The Effect of Posture and Dynamics on the Perception of Emotion


Anger Disgust Fear Happiness Sadness Surprise

Figure 1: *Characteristic frame for each emotion from the clip with the best recognition rate.*

Abstract

Motion capture remains a popular and widely-used method for animating virtual characters. However, all practical applications of motion capture rely on motion editing techniques to increase the reusability and flexibility of captured motions. Relatively little research has looked at the perceptual effects of motion editing, particularly how editing might effect the emotional content of a captured performance. Thus, in this work we perform three experiments to gain a better understanding of how changes in pose and dynamics, two factors shown to be important perceptual indicators of emotions, might effect the emotional content of a captured clip. Through these studies, we confirm several findings on the perception of emotions based on a varied motion clip set; we determine that emotions are mostly conveyed through the upper body; that the perceived intensity of an emotion can be reduced by blending with a neutral motion; and that posture changes can alter the perceived emotion but subtle changes in dynamics only alter the intensity.

Keywords: emotions, perception, virtual characters

1 Introduction

Virtual characters in games and movies need the ability to convey emotions in a convincing way. To engage us in a movie or game, we need to be able to create expressive characters. In games or virtual applications, we might even want to be able to change the emotions that are being conveyed or their intensity on the fly. Motion capture remains a popular and widely-used method for animating virtual characters. This technique is established and faithfully translates the nuances of an actor's performance. However, one limitation of motion capture is that it does not inherently adapt to new situations. Thus, extensive research has explored how to increase the reusability and flexibility of motion capture clips, leading to numerous techniques in common use today, such as inverse kinematics, interpolation, blending, retargeting, morphing, move trees, motion graphs, overlays, and splicing. Further extensive research, mostly in psychology, has explored how we perceive emotions. However, relatively little research has looked at the perceptual effects of motion editing, particularly how editing might effect an actor's emotions or how we can actively alter the emotional content of a performance.

In this paper, we investigate which aspects of body language are important for conveying emotions with two goals in mind. First, by understanding how changes such as those commonly introduced by motion editing might alter the emotional content of a motion, we can ensure that the important aspects of a performance are preserved. Second, this information provides valuable insight on *how* we may edit existing motions to change its emotional content, further increasing its reusability.

We study six basic emotions [Ekman 1992] shown to be readily recognized across cultures: anger, disgust, fear, happiness, sadness, and surprise (Figure). The motion of a character's body effectively expresses all basic emotions [Atkinson et al. 2004], including its context and intensity, and is the focus of our study.

Many motion editing techniques effect only a part of the body or may make changes to either poses or dynamics. As some alterations only affect some joints of the body, we first determine which parts of the body are most important for conveying emotions by partially occluding the body. We then choose which motion editing operations to examine more closely based on previous work. Notably, two characteristics of motions have been found to be crucial for the perception of emotions: posture and dynamics (also called form/shape and motion in some references). People are able to recognize emotions purely from images of poses [Atkinson et al. 2004; Coulson 2004], However, it has also been shown that velocity, accelerations, and jerk might also influence our perception of emotions [Roether et al. 2009]. Additionally, much previous work focuses on a specific type of motions, such as gait [Roether et al. 2009]. We did not want to restrict our actor to a specific type of motions and therefore gave him the liberty to express each emotion freely. Our work uses many of the results from studies on specific motions and examines if they also hold true for other types of motions.

We performed three experiments to gain a better understanding of the perception of emotions based on posture and dynamics. We recorded an actor giving ten short performances of each basic emotion, for a total of 60 motion clips, which were mapped to a generic humanoid virtual character.In our first experiment, we analyse this large set of 60 clips to search for differences in posture and dynamics between emotions and to compare the perception of our stimuli to previous work. We also establish a baseline set of the twelve animation clips (two for each emotion) having the highest recognition agreement among viewers. In the second experiment, we determine what part of the body (either head, upper body and head, or lower body) conveys the emotion most strongly. In the third experiment, we systematically alter the poses and joint velocities to determine how such changes affect the perception of the emotion. Our experiments yield the following observations:

- We confirm several findings on the perception of emotions based on a larger and more varied set of clips. For example, we confirm that happy and angry movements have higher velocities and greater joint amplitudes whereas sadness has slower joint velocities and small amplitudes.
- Emotions are mostly conveyed through the upper body.
- The perceived intensity of an emotion can be reduced by blending with a neutral motion.
- In a simplified way, we find that posture changes can alter the perceived emotion and its intensity while changes in dynamics only alter the intensity.

2 Related Work

There exists extensive research [Roether et al. 2009] in psychology that aims to understand the perceptual significance of body motion on conveying emotions. Coulson [2004] showed that happiness and sadness were clearly recognizable while disgust was harder to discern. He also found that surprise and fear was harder to discern from purely static poses. The work in [Wallbott 1998] observes a relationship between emotion type and posture characteristics, showing that differences in emotion can be partly explained by the dimension of activation. Atkinson *et al.* [2004] showed that emotion could be recognized from body motion, with exaggerations in motion increasing the recognition accuracy. Roether *et al.* [2009] observed that elbow and hip flexion were important attributes for anger and fear, while head inclination was important for recognizing sadness in motions.

The work in [Kleinsmith et al. 2006] conducted a study to evaluate the cultural differences in the perception of emotion from static body postures, observing moderate similarity across cultures. The work in [Pasch and Poppe 2007] evaluate the importance of the realism of the stimuli on the perception of emotion, demonstrating that high realism did not always conform to an increase in agreement of the emotional content. The work in [McDonnell et al. 2008] investigates the role of body shape on the perception of emotion and finds that emotion identification is largely robust to change in body shape. Recent work [Ennis and Egges 2012] investigates the use of complex emotional body language on a virtual character and observes that negative emotions are better recognizable.

A majority of these studies focus on specific motion categories such as gait [Crane and Gross 2007; Wallbott 1998] and observe relationships between the emotional state of a character and its posture or motion dynamics. We build on top of these studies by not restricting the actor to any specific motion category and generalize the perceptual significance of body movement on emotion across a varied motion set.

Impact of Motion Editing. Avoiding unwanted artifacts during motion editing is an important issue in computer animation. The work in [Ren et al. 2005] presents a data-driven approach to quantifying naturalness in human motion. They evalute the effect of a variety of commonly used motion editing operations including motion keyframing, adding noise [Perlin 1995], and synthetic motion transitions on how it affects naturalness of motion. The work in [Kenneth Ryall and O'Sullivan 2012; Reitsma and Pollard 2003] observed the sensitivity of motion retiming to the perception of walking and ballistic motions. Participants were more sensitive to time warping when slow motions were made faster than when fast motions were made slower. Safonova and Hodgins [2005] analyze the effect of interpolation on physical correctness and found that such operations can create unrealistic trajectories for the center of mass or create unrealistic contacts. The EMOTE system [Chi et al. 2000] gives explicit motion formulas which are based on motions (called Efforts) and spatial body type (Shape), based on Laban Movement Analysis. [Laban 1971]. However, this work does not explicitly address co-dependencies between motion and pose. [Gielniak et al. 2010] demonstrates the ability of modifying velocity profiles to create different styles of motions, but does not provide insights into why such changes work.

3 Experiment 1: Emotion Recognition and Movement Analysis

In our first experiment, we determine which recognition rates we can achieve with our stimuli and we perform a basic analysis of the velocities and postures of our motions. The results serve as a baseline for the second and third experiment. Also, they allow us compare our results to previous studies and to validate some results with a larger and more diverse set of motions.

3.1 Stimuli creation

We invited an actor to give ten short performances of each of the six emotions anger, disgust, fear, happiness, sadness, and surprise (60 animation clips in total). The actor was asked to convey each emotion as convincingly as possible using his entire body and no vocal cues. He was also told that his face and hands would be blurred. His performances were recorded with a 12-camera optical Vicon system and post-processed in Vicon Nexus and Autodesk Motion Builder. A standard skeleton with 55 joints (including the fingers) was used. We then created a skinned character adapted to the actor's skeleton.

As we did not record the detailed facial or finger motions, we box blur the face and hands of the virtual character similar to [McDonnell et al. 2008] to ensure that the motionless, unnatural-looking faces or fingers would not distract the viewer. We kept the blurred area as small as possible, hiding the facial features and the finger motions of the character but still showing the general orientation of the head and the hands. The box blur algorithm was implemented as a Maya plugin.

The resulting character was rendered in a neutral environment. We obtain a total of 60 clips, each between 2 and 10 seconds long at 24 fps.

3.2 Method

Fifteen participants (8M, 7F), mostly undergraduates, between 17 and 53 (mean 25.6) watched all 60 clips. All participants were naïve to the purpose of the experiment and had normal or corrected to normal vision. After each clip, they were asked to specify which emotion they think is being conveyed in the video with a forced-choice between anger, disgust, fear, happiness, sadness, and surprise. As the goal of this experiment was to find how well our stimuli conveys the basic emotions, participants could perform the study at their own pace and view each clip as often as they wanted. They were sent a link to the study and were allowed to view the stimuli on their own computers and to take breaks when they wanted. The clips were presented in a different random order for each participant.

After all 60 clips had been viewed and an emotion selected for each clip, participants were asked to watch them a second time and to rate the intensity and energy of the emotion on a scale from 1 (not intense/low exertion) to 5 (very intense/high exertion). Definitions

Emotion	Happiness	Sadness	Anger	Disgust	Fear	Surprise
Happiness	**68.0**	3.3	24.7	0.7	0.0	3.3
Sadness	13.3	**50.4**	10.4	8.1	12.6	5.2
Anger	5.6	12.7	**72.1**	6.7	0.0	3.0
Disgust	9.6	20.7	7.4	**46.7**	11.1	4.4
Fear	0	6.7	1.0	9.5	**71.4**	11.4
Surprise	5.2	9.6	8.1	3.0	8.9	**65.2**

Table 1: *Confusion matrix from our baseline experiment. Entries show the percentage of times our participants chose each emotion in a forced choice experiment. The displayed emotions are listed on the left, the selection of the viewer at the top.*

of intensity – "How deeply the person feels the emotion" – and energy – "The level of exertion and vigor of the person's movement" – were displayed on screen.

The entire experiment took between 30 and 45 minutes to complete. Participants were compensated with pizza.

3.3 Results

On average across all clips, 62.4% of the clips were recognized correctly. In the confusion matrix in Table 1, we see that happiness, anger, fear, and surprise were recognized best whereas disgust and sadness were recognized least. Disgust was mostly confused with Sadness. With 12.5% of the total selections, disgust was also selected less often than any other emotion (all emotions were displayed equally often: 16.7% of the time). Disgust is known to be a less readily recognized emotion and our result is consistent with a large body of work [Ekman 1992; Atkinson et al. 2004]. However, sadness is typically recognized at a higher rate. Our hypothesis regarding this finding is that the actor often tried to show grief and distress, where the body typically moves more than in a depressed individual. Without facial capture, this subtely was lost.

From this experiment, we choose two animated performances with the highest recognition rates to use for all subsequent experiments: two anger motions each with 100% correct recognition; two disgust motions (recognition rates 80% and 93%); two fear motions (93% and 100%); two happy motions (93% and 100%); two sad motions (80% and 86%); and two surprise motions (100% and 87%).

We also analyze the pose and velocities of our motion clips and compare our findings to other published studies. Figure 2 shows histograms of the rotational speeds for the major animated joints of our character, namely the hips, legs, knees, ankles, spine, shoulders, elbows, wrists, and neck. To compute angular velocities, we first compute quaternion rates using 5-point central differencing and then convert the quaternion rate to an angular velocity vector according to [Diebel 2006]. Our motions are consistent with previous published research which states that anger and happiness tend to have larger and faster joint movements, where fear and sadness tend to have minimal and slow joint movements [Roether et al. 2009].

Figure 3 compares the amplitudes for the head, shoulders, and elbows (amplitude is defined as the difference between the max joint angle and min joint angle for each motion category). Our findings are consistent with previous research which states that happiness and anger have higher amplitudes whereas sadness and fear have lower amplitudes. Existing research is less clear regarding disgust and surprise. For our dataset, surprise shared amplitude characteristics with fear, but had greater elbow movement. Disgust had high elbow movement but low head and shoulder movement.

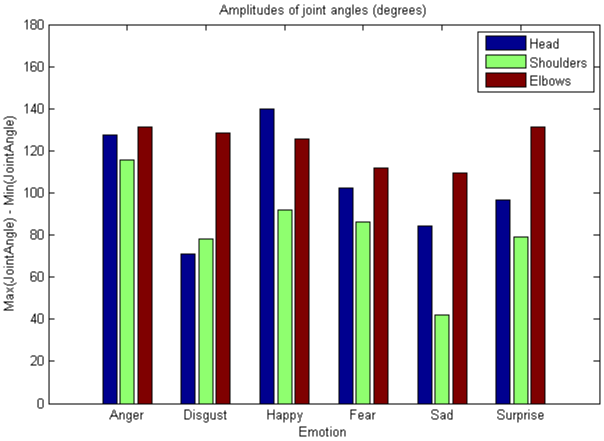


Figure 3: *Joint amplitudes. Our captured motions are consistent with published research which states that happiness and anger have higher amplitudes whereas sadness and fear have lower amplitudes.*

Lastly, we looked at modal and average flexion angles, defined as the angle between limbs. Specifically, previous research describes reduced head angle for sad walking and increased elbow angle for fearful and angry walking [Roether et al. 2009]. However, our motion set did not produce convincingly consistent results. Most joint angle distributions were not normally distributed. Based on histograms of joint angle, both sad and disgust motions had modal head angles of 160 (where 180 corresponds to looking straight forward and 90 degrees corresponds to looking straight down) whereas all others had modal head angles of 170 degrees. Elbow angle was greatest for disgust and fear (110 degrees, where 180 corresponds to a fully flexed arm), second largest for sadness and anger (150 degrees), and smallest for surprise and happy (170 degrees). To explain these results, many of our sad clips had the hands at the face, and several of our disgust motions huddled the arms into the body. Many of the anger motions contained punching and swinging gestures.

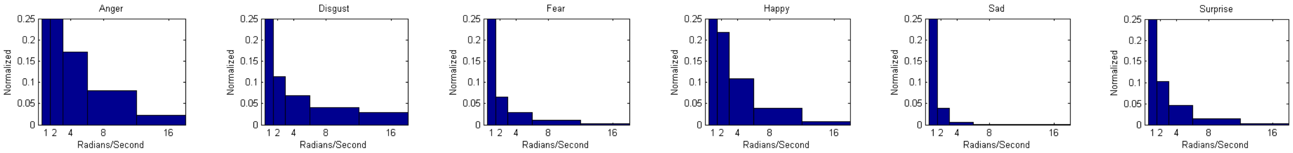
A repeated measures ANOVA was used to determine that difference emotions showed significant differences in intensity and energy (F(5,819)=23.79, p = 0 for intensity and F(5,819)=46.84, p=0 for energy). Post-hoc Tukey tests was used to determine that the intensities and energies of happy and angry were significantly higher than the other emotions; that all emotions except disgust were significantly higher in intensity than sadness; and that all emotions were significantly higher in energy than sadness.

4 Experiment 2: Partial Occlusions

Many motion editing operations can be applied to parts of the body of a virtual characters. For example, inverse kinematics or overlays might just be used on the upper body while techniques to adapt walking motions to different terrain might only affect the lower body. Therefore, in our second experiment, we determine which parts of the body are important in conveying emotions.

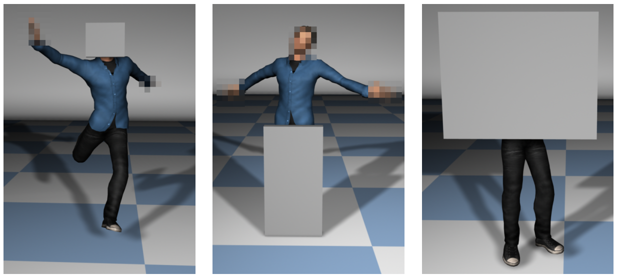
4.1 Stimuli

We chose the two clips with the highest recognition rates from experiment 1. We then occluded different parts of the body: the head motion (or NH for "No Head motion"), the lower body motion (NL), and the upper body motion (NU). The unaltered motion is labeled OR for "original". We did not alter the root/hips



(a) (b) (c) (d) (e) (f)

Figure 2: *Comparison is rotational speeds across our original motions. Our motions are consistent with previous published research which states that anger and happiness tend to have larger and faster joint movements, where fear and sadness tend to have the least joint movement. For our motions, surprise and disgust lie somewhere in between these two extremes.This analysis includes speeds for the major joints: hips, legs, knees, ankles, spine, shoulders, elbows, wrists, and neck.*



(a) (b) (c)

Figure 4: *Stimuli examples from our second experiment in which we hid either the head, the lower body, or the upper body.*

motion for any of the conditions. To occlude the body parts, we erase all motion from the considered part and covered it with a nondescript cube that we attached to the character (see 4). We obtain 6 Emotions x 2 Clips x 4 Occlusion types = 48 different clips.

4.2 Method

Sixteen participants that were not involved in the previous experiment watched all of the clips in small groups of 1–3 participants on a large projection screen in a seminar room. As the aim of this experiment is not to determine the highest possible recognition rate of each clip but to investigate differences between several partial occlusions, we chose a fast pace for this experiment. Participants viewed a clip once. Then they had a total of six seconds to specify the perceived emotion with a forced-choice between the six basic emotions and the perceived intensity of that emotion on a scale from 1 to 5 similar to experiment 1. After four seconds, a sound was played together with the number of the next clip to warn participants that they had to look at the screen again. Then the next clip started.

Our pilots showed that six seconds was very short but that participants were able to follow the instructions after a short training phase. However, our pilots also showed that it was not possible for participants to effectively distinguish between the intensity and the energy of an emotion in such a short amount of time. We therefore discarded the energy ratings that we used in the first experiment.

A second reason for choosing a very fast pace for this experiment was that participants would watch the same motions with different occlusions. Once a non-occluded motion clip has been viewed, it might be possible for the participants to recognize that clip again when parts of it are occluded and to infer the perceived emotion and intensities based on the original motion. Our fast pace did not give participants enough time to think about the motions. Based on questions that we asked participants during the debriefing, we assume that most of them started to recognize some of the motion clips towards the end of the full experiment.

Before we started the experiment, participants were given four training clips that were not used in this experiment. A short break to answer any questions ensured that participants understood the instructions. The participants viewed all 48 clips in random order. After a short break, they viewed all 48 clips again in a different random order. The full experiment took about 25 minutes to complete and participants were rewarded with $5.

4.3 Results and Discussion

4.3.1 Emotion recognition

Three participants did not follow the instructions or check the boxes in an illegible manner. They had to be discarded from the analysis, leaving 13 participants in our analysis.

To analyze the results for the emotion recognition, we computed the error rates for each participant, emotion, and occlusion type by averaging over the two clips and two repetitions. We then performed a repeated measures ANOVA with the within-subject factors *Occlusion type* and *Emotion*. We used Newman-Keuls post-hoc tests to determine the origin of any effects.

We found a main effect of Occlusion type with $F(3,36) = 62.8, p \approx 0$, due to the fact that the condition where the upper body was hidden had significantly higher error rates (lower recognition rates) than the other three Occlusion types. This effect was surprisingly distinct as can be seen in Figure 5. There were no significant differences between the other three occlusion conditions.

As expected, we also found a main effect of Emotion, meaning that the different emotions were not recognized equally well. Fear was recognized best on average and significantly better than all other emotions except Happy. Sadness had the lowest recognition rate (or highest error rate), which was differed significantly from Fear and Happy.

Furthermore, there were interaction effects between the Occlusion type and the Emotion. They can be explained through three origins: 1. Fear was the only emotion where the error rates remained the same in all Occlusion conditions, 2. Anger with occluded upper body (NU) was recognized less well than other motions, leading to significant differences with three of them, 3. Sadness with an occluded head (NH) was recognized significantly less well than eight other motion.

Based on these results, we infer that the upper body is crucial for the perception of emotions. The lower body or the head alone were not relevant in our set of clips to determine which emotion was displayed. The non-importance of the head could be due to the fact that the head was already box blurred in our baseline stimuli and that therefore hiding the head entirely might not have a considerable impact. However, the lower body was not blurred and it seemed that a considerable part of the emotion could be conveyed through lower body motions, for example through the kicking motion for Anger or the running away motion for Fear.

Interestingly, occluding the lower body had the smallest effect for the emotions that did display very distinct lower body motions, namely Fear and Anger. It might be possible that the viewers inferred the lower body motions based on the movements of the upper body. When creating our stimuli, we decided to hide the lower body motion but to keep the full motion of the character including the hips. We also considered several other options, including to delete the hips motion or to replace the lower body motion with a neutral lower body motion. However, these options seemed to suggest completely different full body motions instead of just hiding parts of the body and were therefore discarded.

Also, we notice that Sadness had a relatively high recognition rate when the head was occluded, which complies with previous work that the head motion is particularly important to display Sadness.

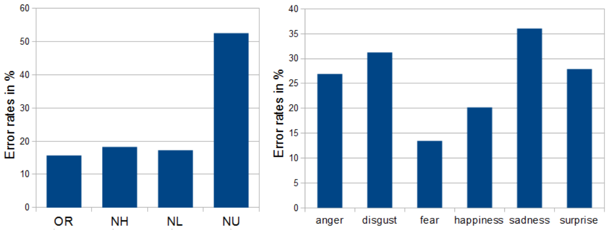


Figure 5: *Error rates for each condition (left) and for each emotion (right).*

5 Experiment 3: Posture and Dynamics

Much previous research suggests that velocity, accelerations, and jerk (defined as the time derivative of acceleration) are important factors in emotional body language [Roether et al. 2009] along with pose. However, the relative importance of pose and dynamics has not been studied. Because many motion editing procedures such as interpolation, blending, and smoothing can result in changes to both pose and dynamics, we investigate these effects. We assume that at a small scale those changes might affect the intensity at which an emotion is perceived, at a larger scale the motion might not be recognized anymore.

5.0.2 Stimuli

The stimuli for this experiment were created by filtering the major joint curves of our best-recognized motions to produce changes to either the pose, the velocities, or to both. For this experiment, we created four conditions: two conditions (BB25, BB25) in which we change the pose and velocities by blending the upper body with a neutral posture (Figure 6), one condition (TW200) in which we change the timing but not the poses through timewarping, and one condition (OFF) where we change the poses but not the timing by setting constant offsets to either the shoulders, elbows, or head (Figure 8).

Our two body blend conditions (BB25, BB50) blend the joints of the upper body, from the spine and upwards. The upper body was chosen because the previous experiment showed it to be the most relevant for the perception of emotions. BB25 blends 75% of the original motion with 25% of a neutral pose having the arms down at the side. BB50 blends 50% of the original motion with 50% of a neutral pose. Joint rotations are represented with quaternions and blended frame by frame.

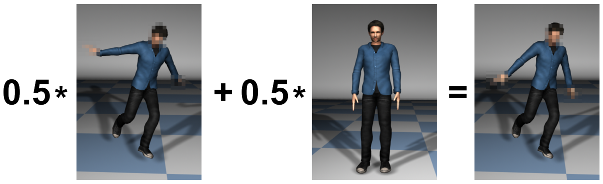


Figure 6: *Bodyblend (BB) condition. The upper body joints are blended with a neutral motion having the arms at the side. The above example shows the result of blending 50% of the original motion with 50% of the neutral motion. Joint rotations are represented using quaternions and blended with slerp. This condition changes both pose and velocity.*

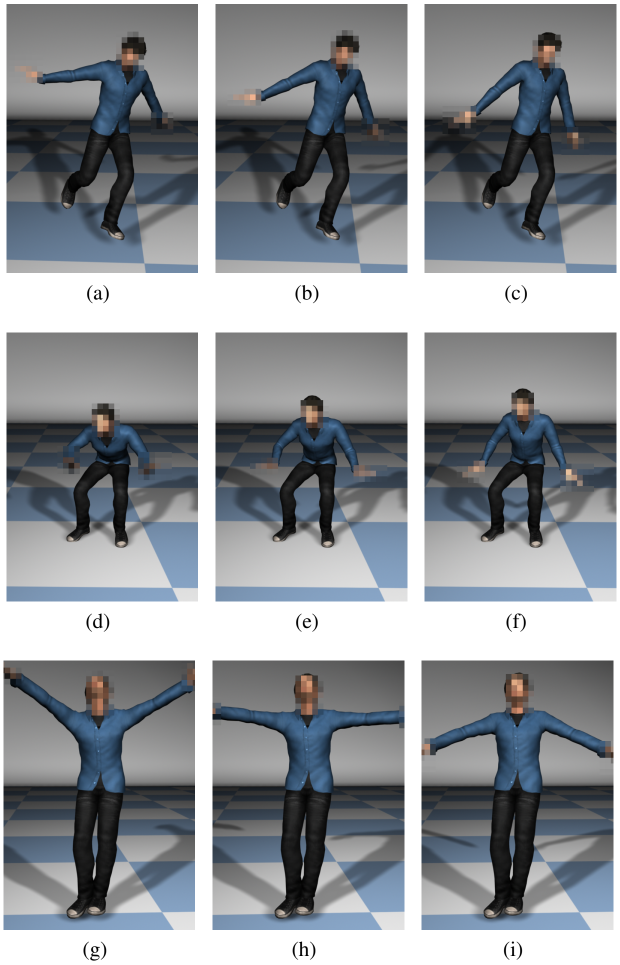
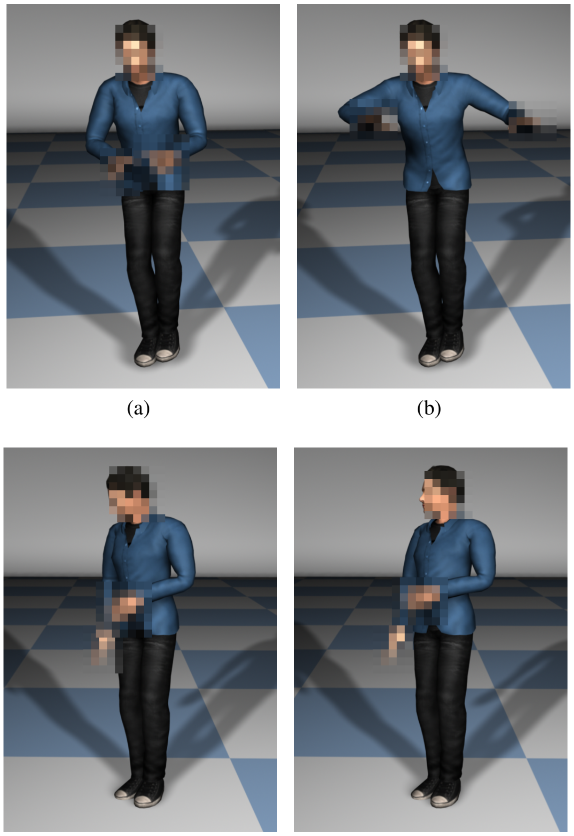


Figure 7: *Stimuli examples from bodyblend (BB) conditions. Original motions appear in the first column. The second column shows BB25, which retains 75% of the original motion. The third row shows BB50, which retains 50% of the original motion. As the poses moved towards neutral, the perceived intensity of the emotion is decreased.*



(a) (b) (c) (d)

Figure 8: *Stimuli examples from the offset condition. Original poses appear in the first column. Modified poses appear in the second column.*

Our timewarping condition (TW200) modifies the timing of the motion such that no joint velocity is higher than a given maximum. We choose our maximum value separately for each emotion as 200% of the average speed of the fastest moving joint. For example, if the fastest joint has an average speed 4 radians/s, the maximum joint speed for this motion will be 8 radians/s. Given a maximum speed, timewarping is performed by computing new times for each frame and then resampling the motion curves at the original framerate. Specifically, if a frame originally occured at time t and had its fastest joint i moving at $v > v_{max}$, we adjust the time for this frame so that it occurs at $t + v/v_{max}\Delta t$, where Δt is 1/framerate. The curve is resampled by interpolating between the original poses.

Our offset condition (OFF) modifies the poses without changing the timing. Offsets were specified manually for either the shoulders, elbows, or the spine and neck by an artist who specified an offset pose for a single reference frame $q(\hat{t})$ of each original motion. From the offset and reference pose, we compute an offset rotation q_{offset} which is then applied to all motion frames.

$$q^{offset} = (q(\hat{t}))^{-1} q^{user}$$

$$q_i^{new}(t) = q^{offset} q_i(t)$$

For our offset condition, we created 4 motions which changed the elbows, 4 motions with altered shoulders, 4 motion which modified the neck and spine upwards, and 4 motions where the neck and spine went downwards.

When applying these four posture and velocity conditions — BB25, BB50, TW200, and OFF — to the two clips with the best recognition rates for each emotion (and keeping the original motion OR) we get 6 emotions x 2 clips x 5 motion alterations = 60 clips

5.1 Method

We used exactly the same fast paced method than in experiment 2. Seventeen naïve participants, which were not involved in any of the previous experiments, took part in experiment 3, which took less than 30 minutes to perform. They were rewarded with $5.

5.2 Results and Discussion

One participant had to be excluded from the analysis as most checks were between two boxes leaving the answers of 16 participants for the analysis. We analyzed the data in the same way than the previous experiment.

5.2.1 Emotion recognition

There was a main effect of the motion Alteration with $F(4, 60) = 5.1, p < 0.05$. The alterations BB50 and OFF were recognized significantly less well than the original condition. There were no significant differences in the recognition rates of BB25, the timewarped motion (TW200), and the original condition (OR). We also found a main effect of Emotion ($F(5, 75) = 6.1, p < 0.001$) due to the Sadness motion being recognized at a significantly lower rate than all of the other emotions, which restates a result we found throughout the whole study.

Finally, there were interaction effects between the Alteration and the Emotion ($F(20, 300) = 3.8, p \approx 0$) mostly due to the fact that Sadness had even worse recognition rates when an offset was added or when it was blended with a neutral motion.

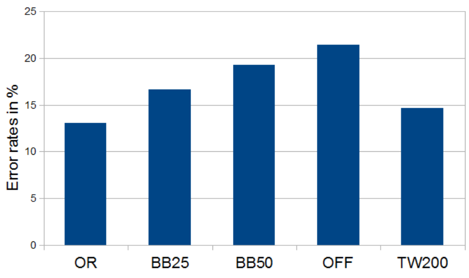


Figure 9: *Error rates for each condition*

5.2.2 Intensities

As expected our motion Alterations also changed the perceived intensities of the emotions. The perceived intensities of the clips with the alterations BB50 and TW200 were signigicantly reduced as a main effect of the Alteration showed $(F(4, 60) = 5.1, p < 0.05$.

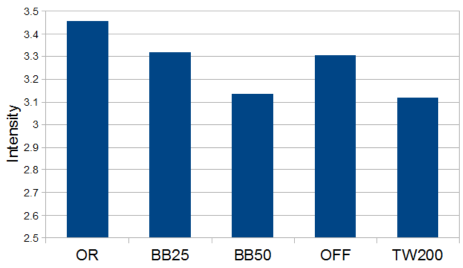


Figure 10: *Intensity for each condition*

6 Conclusion

The goal of this work was to investigate how changes to captured motion clips, such as those which might commonly occur through motion editing, might alter the perception and intensity of an emotional performance. Unlike much previous research, which looked at categories of motion, such as gait, we study a varied set of emotion clips. From these, we learn that the upper body motion is most crucial for the recognition of emotions. The lower body and head motions are not relevant when the upper body can be seen. We also saw that although many heuristics for pose and velocity carried over to our motion set, some heuristics such as the ones involving elbow flexion did not apply. Lastly, we determine that the perceived intensity of an emotion can be reduced by blending with a neutral motion; and that posture changes can alter the perceived emotion but subtle changes in dynamics only alter the intensity.

These findings might motivate one to take care when splicing emotional gestures onto characters or using IK to move the arms and upper body, since changes to the upper body effect emotion recognition and other subtle changes may reduce its intensity. When blending, we might also take care to blend important joints, such as the head, using smaller blend weights if we do not wish to dilute the emotional content. Future work will try to verify these hypotheses as well as determine whether such heuristics can be used to increase or decrease the emotional content. For example, we might try procedurally modifying some of our initial motion set which had poor recognition rates.

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