A Dancing Virtual Agent to Evoke Human Emotions (Extended Abstract)

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ABSTRACT
This paper presents an experimental study investigating the impact of dancing IVAs on human emotions. The results showed that watching a dancing IVA depicting different emotions significantly influenced human emotions. Additionally, the participant's anger, sadness and happiness were significantly dependent on which dancing character's emotion they watched. Moreover, the results of the study showed that while most of the participants were able to recognize the emotions depicted by the dancing IVA, correct recognition of the dancing IVAs' emotions was not necessary to have the intended influence on human emotions. These results suggest that some of the benefits associated with dancing, such as dance therapy, could be achieved just by watching an IVA.

Categories and Subject Descriptors
I.2.11 **[Artificial Intelligence]**: Distributed Artificial Intelligence– *intelligent agents, multiagent systems.*

Keywords
Intelligent Virtual Agents, Emotion, Dancing

1. INTRODUCTION
Dance is a universal human language. Dance has been considered in the context of the believability of the behavior of intelligent virtual agents (IVA) [6, 8-10] and has been analyzed for emotion recognition [2; 3] and expression [1] and modelled to enhance IVA expressivity [7].

Despite some research involving IVAs and dance, there is little research concerning the influence of dancing IVAs on human emotions. Integrating emotion into a dancing IVA has the potential of helping humans to express themselves and increase their capacity for communication, as has been found in Dance Movement Therapy [4]. In order to understand the relationship between a dancing IVA that portrays emotions through movements and human emotions, the following research question was investigated: *Can a dancing IVA influence human emotions?*

2. APPROACH
To answer the research question, we conducted an experiment involving participants watching a dancing IVA that displays three different emotions (anger, sadness and happiness).

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The experiment was based on a 'repeated measures' design with one within subjects factor (dancing character) and one between-subjects factor (display order). The dancing character factor displayed three different emotions. There were six different display orders as shown in Table 1. Each participant watched the three dancing characters in only one display order of emotions. Each display of the dancing characters took one-minute and 50-seconds. The display order of emotions was randomly allocated to participants by the survey software (www.qualtrics.com).

Table 1: Between-within subject design: Display Orders

Display Order of Emotions	**Dancing Character**		
	First	Second	Third
ASH	Angry	Sad	Happy
SHA	Sad	Happy	Angry
HAS	Happy	Angry	Sad
AHS	Angry	Happy	Sad
SAH	Sad	Angry	Happy
HAS	Happy	Sad	Angry

In order to design and implement a dancing character that depicted happy, angry or sad, we drew on the dance psychology literature which describes how these emotions are portrayed in dance and earlier work in IVA research (e.g. [1; 8]). The design of the angry, sad and happy dancing character follows a similar approach to a study by Camurri, Lagerlöf and Volpe [2] classifying the dance movements with respect to emotions (Anger, Sadness and Happiness) and Laban's dimensions [5]. The Laban dimensions include Time (duration), Weight (tension, transfer and activity), Space (contraction and expansion) and Flow (frequency, tempo changes/pauses, rhythm).

3. Results

3.1 Can humans recognize IVA emotion?
The 55 participants who completed the survey were automatically and randomly allocated into one of the six orders by Qualtrics. The participants' recognition results are shown in Table 2 and reveal that recognition of the happy character was the highest, followed by the sad character and lastly the angry character.

Table 2: Individual Recognition Results

	Recognition Response – count (percentage)					
Stimulus	Happy	Sad	Angry	Surprise	Disgust	Fear
Angry IVA	12 (21%)	4 (7%)	26 (47%)	7 (12%)	3 (5.5%)	3 (5.5%)
Sad IVA	0 (0%)	40 (72%)	1 (1.8%)	1 (1.8%)	0 (0%)	13 (23%)
Happy IVA	50 (91%)	1 (1.8%)	0 (0%)	2 (3.6%)	0 (0%)	2 (3.6%)

3.2 Can IVA Emotion Influence Human Emotion?

The influence of watching an angry, sad or happy dancing character was investigated at four time points (referred to as levels in SPSS) by measuring the participants' corresponding feelings 1) before watching any character (pre-questionnaire), and after watching 2) angry 3) sad and 4) happy dancing characters. Note that the display orders for 2-4 were randomized across participants.

A repeated measures ANOVA (multivariate test) revealed a significant difference in the means at four time points for angriness ($p=0.002$), for sad ($p<0.001$) and for happiness ($p<0.001$). To determine which means were significantly different from each other, we used post-hoc tests and compared each mean with each other by using Bonferroni correction for multiple comparisons with an adjusted significance level of 5%.

For angriness, the results identify a significant difference in the means between level 1 and 2, angriness at pre-questionnaire and angriness after watching the angry dancing character ($p=0.024$). There was no significant difference in feeling of anger after watching the sad dancing character ($p=0.350$) or after watching the happy dancing character ($p=0.057$), though the p-value is approaching significance, possibly because the angry and sad dance were less differentiated from each other. Therefore, we can conclude that the participant's angriness is significantly dependent on which dancing character they watched (i.e. which emotion the dancing character displayed). Specifically, we conclude that watching an angry dancing character can influence the human's feeling of anger.

For sadness, the results identify a significant difference in the means between level 1 and 3, sadness at pre-questionnaire and sadness after watching the sad dancing character ($p=0.001$). There was no significant difference in feeling sad after watching the angry dancing character ($p=0.262$) but there was significant difference in feeling sad after watching the happy dancing character ($p=0.003$). Therefore, we can conclude that the participant's sadness is significantly dependent on which dancing character they watched. Specifically we can conclude that watching a sad or happy dancing character can influence the human's feeling of sad.

For happiness the results identify a significant difference in the means between level 1 and 2, happiness at pre-questionnaire and happiness after watching the angry dancing character ($p<0.001$). There was also a significant difference in the means between level 1 and 3, happiness at pre-questionnaire and happiness after watching the sad dancing character ($p<0.001$). There was no significant difference in feeling happy after watching the happy dancing character ($p=0.175$). This may be because they feel happier than the happy dancing character and only a happier dancing character can make them happier. Therefore, we can conclude that the participant's happiness is significantly dependent on which dancing character they watched. Specifically we can conclude that watching a sad or angry dancing character can influence the human's feeling of happy.

4. CONCLUSIONS AND FUTURE WORK

The results of the study have shown that the influence of the angry or sad dancing characters on humans' emotions is irrespective of their recognition of the emotion or whether or not they like dancing or the character. This was also true for the participants who like dancing or the character for the happy dancing. This is an important finding, as it indicates that the IVA could possibly be used for therapy and deliver benefits even if a patient might not be able to recognize the emotion. However, the results showed that the influence of the happy dancing character on human's feeling of happy could be accounted for by recognition of that emotion.

The literature describes additional features we did not implement. Our study was restricted to three emotions and our initial model was captured from a human dancer and then tweaked according to the features. As future work, more features and emotions could be implemented using a more automated process and the study repeated with more participants representing a wider age range, different cultures and other factors. Finally, to further explore the benefits for dance therapy, a study involving investigation of the influence of the dancing characters with and without music is needed.

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