Arabic Accented Facial Expressions for a 3D Agent

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1. INTRODUCTION

In this study we attempt to identify and develop a suitable set of facial expressions for a 3D agent that embodies the Arabic culture. We also evaluate how Arabs and non-Arabs recognize Arabic facial expressions implemented on a 3D agent.

Our motivation is to facilitate the human interaction with a 3D agent. This requires the agent to display emotions in order to make it more believable [1]. When humans interact with a 3D agent, they typically expect the agent to have human-like behavior [6]. Hence, the agent's expressions to display emotions must match that of human behavior [13]. Furthermore, the features of a 3D agent induce human opinions about the agent, meaning, humans expect the agent to behave in a specific manner according to its features [5]. Therefore, a 3D agent with Arabic features must also display Arabic facial expressions.

Facial expressions play an important role in human-human communication [4]. Although expressions are deemed universal [4], they are also accented [5]. As in language, people of the same culture have the same accent in facial expressions; people from the same culture also have an in-group advantage in understanding that specific accent in facial expressions.

In this study we answer the following questions to investigate the in-group advantage for Arabic facial expressions: can an Arabic specific accent be identified in facial expressions? And do Arabs and non-Arabs recognize accented expressions that are implemented on a 3D agent differently?

2. BACKGROUND

Human facial expressions exhibit universal characteristics [2]. They also can exhibit differences that create misunderstandings between people from different cultures [11]. Humans can misinterpret the facial expressions of people from different cultures, which can lead to miscommunication [5]. The misinterpretations are due to the fact that people can move their eyebrows, mouth or have subtle expressions according to their culture [11]. These differences challenge the theory of the universality of human facial expressions and give people from the same culture an in-group advantage in recognizing facial expressions [5][11][12]. The differences also create the concept of an "accent" in facial expressions; which means that people from the same culture recognize and understand their expression accent better and they have the in-group advantage in recognizing and understanding their specific cultural accent in facial expression.

The in-group advantage in the recognition of facial expressions is amplified in avatar facial expressions and animated characters [8][9]. This is observed by studies carried out in Asian [7] and Western [8] countries. Other studies investigate the effect of changing a specific feature, for example: when the movement of eyebrows or mouth varies, the recognition of the expressions also varies between Japanese and Americans [9]. None of these studies examine Arabic facial expressions. They also do not examine the existence of the in-group advantage in the recognition of 3D agent expressions.

2.1 Testbed: the cross-cultural 3D agent

To investigate the Arabic specific accent in facial expressions we use Hala as our testbed. Hala is a 3D agent with Arabic features, it is a bilingual cross-cultural robot developed at Carnegie Mellon University in Qatar (CMUQ). It is deployed at CMUQ's reception area, where it interacts with students and visitors of different cultures. Hala's old facial features, as shown in Figure 1, had no cultural association. Therefore Hala's facial features have been redesigned to have Arab facial features [Figure 1].

Figure 1: Hala's model, old (left) and new (right)

The new facial features allow the 3D agent to better embody the Arabic culture. To further improve its interaction with humans it needs to also display facial expressions when conveying emotions. In this study, we use Hala's new model.

3. OUR APPROACH

In our study, we select 6 emotions to identify the Arabic accent in their facial expressions: anger, disgust, surprise, happiness, sadness and disappointment. The first five expressions convey some of the major emotions; they are considered to be universal for human facial expressions [4]. As for disappointment, it is claimed that it sends the same signal as sadness and therefore sadness and disappointment cannot be easily distinguished [2][3]. We identify the Arabic accent in each facial expression and implement the expressions on our 3D model. We run an initial assessment in Qatar to verify and improve the expressions. Finally, we run a larger scale experiment in Qatar and Pittsburgh with the improved expressions.

3.1 Identifying the Arabic Accent

As a first step, we identify the Arabic specific accent in facial expressions. We could not identify a published database with Arabic facial expressions. We commence by taking videos of six participants while narrating a story that invokes an emotion. Participants are Arab female

students at CMUQ between the ages of 19-22. All of them spent the majority of their lives in Arab countries.

Each participant reads 6 stories that are written in the Modern Standard Arabic language. After reading each story, the participants are video recorded while narrating the story in Arabic using their own dialect. To ensure that each participant shows the intended expression of the story, the required emotion is written prior to the first sentence in the story they read. The stories were either based on a situation that a university student would commonly face, such as worrying about failing in an exam, or based on folklore stories such as that of Layla and Majnun [10]. If the participant does not relate to the story with the suggested emotion, they are permitted to disregard it (happened once). The participants are video-recorded privately to reduce having any influence on their expressions. Some of the common features observed in the participants' expressions are shown in Table 1.

Table 1: facial features when displaying expressions

Expression	Features			
	Eyebrows	Eyes	Lips	Other
Sadness	Slightly upward and drawn together	Slightly closed	Tightly closed and raised.	
Disgust	Raised and close to each other	Tightly closed	Corners of the mouth are pulled downward.	Lines from nose until the corner of the lips, caused by the cheeks movement.
Anger	Raised and slightly close to each other	Slightly closed	Upper teeth are shown by a frown.	Lines are shown on the forehead.
Disappointment	Tip of the eyebrows are slightly raised	Slightly closed.	Tightly closed and slightly raised.	
Surprise	Raised	Widely open.	Only the upper teeth are shown.	
Happiness	Slightly raised	Eyes are rather widely open.	Upper and lower teeth are shown.	Lines are shown from the tip of the nose until the tip of the mouth.

The facial expressions of the 3D agent were implemented using a tool that is developed by CMUQ based a slightly modified version of the Facial Action Coding System (FACS). It allows the manipulation of the muscles of the 3D agent face by using an action unit (AU) that controls the intensity of the muscle. The implemented expressions are based on the features mentioned in Table 1 and on muscles that move commonly in a certain facial expression across the majority of the participants. We assume that the expressions displayed by the majority of Arabic subjects include the Arabic accent. The common features observed among the different participants suggest that there are indeed common characteristics between the expressions of Arabs. Comparing the recognition of the expressions by Arabs and non-Arabs can reveal the distinctive difference in any expression.

3.2 Verify and Improve the Expressions

Our second step in this study is to conduct an initial assessment to improve the facial expressions in order to run a larger scale experiment.

The six facial expressions implemented by the FACS are used in a voluntary small-scale web-based survey with students and staff members from CMUQ. But the survey is not exclusive for this group because anyone with the URL of the survey webpage has access to it. Participants are asked about their ethnicity (Arabs or non-Arabs) and demographic information (gender and age). For the assessment, the subjects are asked to map each of the six expressions to a single emotion. The six expressions are ordered randomly and the participants choose the most appropriate emotion. Afterwards, the subjects rate their confidence in choosing the emotion on a ten-level Likert scale. A total of 34 subjects completed the survey.

The initial assessment results are shown in Figure 2. Happiness is the most recognized expression and sadness is the least. Half of the subjects matched our classification of the expressions: 26% Arab and 24% non-Arab. However, sadness, disgust and disappointment are less recognized than the three other expressions.

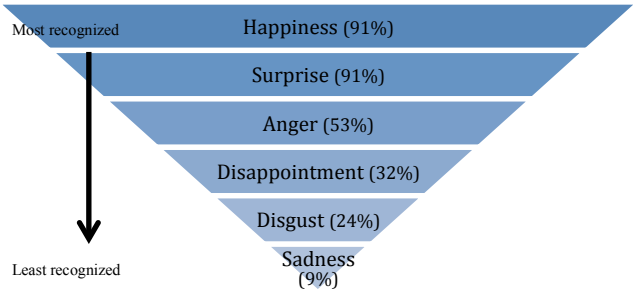

Figure 2: results of the initial assessment, the percentage represents the number of people who matched our classification of the expression

The low recognition of disappointment, disgust and sadness suggests that they must be improved. For that reason we use the same approach to collect more facial expressions from three Arab female participants in the same age group. The newly recorded facial expressions are added to the existing expressions. Disappointment, disgust and sadness are, therefore, adjusted to accentuate the difference between them. The same features that are described in Table 1 were found, the expressions were only accentuated according to the new-recorded videos.

3.3 Evaluation of the recognition of Arabic accented facial expressions

Similar to the initial assessment, we conduct a voluntary web-based survey that is distributed to a larger population of students and staff of Carnegie Mellon University on the Qatar and Pittsburgh campuses. Participants are asked about their origin, their current country of residence, two countries where they lived the longest, and their age and gender. To evaluate the recognition of the Arabic accent in facial expressions, the subjects are asked to map each of the six expressions to a single emotion. The table

below shows the countries of origin and the countries that the participants lived at and our classification of whether they are Arab or non-Arab:

KSA, Somalia, UAE, Jordan, Palestine, Saudi, Bahrain, Qatar, Yemen, Morocco, Lebanon, Iraq, Egypt, Mauritania, Sudan, Tunisia, Syria	Arab
India, Ireland, Kenya, Romania, United States, China, Portland, Pakistan, Indonesia, United Kingdom, Germany, Uzbekistan, Nepal, Canada, Mexico, Nigeria, Delhi, India, Australia, Japan, Bangladesh, France, Uruguay, Italy, Iran, Taiwan, Cyprus, Netherlands, Turkey, Denmark	Non-Arab

From this experiment, we collected a total of 114 responses. The results of the experiment are shown in Table 2 and Table 3. Table 2 shows the recognition of an emotion versus the intended emotion, the top percentage represents the number of Arabs and the bottom percentage represents the number of non-Arabs. Table 3 shows the average ratings of recognizing an emotion versus the intended emotion. Similar to Table 2, the top number represents the average of Arabs and the bottom number represents the average of non-Arabs. The darker shade in the table indicates the higher value.

Table 2: Arabs and non-Arabs recognition of an emotion. For each pair, Arab's percentage is shown on the top.

		Recognized as					
		Sadness	Disgust	Anger	Disappointment	Surprise	Happiness
Intended emotion	Sadness	9%	9%	49%	33%	0%	0%
		8%	10%	42%	39%	0%	0%
	Disgust	51%	35%	7%	7%	0%	0%
		31%	31%	15%	23%	0%	0%
	Anger	2%	42%	35%	2%	19%	0%
		1%	51%	35%	1%	11%	0%
	Disappointment	33%	7%	5%	56%	0%	0%
		59%	4%	0%	35%	1%	0%
	Surprise	2%	5%	2%	0%	74%	16%
		0%	3%	3%	0%	79%	15%
	Happiness	2%	2%	2%	2%	7%	84%
		0%	1%	4%	1%	8%	85%

As shown in Table 2, the recognition of the positive emotions (Surprise and Happiness) is high and differs slightly between Arabs and non-Arabs. Both groups mostly confuse happiness with surprise and surprise with happiness. As for negative emotions the recognition is low and also differs slightly between Arabs and non-Arabs. One exception is disappointment; Arabs recognize disappointment significantly better than non-Arabs. There is an inverse relation in the recognition of disappointment as disappointment and the recognition of disappointment as sadness; Arabs match our classification of disappointment with percentage of 56% and non-Arabs with a percentage of 35%, Arabs recognize disappointment as sadness with a percentage of 33% and non-Arabs with a percentage of 59%.

There are only a few instances where the difference is statistically significant between Arabs and non-Arabs: 1) When the intended emotion is disgust and the recognized emotion is sadness (p-value=0.05). 2) When the intended emotion is disappointment and it is recognized as disappointment (p-value=0.05). 3) When the intended emotion is disappointment and it is recognized as sadness (p-value=0.01).

The comparison between non-Arab living in an Arab country and non-Arabs living in a non-Arab country held no statistical significance with any expression.

As shown in Table 3, the averages of the confidence in choosing an expression differ slightly between Arabs and non-Arabs. The biggest difference occurs only when few participants choose an expression, and therefore that difference can be neglected. For example: there is a 4-point difference between the averages of Arabs and non-Arabs when the intended emotion is happiness and it is recognized as disgust. However, this difference is not significant as few Arabs and non-Arabs recognized it as such.

Table 3: Arabs and non-Arabs average confidence of an emotion. For each pair, Arab's percentage is shown on the top.

Confidence level

		Recognized as					
		Sadness	Disgust	Anger	Disappointment	Surprise	Happiness
Intended emotion	Sadness	4	6	6	5	-	-
		6	4	6	6	-	-
	Disgust	7	5	7	6	-	-
		6	6	5	5	-	-
	Anger	10	6	6	6	5	-
		7	6	7	7	6	-
	Disappointment	6	3	5	6	-	-
		6	4	-	6	2	-
	Surprise	1	2	1	-	6	8
		-	3	3	-	6	8
	Happiness	3	5	5	2	6	8
		-	9	1	1	6	8

4. DISCUSSION AND CONCLUSION

These results suggest that unlike Avatar facial expressions in western design [8], Arabic positive facial expressions that are implemented on a 3D agent are better recognized. Arabs and non-Arabs recognize these expressions as the intended emotion. As for negative expressions, they are poorly recognized as the intended emotion. Although unlikely, the low recognition of negative emotions might relate to the implementation of the expressions. The verification of the expressions eliminates that possibility. A more probable reason is that the negative expressions of a 3D agent are hard to recognize. Context is needed to reveal more information about the expression.

The results also reveal that some of the expressions are differently recognized between Arabs and non-Arabs. Sadness and disappointment are claimed to send the same signal [3] but Arabs were better able to recognize disappointment. The statistically significant difference between the recognition of Arabs and non-Arabs of disappointment suggests that disappointment, when implemented on 3D agent, is more culturally dependent than other expression. Our specific implementation of disappointment has a characteristic that Arabs can detect. The same signal makes non-Arabs recognize the expression as sadness. The results also suggest that disgust sends a signal similar to sadness, Arabs can detect that signal and non-Arabs cannot. Both of these observations reveal that Arabic expressions have a unique accent. However, it is not obvious for all the expressions.

In addition, the origin of the participants is more significant than the country of residence. As the results bear no statistical significance when comparing between non-Arabs in Arab countries and non-Arabs in non-Arab countries.

5. FUTURE WORK

As the results suggest, the origin of the participants affects the recognition of a 3D agent's expressions. To further validate the current results, a study about the recognition of western or universal facial expressions of a 3D agent is needed. In addition, a more detailed study of the hard-to-recognize negative expressions must be carried out. This work can attempt to identify whether culture-specific accents exist in all negative expressions and whether implementing them on a 3D agent improves recognition within the in-group. Finally, and to further investigate the importance of creating culture-specific expressions on a 3D agent, other factors must be considered and compared. For example: the context coupled along with the accent of an expression might have a greater affect on the recognition.

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