Evaluation of Graceful Movement in Virtual Fitting through Expressed Emotional Response and Emotion Expressed via Physiology Measures

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Abstract. Graceful interaction is a form of interaction that incorporates quality movement that can invoke the emotional appeal of users engaged with it. However method of evaluation of the quality graceful interaction has not been discussed. As we argue that graceful interaction can evoke emotion, we explore the use of possible instruments to evaluate graceful interaction based on the valence–arousal model. To measure emotional response of arousal the response is using verbal and non-verbal instruments. The former is based on self-report emotions and the later through autonomic measures of emotion via bio-physical measures of skin conductance. We conducted an experiment with six participants who were given the tasks to perform movement tasks in virtual fitting using three different virtual fitting room (VFR) applications available on e-commerce fashion retailing websites. The selection of the VFR applications was based on the presence of two identified graceful interaction design elements, which are tempo and sequence as prescribed by the graceful interaction design model. While performing the tasks, each participant's physiology measure of emotional response was recorded using the tool BioGraph Infiniti. Upon completion, the participants were requested to report their emotional response in an instrument constructed based on the valence arousal model. Finally each participant was also interviewed to state the VFR applications they preferred. The analysis of each type emotional response were made and the findings showed the congruence between the verbally expressed emotional response and physiology measure of emotional response in performing graceful interaction tasks. This suggests that the evaluation of graceful interaction can be made by the use of verbally and non-verbally expressed emotional respond instruments.

Keywords: aesthetic experience, graceful interaction, emotional design, virtual task, physiological measure, human computer interaction.

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1 Introduction

Early definition of interaction design was centred on the notion of "shaping of interactive systems with particular emphasis on their use qualities" and was extended to include the use context where the computer is part of the mediated activity system [1]. Good interaction design encompasses three quality perspectives: constructional quality for the structure; ethical quality for the function and aesthetic quality for the form [2]. When considering the overall quality of the interactive product experience, HCI research has covered the users' perspective on the role of aesthetics for systems usefulness and aesthetic appeal. It has been argued that aesthetic appeal should not be only focus on visual aesthetics but encompass aesthetics in movement interaction. Though the quality of movement interaction can be measured through measures of efficiency and ease of use, as interaction design extends into interaction that yields aesthetic experience, measures of quality may also relates to emotional measures.

Graceful interaction is an aesthetic experience of a human in moving beautifully. In HCI, graceful interaction is claimed to be a form of interaction that incorporates quality movement that can invoke the emotional appeal of users engaged with it [3]. However the method of evaluation of quality graceful interaction is still unexplored. The valence–arousal model [4] is a popular model used to capture two dimensions of emotion which are pleasure and arousal. The former describe the pleasantness and the later describes physical activation. In dealing with movement quality, instruments for emotional measures related to arousal can be classified into two major types: verbal and non-verbal. In this work we chose the use context of virtual fitting in the apparel e-commerce environment that tries to enhance the shopping experience of the customer. Here, we seek to evaluate the quality of graceful interaction in virtual fitting tasks using emotional measures through the triangulation of expressed emotional response and emotional response via physiology measures of skin conductance.

2 Related Work

Graceful interaction was first discussed in the design of dialogue systems in [5] in the context of spoken and written man-machine communication where the focus was on user friendliness in command line interaction style. Later graceful interaction was studied in the context of intelligent environment in addressing issues of how the user can deal appropriately with anything a system happens to do so as anyone observing the user perceive the interaction as effective and effortless while at the same time appearing to be rational and elegant [6]. In these early works of graceful interaction the underlying concept is centred on the notion of ease of use rather than the notion of aesthetics where gracefulness should be related to. In [3] the concept of graceful interaction is revisited and argued from the success of invoking the user's emotional stimulation in an artifact in line with concept of flow in [2]. Here, in [3] graceful interaction is viewed as a form of quality engagement through the dynamic property of an interaction in a movement or action that is normally recognized as 'pleasing or attractive' to the users engaged with it. A model of graceful interaction through the use of

Laban Theory of Movement [3] describes four design elements: rhythm, tempo, direction and sequence. The model was further described through the phenomena mapping with dance movement [7] and tested for its ability to evaluate movement quality using the Laban Movement Analysis [8].

Aesthetic concept is generally perceived as a philosophical discipline and scientific effort to make aesthetic judgement is frown upon. Despite that there are arguments that aesthetic perception combines senses, science and the experience of beauty in neural systems that determine pleasure [9]. Based on these arguments attempts of measuring aesthetics were made both from theoretical and empirical perspectives. Theoretical models such as Birkhoff aesthetic measures, Klinger and Salingaros aesthetic measure and informational aesthetic measures informed the influence of harmony, symmetry or order of the aesthetic forms which implies that the complexity and disorder in the forms create an unpleasant response from the viewer [10]. Aesthetic judgment has also been explained through neurological explanatory model where aesthetic is shown to be a function of an evaluation process which implies that habitual aesthetic evaluation may affect the process of aesthetic evaluation [9]. Empirically the value of aesthetic forms is most apparent on the effect of the users as seen through the affective priming paradigm [11] that leads the empirical measurement of emotion to make aesthetic judgement [12]. As affect or emotion is a mind-body phenomenon, it can be defined by different components such as behavioural response, expressed reactions through verbal reaction (e.g. Kansei), non-verbal reaction (e.g. smiling), physiological reaction (heart beat) and [12]. Affect has at least two qualities: valence (pleasantness or hedonic value) and arousal (bodily activation). Emotional granularity can be used in verbal instruments that can be developed based on the valence-arousal model [13]. Non-verbal instruments for measuring expressive reaction may also include measurement from facial and vocal expression analysis. Emotions that manifest into physiological reaction can be detected through various measures such as blood pressure responses and skin conductance responses (SCR). Skin conductance is widely used in research to serve indicators of processes such as attention, habituation and arousal [14].

3 Research Method

To evaluate the quality of graceful interaction we conducted an experiment with six participants to measure their arousal level via expressed verbal reaction and physiological reaction. The participants were asked to perform virtual fitting tasks using three different virtual fitting room (VFR) applications as the artefacts of inquiry. The VFR applications are selected from the retailing websites of fashion stores of H&M (VFR1), brides.com (VFR2) and F&F (VFR3) based on the presence of two identified graceful interaction design elements, which are tempo and sequence following the graceful interaction design model of [3]. The VFR1 represents graceful interaction with design elements of tempo-fast and sequence-order while the VFR2 represent graceful interaction with design element of tempo-slow and sequence-order. VFR3

represents graceful interaction with design elements sequence-disorder. A summary of VFR used are shown in Table 1.

Table 1. Graceful Design Elements in the VFR

VFR Applications		Graceful Interaction Design Element			
		tempo		sequence	
Abbreviation	E-Commerce Site	fast	slow	order	disorder
VFR1	H&M	√		√	
VFR2	brides.com		√	√	
VFR3	F&F				√

For VFR1 and VFR2, the tasks to perform are: selection of an apparel (T1) and virtual fitting of the apparel in the avatar (T2). However for VFR3, both tasks are integrated. During the tasks, the SCR of each participant was recorded as the physiology measure that detects level of arousal using the tool BioGraph Infiniti. The participants wore physiology sensors attached to their two fingers. The SCR graphs are produced by plotting SCR at the y-axis and the response time duration at the x-axis. After performing the tasks the participants were asked to rate a checklist of positive emotion for valance (pleasure) and arousal to capture their emotional response towards the gracefulness of the virtual fitting activities. The participants are then interviewed to determine their preference of the movement quality.

4 Results and Analysis

4.1 Analysis of Verbal Expressed Emotional Response

The high ratings (>3) given by each participants were to each positive emotion of valence and arousal for each VFR is shown in Table 2.

Table 2. Analysis of Arousal and Pleasure Verbally Expressed Emotional Response

VFR	Positive Discrete Emotion of Arousal (rating > 3)				
	aroused	astonished	excited	delighted	happy
VFR1	5	4	5	4	5
VFR2			4	4	4
VFR3	4	4	4	4	4
	Positive Discrete Emotion of Valence (Pleasure) (rating > 3)				
	pleased	glad	content	relaxed	calm
VFR1	4	4	5	5	4
VFR2		4	4		
VFR3	4	4	4	4	4

For the arousal dimension, all participants gave a high score to all discrete emotion of VFR1 and VFR3. However the scores for VFR1 are generally higher compared to VFR3. For VFR2 the participants only gave high score to discrete emotion of excited, delighted and happy. Similarly for the valence dimension, the participants gave high scores to all discrete emotion of VFR1 and VFR3. For VFR2 the participants only gave high score for glad and content. This implies a higher rating of expressed emotional response is given to movement with fast tempo (VFR1) when compared to movement with slow tempo (VFR2). The results also showed that movement with the sequence of order (VFR1) received higher rating of expressed emotional response when compared to sequence of disorder (VFR3). This result is in agreement with theoretical aesthetics measure which states that disorder will cause unpleasant response from reviewers.

4.2 Analysis of Preference

When the participants were asked for VFR applications they preferred, all of them stated VFR1 as the most preferred. When asked for their individual preference of movement quality for graceful interaction all of the participants chose tempo-fast and sequence order. This concurs with the scores for both high and low dimension emotional response for VFR1 as shown in Table 3.

Table 3. Preference for Movement Quality

Participant	Preference for Movement Quality		Preference for the Combination of the Movement Quality
	Tempo	Sequence	
P1	Fast	Order	More than two
P2	Fast	Order	More than two
P3	Fast	Order	More than two
P4	Fast	Order	More than two
P5	Fast	Order	More than two
P6	Fast	Order	More than two

The analysis of movement quality preference also concurs with the results obtain from the analysis of emotional granularity of expressed emotional response.

4.3 Analysis of Expressed Emotional Response via Physiological Measurement of Skin Conductance

Peaks in the SCR graph represent the participants' arousal while using the VFR applications. Observation of the peaks is focused on the time taken to reach the peaks and the frequency of peaks. The high frequency of peaks represents the occurrence of individual peaks in the signal where the density of the peak and peak onset times are

associated with sympathetic arousal which give sense on how arousing the activity performed. The SCR graph for each participants showed that each of the participants experienced different types of arousal even though they were doing the same tasks at the same place. The graphs also showed unique and different physiological signal as the body condition of participants are not similar to each other. It means the body condition also influenced the emotional state of participants.

Time to Reach First Peak. An analysis of the time taken to reach the first peak in the SCR graph is shown in Table 4.

Table 4. Time Taken to Reach the First High Frequency Peak

Participants	Time taken to Reach the First High Frequency Peak				
	Task 1		Task 2		Combined Task
	VFR1	VFR2	VFR1	VFR2	VFR3
P1	00:00:12	00:00:20	00:00:15	00:01:00	00:01:30
P2	00:00:26	00:00:20	00:00:16	00:02:30	00:00:45
P3	00:01:05	00:03:00	00:00:15	00:00:30	00:02:05
P4	00:00:11	00:01:00	00:00:19	00:01:00	00:00:20
P5	00:00:14	00:01:30	00:00:21	00:00:30	00:01:40
P6	00:00:21	00:00:10	00:00:12	00:01:16	00:00:20

All participants took a longer time to show an emotional response when performing the Task 1 and Task 2 in VFR2 (except for P2) when compared to VFR1. The result is more difficult to interpret for VFR3 as the tasks were combined (application constraint). However, the time to peak is generally shorter than VFR2 but longer than VFR1. This result concurred with the results obtained for the expressed emotional response in section 4.1 and 4.2.

Number of Peaks Frequency in SCR Graph. The high peak frequency in the SCR graphs is correlated to the high arousal level. The comparison of SCR graphs of each of the participants performing Task 1 and Task 2 using VFR1and VFR2 are shown in Table 5 and Table 6 respectively.

The SCR graphs of each participant using VFR3 is shown in Table 6.

The SCR graphs of every participant show different peaks because some of the participants took a longer time to select a model compared to others. The number of high frequency peaks in the SCR graph for each participant is summarized in Table 7.

It can be seen that in Task 1 the number of high frequency peaks for VFR1 and VFR2 are almost similar. However in Task 2, the number of high frequency peaks for VFR1 and VFR2 are higher than Task 1. This can be interpreted as there is a low arousal for movement activity in Task 1 when compared to Task 2. In addition the number of high frequency peaks Task 2 is higher in VFR1 as compared to VFR2. Similarly there is also an indication of high arousal for movement activity in VFR3. Nevertheless, the number of high frequency peaks for all participants are generally

higher in VRF1 compared to VRF3. Again this result indicates that physiological measures also yield results that VFR1 produced a higher arousal when compared to VFR2 and VFR3 and VFR3 produced a higher arousal when compared to VFR2.

Table 5.

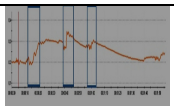
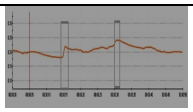
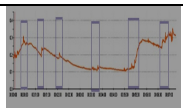
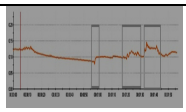
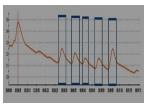
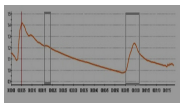
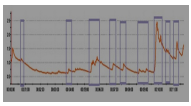
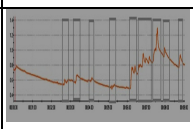
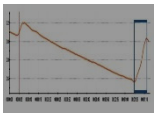
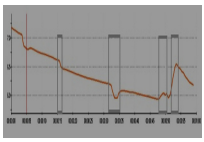
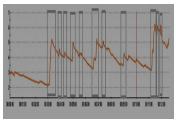
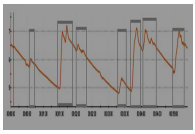
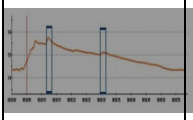
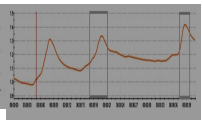
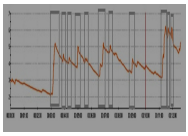
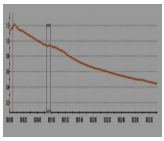
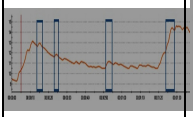
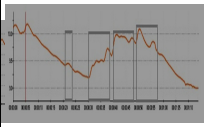
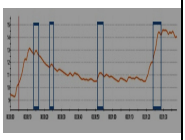
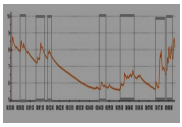
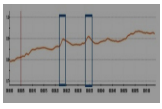
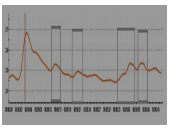
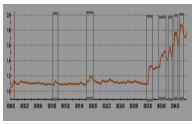
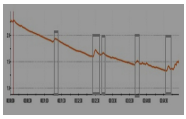
Partici-pants	SCR Graph for Task 1		SCR Graph for task 2	
	VFR1	VFR2	VFR1	VFR2
P1				
P2				
P3				
P4				
P5				
P6				

Table 6.

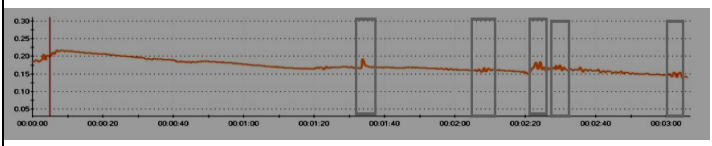
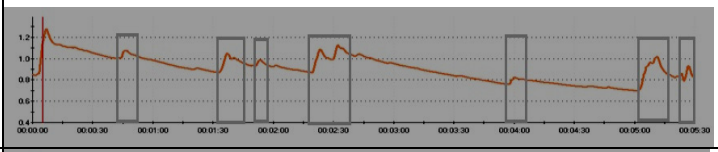
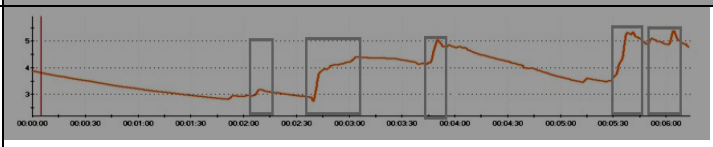
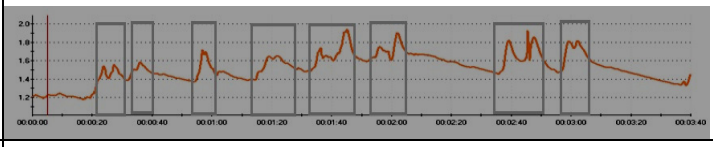
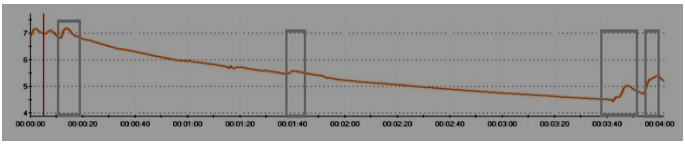
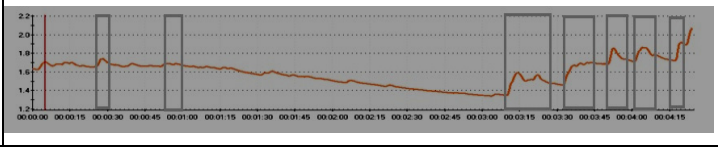
Partici-pants	VFR3 (tempo – fast; sequence – disorder)
P1	
P2	
P3	
P4	
P5	
P6	

Table 7.

Participants	Number of High Frequency Peak				
	Task 1		Task 2		Combined Task
	VFR1	VFR2	VFR1	VFR2	VFR3
P1	3	2	6	3	5
P2	5	2	9	7	7
P3	1	4	11	5	5
P4	2	2	10	8	8
P5	4	4	16	4	4
P6	2	4	7	7	7

4.4 Discussion

The results of obtained in this work shows a similarity in the measures of emotional response towards the movement quality exhibited in the activities of the VFR application. The results consistently indicate that movement quality with graceful element of tempo-fast produced a higher arousal as compared to tempo-slow. As for graceful element of sequence, sequence-order produced a higher arousal as compared to sequence-disorder. This finding is support theoretical models aesthetics by Birkhoff' and Klinger and Salingaros. Though these models were used to describe aesthetics of static form, this work shows the same can be applied to dynamic forms of aesthetics such as graceful interaction. The findings showed that the non-verbal measure of expressed emotional appeal of graceful interaction is in congruent with the measure of verbal expressed emotional appeal. Nevertheless, more analysis can performed based on the data of the physiology measures of skin conductance. For instance an analysis of emotional response for each task performed by the participants can be analyzed. This is more is more difficult to do when using self report assessment where participants may be unsure on the ratings to be given as they find it difficult to differentiate each tasks.

Although this work shows some promising results to determine suitable evaluation methods for graceful interaction design, the study has its limitation. This is because the VFR applications used are readily available applications which do not incorporate all four design elements of graceful interaction. The study is limited to the design element of temp and sequence only.

5 Conclusion

The usual method of evaluating user experience is based on performance metrics such task completion time seems cold and unfeeling and is not suitable for evaluating aesthetics experience. Other methods suggested in the literature include the arousal measure either through the use of verbal and non-verbal expressed emotional appeal. For the non-verbal expressed emotional appeal, biophysical data can reflect the arousal that takes place during the interaction. In this work we have shown that the measures from biophysical data are in congruent with the data obtained from the verbal expressed emotional appeal which is the more method of measuring arousal. As non-verbal expressed measures cannot be faked it may be a more reliable measure for the movement quality of graceful interaction. This work is an early effort to determine methods of evaluation of graceful interaction. More work is needed to explore on measures for the other graceful design elements which are rhythm and direction.

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