The Most Significant Feature of 'Swing' as Motion-Emotion Understanding

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ABSTRACT

In this research, we focused on one of the most common form of movement in the design of motion-emotion understanding interface: Swing. Many researches described how the features of swing may affect emotional information. Our interest lies on which feature of swing affect most significantly in the design of motion-emotion understanding interface. Experiments were conducted to find the most significant feature of swing. Physical variables as max angle (A), frequency (f) and speed change(λ) were selected and investigated. The results indicated frequency (f) is verified as the most significant feature. It has observable effect on both the valence and arousal of emotions. High frequency can be regarded as positive, intensive emotions while low frequency be decoded as negative, calm emotions.

1. INTRODUCTION

Generally, in the field of identifying the movement-emotion relationship, Tek-Jin Nam *et al.* concluded emotion-movement relationship framework (Figure 1) based on Russell's emotion circumplex model. According to this framework, fast and open movement represent for excited and happy emotions, slow and disconnected movement are suitable for expressing oppressed and sad emotions.

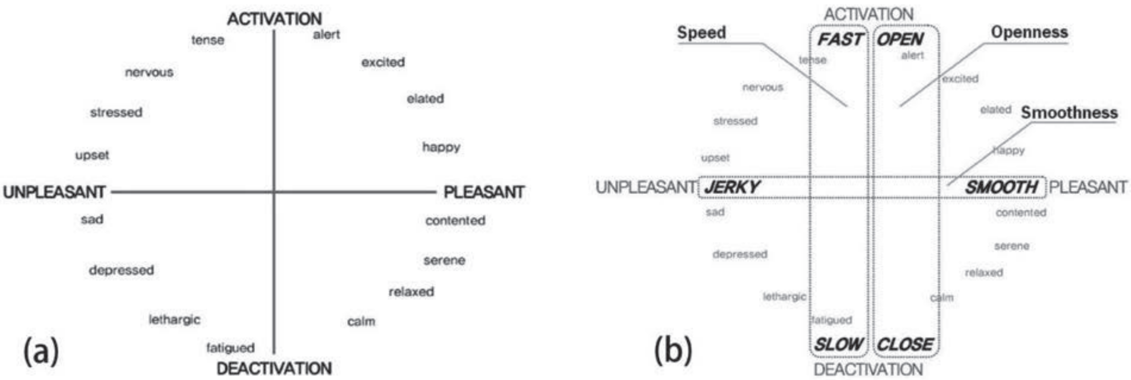

Figure 1: (a) Russell's circumplex model of emotions, (b) Nam et al. emotion-movement relationship framework

Nevertheless, as stated by Ibáñez, the more realistic and complex an approach to show emotions is, the more difficult to maintain its consistency. On the contrary, by using more iconic, more abstract and simpler approaches, it will presumably be easier to maintain its consistency, as the features will be more easily understandable and users' expectations will be smaller. Hence, the motion involved in this studies is located as one of the most basic physical form of movement, the swing of a solid stick.

From the view of mechanism, swing needs only one joint, it performs periodically, it occurs only in two dimensions, these advantages make it easy to be applied in mechanical configuration. For analysis swing's physical feature, simple pendulum is one typical kind of swing form. The differential equation which represents the movement of a simple pendulum is

$$\frac{d^2\theta}{dt^2} + \frac{g}{l} sin\theta = 0 \qquad \boldsymbol{Eq.1}$$

where g is acceleration due to gravity, l is the length of the pendulum, θ is the angular displacement, and t is the time to complete one period. Similarly, in this study, our model for the features of swing is descried in terms of max angle variable (A), frequency variable (f) and speed change variable (λ). From relevant researches, no evidence shows the length of swing affects the meaning of emotion, so in this study, the length variable is ignored.

For the mechanical configuration of a stick's wave, a full angle of less than 90˚ is applied most commonly. So the range of swing's max angle in this study is settled less than 45˚. In this range, 30˚ is settled as the 'large' swing's max angle for the reasons that a full angle of 60˚ is the angle that can be reached easiest. In order to easily controlled in stimuli software, the 'small' swing's max angle is settled as 10˚. Evidences form medical and human image recognition shows the most common frequency of hand wave is one time a second, and it is regarded as relatively high speed. So the 'high' frequency in this study is settled as 1 Hz and the 'low' frequency is settled as 0.5 Hz. In addition, the most common form of speed change is from simple pendulum. As the gravity coefficient remains the same in certain local area, the speed changes trigonometrically. It matches the description of 'smooth change in speed and no acute peak of change' in the studies of motion-emotion understanding. On the contrary, due to the unchanged torque provided by mechanical motivation, the velocity retains the same and changes instantly at the end. This form of speed change matches the description of 'steep peak of change'. These two basic forms in speed change are described visually in Figure 2.

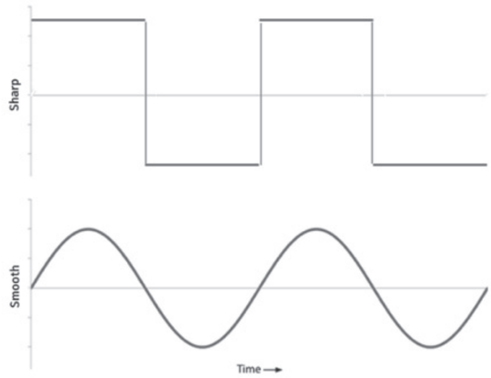

Figure 2: Two basic form of speed change patterns

2. METHOD

A sample of 15 participants, between the age of 21 and 32 (mean age = 25.6, SD = 3.27), was individually involved in Experiment 1. They were either asked by mail to watch a set of 8 pieces of videos and fill in the questionnaires, or invited to the department. Based on the selected variables from prior researches, the combination of large/small max angle variable (A), high/low frequency variable (f) and smooth/sharp speed change coefficient variable (λ) are made as the motion samples, making up 8 pieces of videos. Each video is 360x360 in resolution, showing complete periods of the swinging stick (Figure 3).

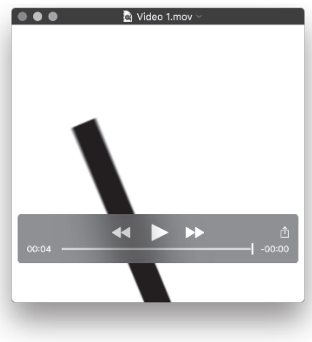

Figure 3: Screenshot of video sample

The questionnaires were aimed to grade valence and arousal of emotions in the negative-positive and calm-intensive dimensions. For each video, the grades of valence and arousal of emotions were scored from -3 to 3. In order to verify whether frequency affects the understanding of emotions independently and investigate the effects of frequency changing. Experiment 2 was arranged separately after Experiment 1.

Another sample of 15 participants, between the age of 22 and 34 (mean age = 27.2, SD = 4.06), were individually involved in Experiment 2. They were either asked by mail or social network to watch the another set of videos and fill in the questionnaires, or invited to the department. Participants graded the range of both arousal and valence of emotions they decoded from the different frequencies shown in the 4 pieces of videos. The sequence of videos was randomly played. From related studies in human-vision recognition, a 10 Hz range of oscillation is usually regarded as the limitation of human's eyes. Since 0 Hz cannot be regarded as movement, we selected a very small value represent the extreme low frequency. The 4 pieces of videos shown to participants differ in only frequency, as 0.5 Hz, 3 Hz, 6 Hz, 9 Hz.

3. RESULTS AND DISCUSSION

In Experiment 1, Independent-samples *t*-test was performed to analyze the significances of specific impacts of max angle, frequency and speed change on valence and arousal respectively. For max angle, there were significant differences (sig=0.004, 0.01) in both valence and arousal aspects, which might reveal a heterogeneity for each. However, in terms of the impacts, a non-significant result for each (p=0.175, 0.25 individually) suggested that no statistical significance was found. For frequency, *p* values of valence and arousal (0.041, 0.009) from the *F*-test and *p* values of valence and arousal (0.004, 0.01) from the *t*-test are smaller than 0.05. Hence, the analysis shows differences in frequency affects valence and arousal significantly for both valence and arousal. For speed change, there is no significant evidence shows whether or not does speed changing affect valence and arousal (Figure 4).

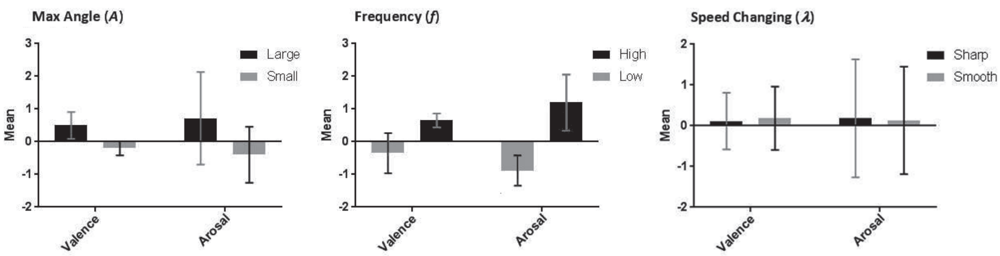

Figure 4: Influence of features

As the relationship between frequency and valence and arousal were measured individually, and a log regressive relation has been found respectively. Since their R^2 are larger than 0.80 (0.9994 and 0.9733), the results in Experiment 2 support the outcomes from Experiment 1. For both valence ad arousal, low frequency can be decoded as negative, calm emotions and high frequency can be regarded as positive, intensive emotions. This results also indicated frequency as the most significant feature of swing can affect the emotion understanding individually (Figure 5).

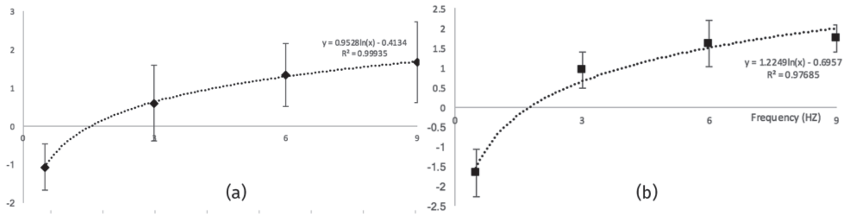

Figure 5: (a)Mean scores of valence; (b)Mean score of arousal

4. CONCLUSIONS

Swing is used to show active and deactive of emotion, also it has been applied to show the pleasant or unpleasant emotions. Experiments were conducted to find the most significant feature of swing that usually applied in the design. Physical variables as max angle (A), frequency (f) and speed change coefficient variable (λ) were discussed and investigated in order to figure out the significance. As results from the experiments, frequency (f) is verified as a significant effect on both the valence and arousal of emotions. High frequency can be regarded as positive, intensive emotions while low frequency can be decoded as negative, calm emotions. Furthermore, we investigated among the human-observable range of frequency in additional experiment. The results support our findings. What's more, both cross points emerge near 1 Hz. The results in this study support the investigation in relevant researches. For future researches, the movement-emotion relationship needs to be further refined with more physical variables, such as rhythms, durations, etc. Meanwhile, more movement in various forms need to be investigated to better understand the relationship between abstract movement characters and specific dimensions of emotions.

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