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Facial Mimicry and Doctor-Patient Satisfaction: The Feasibility of Artificial Empathy in a Clinical Video Data

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Abstract. Good nonverbal communication between doctor and patient is essential for achieving a successful and therapeutic doctor-patient relationship. Increasing evidence has shown that nonverbal communication mimicry, particularly facial mimicry, where one mirrors another's facial expressions, is linked to empathy and emotion recognition. Empathy is also the key driver of patient satisfaction. This study explores how facial expressions and facial mimicry influence doctor-patient satisfaction during a clinical encounter. We used a facial emotion recognition-based artificial empathy model to analyze 315 recorded clinical video data of doctors and patients in a dermatology outpatient clinic. The results show a significant negative correlation between patients' emotions of sadness and neutral and doctor satisfaction, but no correlation between the duration of doctors mimicking patient emotions and patient satisfaction. These findings provide valuable insights into the future design of systems that can further enhance clinician awareness to maintain communication skills in the search for better doctor-patient satisfaction.

Keywords. facial mimicry, doctor-patient satisfaction, emotion recognition, artificial empathy, clinical video database

1. Introduction

One of the essential keys to creating a successful therapeutic doctor-patient relationship is good doctor-patient communication [1]. To achieve effective communication, doctors

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must understand patients' perspectives through verbal and non-verbal behaviors. Among various communication channels, facial expressions play a major role in human interpersonal communication as they can convey 55% of emotional expression [2]. Facial expressions that match the expressed emotions of another person are often called facial mimicry [3]. It is extensively acknowledged that nonverbal behavioral mimicry, such as facial mimicry, can facilitate the understanding of other's emotion, often referred to as empathy [4]. Although the evidence is inconclusive, numerous theories have discussed the capacity of facial mimicry to empathy and the ability to recognize emotion from face, or called facial emotion recognition (FER) [3].

Moreover, empathy has been linked with an increase of patient satisfaction [5]. There is extensive evidence on how patient-perceived physician empathy can affect patient satisfaction [5]. However, there is a lack of evidence addressing how doctor-patient facial expression can affect each other's behavior and how the doctor's tendency to copy patient's facial expression can affect patient satisfaction during a clinical visit. Our study aims to demonstrate how real-world clinical video data can be used to explore the influence of doctor's facial mimicry on doctor-patient interaction. Specifically, our study addressed the following research questions: 1) Does quantification of doctor's and patient's expression of emotions using facial emotion recognition software in clinical video data correlate with doctor-patient satisfaction? 2) Is there a correlation between the duration time of doctor's facial mimicry and patient satisfaction?

2. Methods

We conducted a 10-month data collection study from March to December 2019 involving 4 physicians and 348 patients in a dermatology outpatient clinic, Taipei Municipal Wan fang Hospital, and Taipei Medical University Hospital. We collected our own doctor-patient clinical encounter videos as a training set to build emotion recognition-based artificial empathy. Our study was approved by Taipei Medical University-Joint Institutional Review Board (TMU-JIRB No: N201810020).

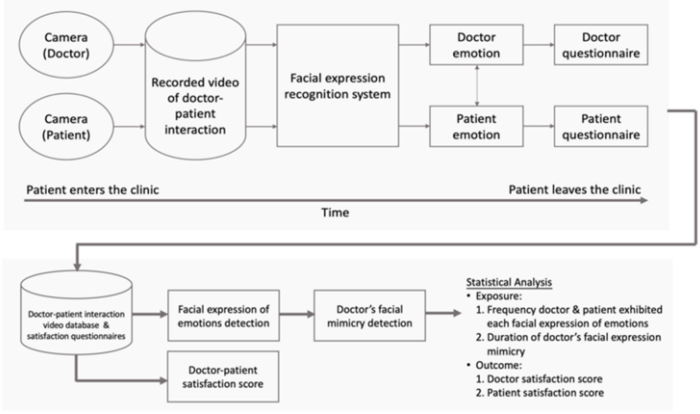

Figure 1. The methodological framework for collecting and analyzing the clinical video data.

2.1. Study design and setting

Figure 1 illustrates our study workflow. First, we used two cameras to capture doctor-patient interactions automatically. Second, we used FER technology to recognize the emotional changes in both patients and doctors over time. Following each clinical session, a satisfaction questionnaire was given to participants. Overall, out of the 348 patients involved in this study, we excluded video data from 33 patients due to video damage, lack of patient consent, and missing data, leaving only 315 eligible video data with an average video time length of 4.36 (*SD* = 2.97) minutes.

2.2. Facial expression recognition system and facial mimicry detection

This study adopted FER system developed by the Industrial Technology Research Institute (ITRI). This system was previously trained on 28,710 Asian face images and obtained an accuracy of 95% for the extended Cohn-Kanade data set [6]. Our FER was divided into three major steps: a) face detection, b) face normalization, and c) facial expression recognition. The face detection module adopted a deep learning-based face detector which robust to face variation as it was previously trained by the Wider Face data set [7]. We then performed a face normalization step to resize the cropped face image into the desired input image size 48x48. After the face images were normalized, the facial expression recognizer module performed facial expression classification using MobileNetV2 [8]. This model was able to identify basic emotions: anger, disgust, fear, neutral, happiness, sadness, and surprise.

In addition, we defined facial mimicry by matching the doctor's facial emotions with the patient's. One facial mimicry instance was counted as present if the doctor exhibited the same emotions 1 second after the patient and met the mimicry condition [4]. We used itertools, a for-loop module in python 3.10 to detect the mimicry duration automatically.

2.3. Measurement and data analysis

We used a 5-point Likert scale satisfaction questionnaire consists of doctor's satisfaction (5 items) and patient's satisfaction (7 items), covering their general satisfaction, interpersonal manner, communication, time spent with the doctor, and medical order. The internal consistency for all items were above 0.90, which show a high level of consistency. We calculated the satisfaction score by summing the participant scale rate and transforming it on a 0-100 scale, where higher scores indicated a greater satisfaction. We used the Spearman correlation coefficient for continuous variables and the Mann-Whitney test for categorical variables. All the statistical analysis was performed using PASW Statistics for Windows, Version 18.0 (SPSS Inc., Chicago, Ill., USA).

3. Results

3.1. Patient characteristics

Our clinical video data includes only Taiwanese people with the average age of patients was 51 years (*SD* = 19). The majority were female (62.5%), and the average patient satisfaction score was 93.28 (*SD* = 10.32). We also calculated the physician satisfaction score, which was slightly lower than the patients (89.71, *SD* = 10.33).

3.2. Facial mimicry, doctor-patient emotional expression, and satisfaction

Table 1. The frequency distribution of doctors and patients exhibited each facial expression and doctor's facial mimicry during clinical encounters (n = 4 doctors; n=315 patients).

Emotion	facial expression		doctor's facial mimicry	
	doctor emotion (n, %)	Patient emotion (n, %)	Mean duration	SD
angry	624 (0.76)	125 (0.15)	-	-
disgust	199 (0.24)	45 (0.05)	-	-
fear	10 (0.01)	5 (0.01)	-	-
happiness	7,298 (8.86)	5,604 (6.80)	2.76	7.31
neutral	50,656 (61.50)	58,736 (71.31)	118.60	103.53
sadness	8,210 (9.97)	5,687 (6.90)	1.85	4.45
surprise	433 (0.53)	863 (1.05)	0.02	0.23
unrecognized	14,941 (18.14)	11,306 (13.73)	-	-
Total	**82,371 (100)**	**82,371 (100)**	**122.95**	**107.35**

Table 1 shows the emotions expressed by doctors and patients during their clinical encounter. After excluding the unknown emotions, we found that both doctors and patients mostly exhibited neutral emotions (61.50% and 71.31%, respectively), followed by sadness (9.97% and 6.90%, respectively). The average duration of doctors mimicking patient facial emotion was 122.95 seconds (*SD.* 107.35).

Bivariate analysis revealed that doctor facial expression of emotions and patient characteristics such as age and gender did not correlate with patient satisfaction. However, we found a negative significant correlation between the proportion of time patients exhibited emotion of sadness and neutral with doctor satisfaction. Specifically, lower duration of time spent by the patient exhibited emotions of sadness ($r = -0.129$, $p = .029$) and neutral ($r = -0.177$, $p = .002$) were associated with higher doctor satisfaction scores. There was no significant correlation between the duration of the doctor's mimicking of the patient's facial expression and patient satisfaction score.

4. Discussion

The result of this study suggests that patient's facial expression, specifically expressions of sadness emotion and neutral can influence doctor's satisfaction level during clinical encounters. This finding aligns with previous study that highlight how negative feeling may affect doctor's behavior and lead to poorer communication [9]. Surprisingly, we found no significant correlation between doctors' facial expressions and patient satisfaction, which could be due to the limitations of our emotion recognition-based artificial empathy model. Our model may have failed to detect weak or infrequent expressions, as well as dynamic movements that were difficult to capture on camera.

In addition, the result of the facial mimicry correlation analysis indicated no significant correlation between doctor's facial mimicry and patient satisfaction. Improving our facial detection through the use of facial action coding schemes, which are better equipped to detect muscle activity, may be necessary to capture facial mimicry as an objective measure of patient satisfaction [10]. However, unlike other studies that mostly used a controlled environment with standard patients and scripted scenarios, our study utilized real-world video data, which can be unpredictable. Therefore, the results may not be statistically significant. Our study has limitations, including its reliance on a single nonverbal modality, self-reported satisfaction questionnaires, and a limited study

setting in a dermatology outpatient clinic. Future studies should consider combining other modalities (such as eye contact, gesture, tone of voice, and body posture) and expanding the study setting to other clinical settings to improve the generalizability of our findings.

5. Conclusions

Our study demonstrated that emotion recognition-based artificial empathy measurement of a person dynamic facial expressions is a valuable source of good nonverbal communication between doctor and patient. Studying individual facial mimicry using real-world video interaction itself is a very challenging task so the outcome seems to largely depend on the study design and measurement definition. In addition, although facial expression is the most dominant factor for exchanging emotions, future research should focus on developing and integrating other nonverbal behavior to provide a more comprehensive understanding of doctor-patient interactions.

Acknowledgments

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