the most intense ($p < 0.0009$), followed by happiness ($p < 0.009$).
Character*Emotion	$F(3, 42) = 7.09$, $p < 0.0006$, $\eta^2 = 0.34$	For sadness, Franklin was significantly more intense than Mery ($p < 0.001$).
Emotion*Brightness	$F^*(2.92, 40.82) = 3.42$, $p^* < 0.028$, $\eta^2 = 0.20, \epsilon = 0.49$	For happiness, 100% brightness more intense than 25% ($p < 0.004$).

Appeal

Effect	F-Test	post–hoc
Brightness	$F(2,28) = 9.86$, $p < 0.0006$, $\eta^2 = 0.41$	100% and 50% brightness more appealing than 25% ($p < 0.004$).
Character*Brightness	$F(2, 28) = 7.38$, $p < 0.0027$, $\eta^2 = 0.35$	Franklin at 25% less appealing than all except Mery at 25%.
Emotion*Brightness	$F(8,112) = 2.95$, $p < 0.005$, $\eta^2 = 0.17$	For all emotions except sadness, 25% brightness less appealing than 50% and 100% ($p < 0.002$). For sadness, 25% only less appealing than 50% ($p < 0.012$).
Brightness*KTFR	$F^*(1.73, 24.25) = 3.72$, $p^* < 0.045$, $\eta^2 = 0.21, \epsilon = 0.43$	No interesting significant differences in post–hoc tests

Table 2. **Online** Experiment: Summary of main effects and interactions with corresponding post–hoc analysis. See Results section for more detail.

Intensity

Effect	F-Test	post–hoc
Characters	$F(3, 174) = 84.64$, $p < 0.0001$, $\eta^2 = 0.60$	Franklin most intense, followed by Malcolm, Mery and Jasmine ($p < 0.002$).
Character*Emotion	$F(3,174) = 53.525$, $p < 0.0001$, $\eta^2 = 0.48$	For Mery, happiness more intense than sadness ($p < 0.0001$), but for Jasmine and Malcolm, sadness more intense than hapiness ($p < 0.047$).
Emotion*Brightness	$F(1, 58) = 22.972$, $p < 0.0001$, $\eta^2 = 0.28$	For happiness, 100% brightness more intense than 25% ($p < 0.009$). For sadness, 25% brightness more intense than 100% ($p < 0.006$).
Emotion*Source	$F(1,58) = 8.12$, $p < 0.007$, $\eta^2 = 0.12$	Sadness perceived as more intense by Prolific (EU) participants than MTurk (US) participants ($p < 0.031$).

Appeal

Effect	F-Test	post–hoc
Character	$F^*(2.28, 132.19)$, $p^* < 0.0001$, $\eta^2 = 0.17, \epsilon = 0.76$	Franklin less appealing than the rest ($p < 0.002$).
Emotion	$F(1, 58) = 31.56$, $p < 0.0001$, $\eta^2 = 0.13$	Happiness more appealing than sadness.
Brightness	$F(1, 58) = 23.85$, $p < 0.0001$, $\eta^2 = 0.29$	100% brightness more appealing than 25%.
Emotion*Brightness	$F(1, 58) = 17.01$, $p < 0.0002$, $\eta^2 = 0.23$	For happiness, 100% brightness more appealing than 25% ($p < 0.0002$).

Table 3. **Effect of Audio**. Summary of main effects and interactions with corresponding post–hoc analysis. See Results section for more detail.

Recognition

Effect	F-Test	post–hoc
Audio	F (1, 28) = 12.14, p < 0.002, $\eta^2 = 0.30$	Emotion recognition better in the audio condition.
Emotion	F(4, 122) = 3.73, p < 0.007, $\eta^2 = 0.12$	Fear less recognized in comparison to anger (p < 0.03).
Emotion*Audio	F(4, 122) = 3.94, p < 0.005, $\eta^2 = 0.12$	Fear less recognized in no audio condition (p < 0.002).
Character*Emotion	F*(2.90, 81.07) = 2.75, p* < 0.05, $\eta^2 = 0.09, \epsilon = 0.72$	No differences between characters according to specific emotions.
Character*Emotion*Audio	F*(2.90, 81.07) = 3.51, p* < 0.03, $\eta^2 = 0.11, \epsilon = 0.72$	In the audio condition, characters did not have an effect on recognition, whereas in no audio condition Mery sadness and Franklin fear were less recognized (p < 0.04).
Emotion*Brightness*KTFR*Audio	F*(8.21, 229.76) = 2.37, p* < 0.018, $\eta^2 = 0.08, \epsilon = 0.51$	No significant interactions with KTFR or brightness.
Character*Emotion*Brightness*KTFR	F*(8.16, 228.41) = 2.05, p* < 0.04, $\eta^2 = 0.07, \epsilon = 0.51$	No significant interactions with KTFR or brightness.

Intensity

Effect	F-Test	post–hoc
Character	F(1, 28) = 5.34, p < 0.03, $\eta^2 = 0.20$	Franklin more intense overall.
Emotion	F(3, 84) = 39.14, p < 0.0001, $\eta^2 = 0.58$	Sadness and fear are similar in intensity, while anger is the most intense emotion, followed by happiness (p < 0.02).
Emotion*Audio	F(3, 58) = 5.86, p < 0.0012, $\eta^2 = 0.17$	No significant differences in intensity between corresponding emotions according to audio/ no audio condition.
Character*Emotion	F*(2.23, 62.52) = 15.36, p* < 0.0001, $\eta^2 = 0.38, \epsilon = 0.76$	Only Mery sadness less intense than Franklin (p < 0.0002).
Emotion*Brightness	F*(3.09, 86.40) = 6.07, p* < 0.0008, $\eta^2 = 0.18, \epsilon = 0.51$	Only happiness least intense at 25% brightness compared to both other brighter levels (p < 0.008).

Appeal

Effect	F-Test	post–hoc
Character	F(1, 28) = 8.52, p < 0.007, $\eta^2 = 0.23$	Mery more appealing than Franklin.
Emotion	F*(2.22, 62.07) = 6.61, p* < 0.0018, $\eta^2 = 0.19, \epsilon = 0.55$	Anger and fear more appealing than neutral expression (p < 0.003).
Brightness	F*(1.49, 41.79) = 14.07, p* < 0.0001, $\eta^2 = 0.33, \epsilon = 0.75$	Brightness at 25% least appealing (p < 0.0003).
Emotion*Audio	F*(2.22, 62.07) = 25.2, p* < 0.033, $\eta^2 = 0.11, \epsilon = 0.55$	Neutral was significantly less appealing than other emotions only in audio condition (p < 0.005).
Character*Brightness	F*(2, 56) = 9.09, p* < 0.0004, $\eta^2 = 0.25, \epsilon = 0.96$	Mery more appealing than Franklin everywhere except at 25% brightness (p < 0.05).
Emotion*Brightness	F*(4.92, 137.74) = 6.35, p* < 0.0001, $\eta^2 = 0.18, \epsilon = 0.61$	All expressions significantly less appealing at 25% brightness than both 100% and 50% (p < 0.0001). Happiness 100% also more appealing than 50% brightness (p < 0.0007).
Emotion*KTFR	F*(5.33, 149.33) = 2.63, p* < 0.0234, $\eta^2 = 0.09, \epsilon = 0.67$	No significant differences between emotions at different KTFR.
Brightness*KTFR	F*(3.00, 84.06) = 5.81, p* < 0.0012, $\eta^2 = 0.17, \epsilon = 0.75$	All brightness levels affect appeal in 4:1 (p < 0.02), whereas only 25% lowers appeal in 2:1 and 1:1.
Character*Brightness*KTFR	F(4, 112) = 3.65, p < 0.008, $\eta^2 = 0.12$	Mery more appealing than Franklin at 100% brightness and 50% brightness and KTFR 1:1 (p < 0.005).

Table 4. **Effect of Background**. Summary of main effects and interactions with corresponding post–hoc analysis. See Results section for more detail.

Recognition

Effect	F-Test	post–hoc
Emotion	$F^*(2.29, 64.21) = 10.3$, $p^* < 0.0001$, $\eta^2 = 0.31$, $\epsilon = 0.57$	Fear less recognized than other emotions except sadness ($p < 0.023$).
Character*Emotion	$F^*(2.74, 76.77) = 10.30$, $p^* < 0.0001$, $\eta^2 = 0.27$, $\epsilon = 0.69$	Franklin's fear less recgonized than other Franklin's emotions and Mery's emotions ($p < 0.042$).
Emotion*Brightness	$F^*(5.72, 160.11) = 2.62$, $p^* < 0.021$, $\eta^2 = 0.09$, $\epsilon = 0.71$	No interesting interactions.
Emotion*KTFR	$F^*(5.09, 142.57) = 2.41$, $p^* < 0.039$, $\eta^2 = 0.08$, $\epsilon = 0.64$	No interesting interactions.

Intensity

Effect	F-Test	post–hoc
Character	$F(1, 28) = 4.97$, $p < 0.035$, $\eta^2 = 0.15$	Franklin more intense than Mery.
Emotion	$F^*(2.02, 56.48) = 56.08$, $p^* < 0.0001$, $\eta^2 = 0.67$, $\epsilon = 0.67$	Anger the most intense, followed by happiness ($p < 0.0002$).
Character*Emotion	$F(3,84) = 13.69$, $p < 0.0001$, $\eta^2 = 0.33$	For only sadness, Franklin more intense than Mery ($p < 0.0002$).
Emotion*Brightness	$F^*(3.99, 111.78) = 7.43$, $p^* < 0.0001$, $\eta^2 = 0.21$, $\epsilon = 0.67$	For only happiness, 100% brightness more intense than 50% and 25% ($p < 0.005$).
Brightness*KTFR	$F(4, 112) = 2.65$, $p < 0.04$, $\eta^2 = 0.09$	No singificant interactions.

Appeal

Effect	F-Test	post–hoc
Character	$F(1,28) = 21.89$, $p < 0.0001$, $\eta^2 = 0.43$	Mery more appealing than Franklin.
Emotion	$F^*(2.57, 71.92) = 3.38$, $p^* < 0.029$, $\eta^2 = 0.11$, $\epsilon = 0.64$	Anger more appealing than all other emotions except fear ($p <0.044$).
Brightness	$F^*(1.62, 45.27) = 17.51$, $p^* < 0.0001$, $\eta^2 = 0.38$, $\epsilon = 0.83$	25% brightness less appealing than 50% and 100% ($p < 0.0002$).
Character*Brightness	$F(2, 56) = 8.72$, $p < 0.0005$, $\eta^2 = 0.23$	For Mery, every higher brightness level is more appealing than its previous level ($p < 0.0019$). For Franklin, 25% significant lower than the others ($p < 0.0002$).
Emotion*Brightness	$F^*(5.24, 146.74) = 4.13$, $p^* < 0.002$, $\eta^2 = 0.13$, $\epsilon = 0.66$	All expressions significantly less appealing at 25% brightness than both 100% and 50% ($p < 0.002$). Happiness 100% also more appealing than 50% brightness ($p < 0.009$)

Table 5. **Effect of Movement**. Summary of main effects and interactions with corresponding post–hoc analysis. See Results section for more detail.

Recognition

Effect	F-Test	post–hoc
Emotion	F*(3.02, 84.57) = 9.15, p* < 0.0001, $\eta^2 = 0.25$, $\epsilon = 0.76$	Anger and happiness higher than sadness, neutral and fear (p < 0.008).
Emotion*Brightness	F*(4.70, 131.68) = 2.48, p* < 0.039, $\eta^2 = 0.08$, $\epsilon = 0.59$	No interesting interactions.
Character*Emotion	F*(2.59, 72.53) = 5.09, p* < 0.005, $\epsilon = 0.65$, $\eta^2 = 0.15$	Mery's neutral lower than anger or happiness (p < 0.0006).
Character*Brightness	F(2, 56) = 3.855, p < 0.03, $\eta^2 = 0.12$	Franklin higher than Mery at 100% brightness (p < 0.04).
Emotion*KTFR*movement	F(8, 224) = 2.287, p < 0.03, $\eta^2 = 0.08$	No interesting interactions.

Intensity

Effect	F-Test	post–hoc
Emotion	F*(2.38, 66.58) = 38.127, p* < 0.0001, $\eta^2 = 0.58$, $\epsilon = 0.79$	All emotions are significantly different in intensity: anger most intense, followed by happiness, sadness and fear (p < 0.03).
Brightness	F*(1.32, 36.81) = 3.77, p* < 0.05, $\eta^2 = 0.12$, $\epsilon = 0.66$	Expression at 25% brightness less intense than at 100% (p < 0.003).
Emotion*Movement	F*(2.38, 66.58) = 7.75, p* < 0.0005, $\eta^2 = 0.22$, $\epsilon = 0.79$	Anger and happiness are more intense than other emotions in movie (p < 0.02) , fear is least intense than other emotions in still images (p < 0.009).
KTFR*Movement	F(2, 56) = 4.34, p < 0.02, $\eta^2 = 0.13$	4:1 KTFR increases intesity only for still images (p < 0.02).
Emotion*Brightness	F*(2.72, 76.26) = 10.17, p* < 0.0001, $\eta^2 = 0.27$, $\epsilon = 0.45$	Intensity for happiness significantly increases with every brightness level (p < 0.002).
Character*Emotion	F(3, 84) = 8.81, p < 0.0004, $\eta^2 = 0.24$	Mery sadness less intense than Franklin sadness (p < 0.002).
Character*Emotion*Movement	F(3, 84) = 4.10, p < 0.01, $\eta^2 = 0.13$	Mery sadness less intense than Franklin sadness only for movie, not for still image (p < 0.0003).
Emotion*KTFR	F(6, 168) = 4.63, p < 0.0003, $\eta^2 = 0.14$,	Sadness at 4:1 ratio more intense than for other ratios (p < 0.04).
Emotion*KTFR*Movement	F(6, 168) = 2.20, p < 0.05, $\eta^2 = 0.07$	No interesting interactions.
Character*Brightness	F*(1.61, 45.01) = 4.32, p* < 0.03, $\eta^2 = 0.13$, $\epsilon = 0.81$	Mery affected by brightness level extremes, Franklin not (p < 0.0002).

Appeal

Effect	F-Test	post–hoc
Character	F(1, 28) = 28.87, p < 0.00002, $\eta^2 = 0.51$	Mery more appealing than Franklin.
Brightness	F*(1.60, 44.92) = 32.76, p* < 0.0001, $\eta^2 = 0.54$, $\epsilon = 0.80$	25% brightness least appealing (p < 0.0001).
KTFR	F*(1.65, 46.12) = 5.00, p* < 0.016, $\eta^2 = 0.15$, $\epsilon = 0.82$	KTFR 4:1 less appealing than both 2:1 and 1:1 levels (p < 0.03).
Character*Brightness	F*(1.48, 41.64) = 16.14, p* < 0.0001, $\eta^2 = 0.37$, $\epsilon = 0.74$	Mery more appealing than Franklin at 100% and 50% brightness (p < 0.002).
Emotion*Brightness	F(8, 224) = 6.26, p < 0.0001, $\eta^2 = 0.18$	All expressions significantly less appealing at 25% brightness than both 100% and 50% (p < 0.0001). Happiness 100% also more appealing than 50% brightness (p < 0.0007).
Brightness*KTFR	F*(2.51, 70.41) = 10.4, p* < 0.0001, $\eta^2 = 0.27$, $\epsilon = 0.63$	At 100% brightness, KTFR 2:1 and 4:1 more appealing than 1:1 (p < 0.02), at 50% and 25% (4:1 more appealing than 1:1 (p < 0.03)).
Emotion*KTFR	F(8, 224) = 3.75, p < 0.0004, $\eta^2 = 0.12$	For happiness, 4:1 ratio least appealing (p < 0.03 in all cases).
Character*KTFR*Movement	F(2, 56) = 3.92, p < 0.03, $\eta^2 = 0.12$	Mery more appealing than Franklin for all KTFR ratios for movies (p < 0.02).
Character*Emotion*Brightness*KTFR	F(16, 448) = 1.75, p < 0.04, $\eta^2 = 0.06$	Increasing KTFR and brightness levels affect happiness for Mery, not Franklin (p < 0.009).

Table 6. **Realism - Brightness Analysis**. Summary of main effects and interactions with corresponding post–hoc analysis. See Results section for more detail.

Recognition

Effect	F-Test	post–hoc
Gender	$F(1, 14) = 7.26$, $p < 0.0174$, $\eta^2 = 0.34$	Male character more recognized than female character.
Emotion	$F(3, 42) = 14.84$, $p < 0.0000$, $\eta^2 = 0.51$	Neutral less recognized than others emotions ($p < 0.0006$).
Shape	$F(2, 28) = 7.48$, $p < 0.0025$, $\eta^2 = 0.35$	Middle more recognized than other shapes ($p < 0.01$).
Gender*Shape	$F(2, 28) = 15.26$, $p < 0.0003$, $\eta^2 = 0.52$	Female realistic and Male toon least recognized ($p < 0.005$).
Emotion*Shape	$F^*(2.88, 40.29) = 5.10$, $p^* < 0.005$, $\eta^2 = 0.27$, $\epsilon = 0.48$	Neutral toon and neutral realistic least recognized ($p < 0.021$).
Gender*Emotion*Shape	$F^*(3.29, 46.06) = 2.83$, $p^* < 0.044$, $\eta^2 = 0.17$, $\epsilon = 0.55$	For male, neutral toon least recognized ($p < 0.0004$). For female, neutral and sadness realistic, and netural toon least recognized ($p < 0.0004$).

Intensity

Effect	F-Test	post–hoc
Gender	$F(1, 14) = 22.48$, $p < 0.0004$, $\eta^2 = 0.60$	Male characters more intense than female characters.
Emotion	$F(2, 28) = 6.94$, $p < 0.0036$, $\eta^2 = 0.60$	Anger more intense than sadness and happiness ($p < 0.025$).
Shape	$F(2, 28) = 10.06$, $p < 0.0006$, $\eta^2 = 0.40$	Realistic shape less intense than the other shapes ($p < 0.002$).
Gender*Emotion	$F(2, 28) = 5.20$, $p < 0.013$, $\eta^2 = 0.35$	Male sadness and happiness more intense than the corresponding female emotions ($p < 0.04$).
Gender*Shape	$F^*(1.29, 18.03) = 41.76$, $p^* < 0.001$, $\eta^2 = 0.66$, $\epsilon = 0.64$	Female realistic less intense than the rest ($p < 0.0002$).
Emotion*Shape	$F(4, 56) = 7.05$, $p < 0.0002$, $\eta^2 = 0.23$	Realistic sad and realistic happy characters less intense than the rest ($p < 0.029$).
Gender*Emotion*Shape	$F(4, 56) = 6.13$, $p < 0.0004$, $\eta^2 = 0.35$	Only for female, realistic sad and realistic happy emotions less intense than the rest ($p < 0.0057$).

Appeal

Effect	F-Test	post–hoc
Gender	$F(1, 14) = 5.78$, $p < 0.0306$, $\eta^2 = 0.29$	Male characters more appealing than female characters.
Emotion	$F^*(2.16, 30.24) = 4.73$, $p^* < 0.014$, $\eta^2 = 0.25$, $\epsilon = 0.72$	Anger and happiness less appealing than neutral ($p < 0.041$).
Shape	$F^*(1.35, 18.87) = 15.21$, $p^* < 0.0005$, $\eta^2 = 0.52$, $\epsilon = 0.67$	Realistic characters less appealing than the rest ($p < 0.0005$).
Brightness	$F^*(1.25, 17.43) = 5.20$, $p^* < 0.029$, $\eta^2 = 0.27$, $\epsilon = 0.62$	25% Brightness less appealing than 100% brightness ($p < 0.009$).
Gender*Emotion	$F^*(2.02, 28.25) = 3.77$, $p^* < 0.035$, $\eta^2 = 0.21$, $\epsilon = 0.67$	For anger, male characters significantly more appealing than female ($p < 0.0007$).
Emotion*Shape	$F(6, 84) = 5.99$, $p < 0.00003$, $\eta^2 = 0.30$	For each emotion, realistic shape is less appealing than other shapes ($p < 0.004$)
Gender*Emotion*Shape	$F(6, 84) = 2.67$, $p < 0.02033$, $\eta^2 = 0.16$	For realistic happiness, the appeal of the male shape drops from the other shapes more significantly than the female shape ($p < 0.0005$).

Eeriness

Effect	F-Test	post–hoc
Emotion	$F^*(1.87, 26.13) = 8.92$, $p^* < 0.002$, $\eta^2 = 0.39$, $\epsilon = 0.62$	Anger and happiness more eerie than neutral and sadness ($p < 0.026$).
Shape	$F^*(1.44, 20.12) = 21.80$, $p^* < 0.001$, $\eta^2 = 0.61$, $\epsilon = 0.72$	Realistic shapes more eerie than other shapes ($p < 0.00015$).
Gender*Shape	$F(2, 28) = 5.96$, $p < 0.0070$, $\eta^2 = 0.30$	Female middle shape more eerie than male middle shape ($p < 0.0014$).
Emotion*Shape	$F(6, 84) = 3.90$, $p < 0.0018$, $\eta^2 = 0.22$	For each individual emotion, realistic shapes more eerie than the other shapes in the same emotion ($p < 0.031$).
Gender*Emotion*Shape	$F(6, 84) = 5.75$, $p < 0.0001$, $\eta^2 = 0.29$	For each individual gender/emotion pair, realistic shapes are more eerie than the other shapes in the same combination of gender/emotion except for female happiness, where middle shape becomes as eerie as the realistic one ($p < 0.002$).
Gender*Shape*Brightness	$F(4, 56) = 3.39$, $p < 0.015$, $\eta^2 = 0.19$	Male toon at 25% more eerie than male toon at 100% ($p < 0.004$).

Table 7. **Realism - KTFR Analysis**. Summary of main effects and interactions with corresponding post–hoc analysis. See Results section for more detail.

Recognition

Effect	F-Test	post–hoc
Gender	$F(1, 14) = 13.66$, $p < 0.0024$, $\eta^2 = 0.49$	Emotions of male characters more recognized than female characters.
Emotion	$F^*(1.36, 19.02) = 9.36$, $p^* < 0.006$, $\eta^2 = 0.40$, $\epsilon = 0.45$	Neutral less recognized than other emotions ($p < 0.0056$).
Shape	$F^*(1.46, 20.41) = 5.83$, $p^* < 0.017$, $\eta^2 = 0.29$, $\epsilon = 0.73$	Realistic shapes less recognized than middle shapes ($p < 0.0067$).
KTFR	$F(2,28) = 4.22$, $p < 0.025$, $\eta^2 = 0.23$	16:1 KTFR less recognized than 4:1 ($p < 0.022$).
Gender*Shape	$F^*(1.39, 19.42) = 10.46$, $p^* < 0.003$, $\eta^2 = 0.43$, $\epsilon = 0.69$	Female realistic shapes less recognized than the rest ($p < 0.049$), male toon less recognized than male middle ($p < 0.038$).
Gender*Emotion*Shape	$F^*(2.8, 39.26) = 4.71$, $p^* < 0.008$, $\eta^2 = 0.25$, $\epsilon = 0.47$	For female, realistic sadness and neutral less recognized ($p < 0.0002$), for male, toon and realistic neutral less recognized compared to middle neutral ($p < 0.0003$).
Gender*Emotion*KTFR	$F(6, 84) = 2.83$, $p < 0.015$, $\eta^2 = 0.17$	For KTFR 1:1, sadness is less recognized for female than male character ($p < 0.0003$).

Intensity

Effect	F-Test	post–hoc
Gender	$F(1, 14) = 65.99$, $p < 0.0000$, $\eta^2 = 0.81$	Male characters more intense than female characters.
Emotion	$F(2, 28) = 12.41$, $p < 0.0002$, $\eta^2 = 0.62$	Anger more intense than sadness and happiness ($p < 0.0027$).
Gender*Shape	$F^*(1.22, 17.09) = 69.51$, $p^* < 0.0001$, $\eta^2 = 0.82$, $\epsilon = 0.61$	Male realistic more intense than male middle and toon ($p < 0.0002$). Female realistic less intense than all other combinations ($p < 0.0002$).
Emotion*Shape	$F(4, 56) = 10.54$, $p < 0.0001$, $\eta^2 = 0.25$	Toon anger less intense than middle and realistic anger ($p < 0.02$), toon sadness more intense than realistic sadness ($p < 0.004$).
Emotion*KTFR	$F(4, 56) = 8.06$, $p < 0.0001$, $\eta^2 = 0.25$	In KTFR 1:1, happiness more intense than in KTFR 16:1 ($p < 0.0012$).
Gender*Emotion*Shape	$F(4, 56) = 8.51$, $p < 0.0001$, $\eta^2 = 0.50$	Female realistic sadness and happiness less intense than all combinations ($p < 0.0002$), male realistic anger more intense than all other combinations ($p < 0.0002$) .

Appeal

Effect	F-Test	post–hoc
Gender	$F(1, 14) = 16.35$, $p < 0.0013$, $\eta^2 = 0.93$	Male characters more appealing than female characters.
Emotion	$F(3, 42) = 6.83$, $p < 0.0008$, $\eta^2 = 0.33$	Neutral and sadness more appealing than anger and happiness ($p < 0.027$).
Shape	$F(2, 28) = 12.13$, $p < 0.0002$, $\eta^2 = 0.46$	Realistic shape less appealing than toon and middle shapes ($p < 0.009$).
KTFR	$F(2, 28) = 9.92$, $p < 0.0006$, $\eta^2 = 0.41$	16:1 KTFR less appealing than 4:1 and 1:1 ($p < 0.049$).
Gender*Emotion	$F(3, 42) = 4.39$, $p < 0.009$, $\eta^2 = 0.24$	Female emotions less appealing than male except for sadness ($p < 0.007$).
Emotion*Shape	$F^*(3.72, 52.02) = 4.04$, $p^* < 0.008$, $\eta^2 = 0.22$, $\epsilon = 0.62$	for neutral, sadness and happiness, realistic shapes are the least appealing ($p < 0.003$).
Emotion*KTFR	$F(6, 84) = 5.37$, $p < 0.001$, $\eta^2 = 0.28$	For anger, 1:1 KTFR more appealing than 16:1 ($p < 0.0002$). For happiness, 1:1 KTFR more appealing than 4:1 and 16:1 KTFRs ($p < 0.0006$).
Shape*KTFR	$F(4, 56) = 10.24$, $p < 0.0001$, $\eta^2 = 0.42$	For toon shape, 1:1 KTFR more appealing than 4:1 and 16:1 KTFRs ($p <0.011$). For middle shape, 16:1 KTFR less appealing than 4:1 and 1:1 KTFRs ($p < 0.0064$).
Gender*Emotion*Shape	$F^*(3.21, 44.88) = 5.52$, $p^* < 0.003$, $\eta^2 = 0.28$, $\epsilon = 0.53$	Realistic shape least appealing for most emotions ($p < 0.04$) except toon anger for both genders, and happiness for females, for which all shapes are equally less appealing.
Gender*Emotion*KTFR	$F(6, 84) = 3.13$, $p < 0.0082$, $\eta^2 = 0.18$	For male happiness, 1:1 KTFR more appealing than 4:1 and 16:1 KTFRs ($p < 0.002$). For female anger, 1:1 KTFR more appealing than 16:1 KTFR ($p < 0.0017$).

Eeriness

Effect	F-Test	post–hoc
Gender	$F(1, 14) = 9.22$, $p < 0.0089$, $\eta^2 = 0.40$	Female characters more eerie than male characters.
Emotion	$F(3, 42) = 10.94$, $p < 0.0001$, $\eta^2 = 0.44$	Anger and happiness more eerie than neutral and sadness ($p < 0.0016$).
Shape	$F(2, 28) = 11.99$, $p < 0.0002$, $\eta^2 = 0.46$	Realistic shape more eerie than toon and middle shapes ($p < 0.0011$).
KTFR	$F^*(1.29, 18.03) = 10.28$, $p^* < 0.003$, $\eta^2 = 0.42$, $\epsilon = 0.64$	16:1 KTFR more eerie than 1:1 and 4:1 KTFRs ($p < 0.0276$).
Gender*Emotion	$F(3, 42) = 4.38$, $p < 0.009$, $\eta^2 = 0.24$	Female anger and neutral more eerie than corresponding male emotions ($p < 0.004$).
Gender*Emotion*Shape	$F(6, 84) = 2.47$, $p < 0.0302$, , $\eta^2 = 0.15$	Male realistic happiness more eerie than most other combinations ($p < 0.0123$).
Gender*Shape*KTFR	$F(4, 56) = 3.25$, $p < 0.0183$, $\eta^2 = 0.19$	For male toon and male middle, 16:1 more eerie than 1:1 but not 4:1 ($p < 0.0089$). For male realistic, 16:1 more eerie than 4:1 but not 1:1 ($p < 0.0073$).
Gender*Emotion*Shape*KTFR	$F(12, 168) = 1.91$, $p < 0.0367$, $\eta^2 = 0.12$	No interesting interactions.