Supporting Bodily Communication in Video based Clinical Consultations

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Abstract
Over the last two decades, video consultations have emerged as an effective practice to offer diagnostic and therapeutic advice to the patients living in rural and remote areas. This thesis aims to understand how bodily expressions such as eye gaze and postures are communicated over video; and how can we design technologies that can communicate such essential information between clinicians and patients. As such, the thesis intends to augment the space of video consultations beyond video medium through the use of computational technologies.

Author Keywords
Video communication; clinical consultation; health; bodily communication.

ACM Classification Keywords
H.4.3 Communications Applications: Computer conferencing, teleconferencing, and videoconferencing.

Research Situation
I am a 2nd year PhD candidate (total duration is 3 years) with Prof. Frank Vetere and Dr. Bernd Ploderer at the University of Melbourne, Australia. I have successfully confirmed my candidature in May 2015. As an interaction designer and information scientist, I am studying the interactions of clinicians and patients with

the underlying video communication technologies for clinical purpose; and identifying ways to improve the interaction through novel design. I have recently finished my first study and currently planning the second study. I will continue working on the second and third study until I submit my thesis by March 2017.

Context and Motivation

HCI has a long tradition in examining bodily communication in the context of video-mediated communication [2,5,10]. Bodily communication, in general, describes conscious and unconscious signs communicated through our body [1]. Examples of bodily expressions include eye contacts, head nods, facial expressions, gestures, posture, and spatial orientation. These signs are not only used to complement verbal communication (e.g., through nods and facial expressions) but they are also used to communicate without words (e.g., through the collaborative gesture of a handshake).

Previous works describe bodily communication as one of the essential parameters in clinical settings where the clinicians and patients exchange bodily cues to establish rapport, articulate the health issue and to treat the patients [6,7,11]. For instance, Heath [7] mentioned that during face-to-face consultations, clinicians maintain constant eye contacts with patients as it comforts the patient in describing their health issue. Additionally, spatial orientation of patients and clinicians with respect to each other as well as to other physical artifacts in the surroundings is also identified as crucial during face-to-face consultations [4].

Bodily communication is, however, limited in video consultations [12,13] that aims to connect patients and clinicians over-a-distance for the purpose of clinical advice. There exist some preliminary evidences that video communication in clinical setting also influences bodily communication in other ways. In this regard, Miller [9] pointed out the difficulties that patients face during video consultations in reading the posture of a clinician. For instance, a clinician - leaning forward - is perceived as concerned about the patient's health issue, whereas a clinician - leaning backward - implies the opposite to the patients. However, an understanding of the significance of other bodily cues, and their impact on clinician-patient interactions during video consultation is missing.

While the importance of bodily communication for face-to-face consultations is well-established, there is a lack of understanding of how bodily information is communicated in video consultations. Early work on video-mediated communication also illustrate that the video callers can reasonably adjust their verbal communication to overcome the limitations of bodily communication [2,8]. However, it is unclear whether and how such limitations and adjustments may impact video-based communication in a clinical setting, particularly, in yielding effective consultation outcome.

This work endeavors to identify and address the challenges in communicating bodily communication during video consultations. Such an understanding is essential to ensure that the introduction of new medium (video) does not hinder the specific needs of clinicians and patients. The thesis intends to encourage design thinking for developing video consultation systems that could enhance the clinician-patient interactions remotely.

Research Phases	Research Methods
Literature Review	Keyword based search for the related topics, methods and researchers within HCI and health
Study 1	Field study; Observation and semi-structured interviews for data collection; Inductive Analysis for analyzing data
Study 2	Lab based testing; Informal discussions to generate design strategy; Thematic coding for data analysis
Study 3	Field Deployments; Observation and semi-structured interviews for data collection; Thematic coding for data analysis

Table 1: Overview of the research methods used across different phases of the research.

Research Question

The main research question investigated in this research is: *How to design communication technologies that can support bodily communication during video based clinical consultations?*

The work began with the general investigation of the existing literature in HCI and health domain, with new ideas being formed and tested as I progressed with the research. The three main research objectives are described below, where each objective defines a separate study.

Objective 1) Understand the existing practices of video based clinical consultations with a focus on bodily communication between patient and clinician. Identify the challenges and design opportunities to communicate key aspects of bodily information over video. **Objective 2)** Identify or propose new design strategy to address the challenges found through Objective 1. **Objective 3)** Create and empirically evaluate a design prototype based on the design strategy devised in Objective 2.

Research Method

This research employs qualitative research practices to get deeper understanding of the video consultations. Table 1 provides an overview of the methods that will be used across the three studies. The first study is an exploratory field study that aims to investigate how bodily cues are communicated over video through semi-structured interviews and observations of video consultations (Obj.1). This study will highlight several design opportunities that I will explore in my second study. The second study aims to explore the design space of video consultation systems through informal discussions with clinicians, patients and designers (Obj. 2). Based upon the insights gained from the second study, I will design a research prototype that will be evaluated in the third study through field deployment in different clinical consultations (Obj.3). In the third study, I will evaluate the user experience with the proposed prototype through observations of video consultations and semi-structured interviews with participants. The study will highlight the issues and challenges that interactions with interactive technologies might bring up during video consultations.

Dissertation Status

In response to my first objective, I started observing video consultations in the domain of physiotherapy at a leading children's hospital in the city. To gain the background knowledge of the key aspects of clinical consultations and to understand the strengths of video consultations, I also observed face-to-face consultations for physiotherapy. Over a period of 8-months, I have observed 10 consultations: 7 video and 3 face-to-face. Along with multiple semi-structured interviews and informal discussions with clinicians and patients, the study revealed several interesting insights.

The study highlights that the clinicians rely upon a wide range of bodily cues related to body movements, postures, and tactile aspects of the patient's body. Clinicians observe the patient's bodily cues right from the start of the consultation, to get a complete picture of their health. Additionally, different bodily cues are relevant across different phases of the consultation: Opening, History Taking, Examination and Diagnosis, Treatment and Closing (as defined by [3]). These bodily cues are naturally available in face-to-face

Phase	Bodily information available in face-to-face consultation	Bodily information available in video consultation (unavailable cues over video are strikethrough)
Opening	Appearance, Facial expression, Movement (walking, sitting), Posture (orientation, engagement), Eye contacts (for attention)	Appearance, Facial expression, ~~Movement (walking, sitting),~~ Posture (orientation, engagement), Eye contacts (for attention)
History Taking	Facial expressions (tears, redness on cheeks, eyes tensed), Tone of speech, Hand gestures (to others and own body), Body movements (depth of squats, hesitation, fatigue), Eye contacts	Facial expressions (tears, redness on cheeks, eyes tensed), Tone of speech, Hand gestures (~~to others~~ and own body), Body movements (~~depth of squats~~, hesitation, ~~fatigue~~), Eye contacts
Examination & Diagnosis	Tactile feedback (body tightness, inflammation, skin temperature), Response to touch (fear, protective spasm, facial expressions), Eye contacts	~~Tactile feedback (body tightness,~~ inflammation,~~ skin temperature)~~, ~~Response to touch (fear, protective spasm, facial expressions)~~, Eye contacts
Treatment	Postures, Body movement (fatigue, flexibility), Facial expression (eyes stressed), Eye contacts	~~Postures~~, ~~Body movement (fatigue, flexibility)~~, Facial expression (eyes stressed), Eye contacts
Closing	Facial expressions, Body language, Eye contacts	Facial expressions, ~~Body language~~, Eye contacts

Table 2: Different aspects of bodily expressions are available across different phases of face-to-face and video consultations.

consultations; However, some of these cues get missed over video. The lack of these bodily cues limited the information space of the clinicians. Consequently, clinicians relied more upon the verbal elaboration of the patient, which did not fulfill the needs aptly. Table 2 provides a summary of the bodily cues that are available in face-to-face and video consultations across different phases of a physiotherapy consultation.

The insights gained from the first study have opened up four design dimensions that will guide my second and third studies. These dimensions speak to: 1) accommodating asymmetries of the roles and responsibilities underlying in the clinical setting; 2) expanding the perspectives of video consultations both in terms of field view and time; 3) augmenting visual acuity with computational (non-visual) technologies; and 4) using sensing technologies to communicate essential tactile information.

Expected Outcomes

The thesis intends to make the following contributions: (1) provide evidence of what aspects of bodily communication are required for clinical assessments in physiotherapy but are not supported by video technologies; (2) highlight opportunities to inform the work of the researchers and designers creating applications for clinical settings; and (3) invoke interests in expanding video consultations from video medium to other computational technologies that can track and communicate the essential bodily cues remotely.

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