# Doctor, Can You See My Squats?: Understanding Bodily Communication in Video Consultations for Physiotherapy

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## ABSTRACT

This paper investigates the challenges of bodily communication during video-based clinical consultations. While previous works describe the lack of eye contact and gestures over video, it is unclear how these limitations impact the course of a clinical consultation, particularly in a domain like physiotherapy where the focus is on improving body movements and functioning. To contribute to this understanding, we conducted observations of 10 naturally occurring video and face-to-face consultations for physiotherapy. We found that clinicians rely on a variety of incidental bodily cues and fine-details of body movements to assess and examine the patient. These bodily cues were noticeable during face-to-face consultations; however, a variety of bodily cues got missed over video. Consequently, video consultations became conversational where the clinicians used verbal conduct to get a fair understanding of the patient's health. To guide design of future video consultation systems, we reflect on our understanding as 4 design sensitivities: Visual Acuity, Field-of-view, Clinical Asymmetries, and Time Sequence.

## Author Keywords

Video communication; clinical consultation; health; physiotherapy; bodily communication; nonverbal communication.

## ACM Classification Keywords

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

## INTRODUCTION

Bodily communication is defined as a crucial aspect of clinical consultations. In a clinical setting, bodily communication is used to establish rapport, to articulate the health issue and to suggest the treatment during a clinical discourse [21,22,24,35]. For instance, patients often find it

hard to clearly describe their bodily symptoms orally and instead rely on nonverbal cues such as eye gaze, facial expression, and body language to communicate their feelings [21,22]. Clinicians, on the other hand, keenly observe such cues to understand patient's emotional and physical wellbeing [21]. For example, a physiotherapist pays attention to the patient's distorted and careful movements to check patient's recovery [4,28]. Similarly, a psychiatrist makes use of patient's abnormal body language, pale face, and hesitation in speaking to understand their stress level [13].

Due to the growing needs to support health services at remote geographical locations, video based consultations have emerged as a viable approach to offer clinical consultations to remote patients [41,44]. So far, the focus of video consultations has remained on establishing audio and video connections between clinician and patient to discuss varied health domains [5,12,13,15]. However, such an audio-video approach on clinical consultations might not be sufficient in supporting all the essential clinician-patient interactions, particularly, the ones that happen through bodily communication. For instance, it is unknown how a physiotherapist sees the distorted movements of their patients over video.

Studying video consultations becomes crucial as prior works in non-clinical settings suggests that certain bodily cues get missed when we move our conversation from physical space to video [14,18,23,31]. For instance, these works suggest that video callers face difficulties in communicating eye gaze, spatial orientation, and hand gestures over video. In response, they adjust their verbal conduct to communicate the intended meaning. However, what remains unclear is whether and how the diminished bodily communication influences the clinician-patient interactions during video consultations. While adjustments through verbal communication can be made, they may not be sufficient for an effective consultation outcome.

This research aims to understand the significance and challenges of bodily communication during video consultations. We chose physiotherapy as a first domain of inquiry because of the increased demand and growing practice of video-based physiotherapy within Australia [1]. We report on 10 naturally occurring video and face-to-face consultations for physiotherapy that were organized by the clinicians to address their patients' needs. We highlight

nine challenges that clinicians faced in interpreting patient's bodily cues across six phases of video consultation.

This paper makes four core contributions. Firstly, the paper extends the literature on clinical consultations by offering the first conceptual understanding of how bodily communication is employed across six phases of physiotherapy related consultations. To this end, our work extends the established phases of face-to-face consultations [6] to define the course of video-based consultations. Secondly, this work expands our understanding of video-mediated communication by describing nine challenges that clinicians faced in understanding bodily information during video consultations. Thirdly, we contribute to the knowledge of bodily communication by providing a detailed narration of the bodily cues used to fulfill varied routines of physiotherapy consultations. Finally, through identifying four design sensitivities, we point to new directions for video consultations that make use of other computational technologies.

## RELATED WORK

Argyle [3] defined bodily communication as the conscious and unconscious non-verbal signals that we use to serve five purposes during social encounters: 1) to express emotions through facial expressions, and gaze; 2) to support our speech using paralinguistic qualities such as pitch, stress, and hesitations; 3) to represent self through different aspects of appearance and body language; 4) to communicate the interpersonal attitudes through touch and gaze; and 5) to fulfill the rituals of a social setting through spatial orientation and gestures. These non-verbal cues are closely intertwined with verbal conversations and are best understood in the given context. William et al. [45] further highlight the importance of bodily communication by suggesting that 55% of our conversation happens through bodily cues and the rest is contributed by verbal conduct.

We discuss the existing literature on face-to-face and video consultations around bodily communication to establish the background for the study.

### Bodily Communication in Face-to-Face Consultations

A face-to-face clinical consultation happens between co-located patient and clinician. In such face-to-face setting, bodily communication not only enhances the overall communication between patient and clinician, but also help in gradually succeeding the consultation through different phases [21,22]. Based on the type of activities that clinicians perform, a typical face-to-face consultation is categorized into the following six distinct but overlapping phases [7]:

1. **Opening** – A face-to-face consultation starts with an *opening phase*, where clinician attempts to build a rapport with the patient through informal conversations.
2. **History Taking** – Once the rapport is established, the clinician extends the consultation to the second phase of *history taking*. Clinician attempts to discover the reasons behind patient's attendance. Patient puts forward their health related complaints, and updates the clinician with the results of the ongoing treatment.
3. **Examination** – After listening to the patient's medical history, consultation proceeds to the third phase of *examination*. The clinician conducts a verbal and/or physical examination of the patient to understand the health issue.
4. **Diagnosis** – The fourth phase is of *diagnosis* where the clinician explains the outcome of examination to the patient and discusses the potential causes and effects of the underlying health condition.
5. **Treatment** – After the diagnosis, *treatment* phase begins. The clinician suggests a medication or therapy to the patient to recover from the current health issue.
6. **Ending** – Finally, the clinician terminates the consultation through small talk and schedules a next appointment, if required.

Bodily communication is critical across all phases of a consultation [21,22,24,36]. For instance, in the opening phase, patients take frequent pauses while describing their health issue to check if the clinician is following them or not. Clinicians also use bodily gestures such as head nods to acknowledge their participation in the dialogue and to encourage patients to elaborate further. Additionally, clinicians maintain constant eye contact with patient to make them comfortable in discussing their health issue [22]. Moreover, appropriate spatial orientation of clinician with respect to patient is also considered critical in inviting patient's participation in the discussion [8,24].

During subsequent consultation phases, clinicians observe a series of bodily cues to understand the underlying health issue and its severity [22]. For instance, the cracking sound in breathing, vibrating gesture near the mouth, and efforts in speaking altogether illustrate the patient's health issue. Clinicians pay attention to these fine-details to diagnose the disease along with other visible aspects such as skin color [33]. As such, clinicians utilize varied bodily cues of the patient to interpret the underlying health issue and to understand the patient's sufferings. While, on the other hand, patients utilize the clinicians bodily information to develop trust in the clinician and in the overall treatment.

### Bodily Communication in Video Consultations

Video consultations (or teleconsultations) are forms of clinical consultations where distantly located clinicians and patients utilize video conferencing tools for the purpose of diagnostic or therapeutic advice [43,46]. Over the last two decades, video consultations have become a popular approach for patients living in remote areas and having mobility issues. Previous works [15,16,31] have explored validity and technical feasibility of video consultations in supporting a variety of clinical domains such as speech pathology [2] and surgery [39]. As yet, the advancements in such systems have been the shift from desktop computers to mobile devices (e.g., tablets and phones) and the increase in

network bandwidth to allow better quality video and audio streaming [5,12,13]. We argue that these advancements in audio and visual technology can fairly supported clinical consultations in domains like dermatology where the relevant health concern is directly visible on body. However, its applicability to domains like physiotherapy can be questioned where the assessment heavily relies on the fine-grained details of patient's body movements. Recent works in HCI have explored the potential of Kinect based tracking [27,41] and aural feedback [38] to get details of patient's movements during exercise. However, these advancements will need in-depth exploration and maturity before they can be used in real-time video consultations.

In the context of video consultations, Miller [30,31] provided a preliminary understanding of the importance of bodily communication. He indicated that patients try to understand clinician's engagement in the ongoing video conversation through their body language. 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. Miller [30] also stated that during a video consultation, clinicians spend less time in socializing (e.g. having informal talks) and converse directly about the patient's health concern. Additionally, the video medium also limits opportunities for haptic interactions with the clinician, which patients always find as comforting according to Placebo Effect [9]. The lack of interpersonal moments and social interactions during video consultations are described as potential risks in establishing an empathetic relationship between clinician and patient [30,40].

Learning from previous works on video communication in non-clinical setting, we know that video callers miss out certain bodily cues such as hand gestures, eye gaze and spatial orientation during video conferencing [14,18,23,32]. However, such bodily cues are always emphasized as crucial part of clinician-patient interactions during face-to-face consultations [21,22]. This raises the need to understand whether video technology can support the essential bodily information required to accomplish different clinical tasks. Such an understanding is required to ensure that the introduction of video technology does not hinder the specific needs of clinicians and patients, and to guide the design of future technologies that could further enhance the clinician-patient interactions.

## FIELD STUDY

The aim of this study is to investigate the role of bodily communication in video consultations, and to identify the challenges in communicating such information over video. To achieve our goals, we conducted a qualitative field inquiry of both video and face-to-face consultations for physiotherapy. We also studied face-to-face consultations in order to understand the differences in clinician-patient interactions during video consultations. Studying face-to-face consultations provided us with background knowledge on how a consultation for physiotherapy happens in a natural environment, and what are the essential activities of a consultation. We utilized this understanding to compare the strengths and limitations of video technology to support the required clinician-patient interactions. Ethics to conduct this study was approved by the ethics committee of the hospital and the university.

### Research Context

The study was conducted in collaboration with the Pain Management Team at Royal Children's Hospital, Australia over a period of 8 months. We chose to study physiotherapy for chronic pain as a first domain of inquiry because of its growing rate within Australia: chronic pain is the third most costly health condition and nearly 30% of children suffer from it [34]. Chronic pain is also a long-term condition where patients continue seeing physiotherapists for months or years, which can severely disrupt education, work life and social connections with peers [25]. This is particularly significant, as some patients from our study had to travel as far as 4000km to visit the hospital. In response to these community needs, the hospital started to offer video consultations for physiotherapy from past 2 years. Our research was, thus, partially inspired by the local need and emerging practice at the hospital.

### Study Setup

We observed 10 naturally occurring consultations organized by 2 physiotherapists: Phil and Paul, for 5 patients: Anna, Jenny, Laura, Camilla, and Susan (names changed). All patients aged between 10-17 years and were having varied chronic pain symptoms: Anna and Jenny had pain in multiple body parts, Laura had pain in her ankle, Camilla had shoulder pain, and Susan had pain in her head. Table 1 enumerates all sessions in the order of their occurrence over 8 months. All consultations were follow-up consultations. Besides the patient and clinician, the consultations involved other people at different times as mentioned in Table 1. All face-to-face consultations happened at the hospital. We observed the video consultations from the clinician's side at the hospital, while patients joined in the video consultations from their home (sessions 1, 6, 8-10), or from the local hospital with their GP (sessions 4 & 5).

The physiotherapists used the following devices during video consultations: a desktop computer with webcam, laptop, telephone and speaker. The hospital department has a dedicated room to organize video consultations where two computer screens and a telephone are placed together on a table. Both clinicians used only one screen for organizing the video consultations, except for the last session where Phil used both the screens. Telephone was used to call patients when there were issues in the video call. Patients, on the other hand, used their laptop as it offered flexibility of moving the camera according to their needs. Furthermore, GoToMeeting [19] and HealthDirect [20] software were used to make video calls. Both the video and face-to-face consultations went for around 60 minutes.

| Session | Type of Consultation | Child (patient) | Others at patient end | Physiotherapist | Others at clinician end |
|---------|----------------------|-----------------|-----------------------|-----------------|-------------------------|
| 1 | Video | Anna | Mother | Phil | Pain Consultant |
| 2 | Face-to-face | Anna | Mother, Father | Phil | Occupational Therapist, Psychologist |
| 3 | Face-to-face | Anna | Mother | Phil | Psychologist |
| 4 | Video | Anna | Mother, GP | Phil | -- |
| 5 | Video | Laura | Mother, GP | Phil | -- |
| 6 | Video | Anna | Mother | Phil | Occupational Therapist |
| 7 | Face-to-face | Laura | Mother | Phil | Pain Consultant, 2 Trainees |
| 8 | Video | Camilla | -- | Phil | Telehealth Manager |
| 9 | Video | Jenny | Mother | Paul | -- |
| 10 | Video | Susan | Mother, Father | Phil | -- |

Table 1: Details of the observed consultations in the order of their occurrence. These sessions were observed by the first author from the physiotherapist's end. (Names of the participants are changed to preserve anonymity.)

## Methodology

Our research methods were informed by the sensitivity of the clinical setting and the hospital ethics guidelines. For instance, since the consultations were organized for young patients (under 18 years) with chronic health conditions, we aimed to keep the setting naturalistic and comforting. We, therefore, did not video-record the sessions nor did we photographed the participants. Additionally, as the patients were located in remote areas, the hospital's ethics committee only allowed observations from clinician end, which reduced our option to observe video consultations from the patient end.

We recruited clinicians based on their practice of organizing video consultations, while clinicians recruited patients as per their health conditions. Also, to reduce the variation in communication style and practices of every clinician, we observed video and face-to-face consultations with same clinicians. Additionally, we aimed to observe the same patients repeatedly in order to understand the suitability of video and face-to-face consultations at different times.

In line with the challenges discussed by Blandford et al. [6], we faced several challenges in studying video consultations that limited our data collection and stretched our study to 8 months. We briefly discuss four key methodological challenges. Firstly, since video consultation is a relatively new practice, most clinicians do not choose to undertake a video consultation. For those that do, their patients do not always agree. Thus, finding a suitable clinician-patient pair that utilizes video consultation was difficult for us. Secondly consultation sessions are structured around the patient's needs. Thus, the consultation frequency for each patient can vary from weekly to several months. Thirdly, video consultations often involve clinicians from different hospitals at remote ends. Their participation in the study might require separate ethics approval from the respective hospital, which is not always feasible given the lengthy process of obtaining ethics approval. This further limited our access to video consultations. Finally, consultations involving vulnerable patients or sensitive conversations are typically not open for observation. Together, these challenges create a complex research environment, which needed to be approached with care and sensitivity.

### Data Collection

In line with earlier studies [6,8], we used three methods to collect rich data: participant observations, semi-structured interviews and informal conversations.

The first author conducted observations of 10 video and face-to-face consultations. The sample size is in line with the recent study on face-to-face consultations [29]. All observations were conducted from the clinician's end without causing any interruptions to the ongoing session. The researcher took field-notes during the consultation, which were elaborated later. Also, we took photographs of the setup (excluding participants) to understand the arrangement of underlying technology. Secondly, to understand the subjective experience with video consultations, we also conducted 10 semi-structured interviews: 7 with clinicians and 3 with patients (and caregivers together). Interviews varied from 20-40 minutes and were audio recorded.

Finally, we capitalized on every opportunity to have informal chats with participants to reflect upon the latest event in a think-aloud manner. With clinicians, we initiated conversation while they were setting up for the consultation, resolving technical issues during the session, and when the session was over. Similarly, we had informal conversations with patients and caregivers when they were waiting for the clinician, or while they were leaving the room after a face-to-face consultation. These conversations varied from a few minutes to even half an hour and were noted down as field-notes.

### Data Analysis

Our data collection and analysis process were closely intertwined. We utilized Inductive Analysis [35] to iteratively collect and analyze the data. We also used Member Checking [37] with physiotherapists to validate

and get feedback on the emerging themes. We went through several rounds of coding for our field notes and interview transcriptions, which started from the first day of data collection. The first author initially coded the data in the hand-written field notes. The emerging trends and themes were created as memos, and were discussed with other authors regularly to reflect upon the data. Lastly, we analyzed the data with the lens of bodily communication to identify patterns of bodily cues during video and face-to-face consultations. Based upon the relevance of bodily cues, we structured the key ideas across 6 known phases of face-to-face consultations [7]: Opening, History Taking, Examination & Diagnosis, Treatment, and Ending.

**FINDINGS**
Below we discuss the challenges of bodily communication in video consultations. Each challenge is marked with enumeration such as C1, C2 and so on. Within each challenge, we first narrate how bodily information was used in face-to-face consultations, and then we bring the contrast with video consultations. Table 2 lists the differences in bodily cues that are communicated across six phases of face-to-face and video consultations.

**Phase 1: Opening**
In this phase, clinicians checked for the following bodily cues of the patient: movement patterns, body posture, orientation and appearance.

*C1: Limited Availability of Incidental Cues*
During a face-to-face consultation, clinicians started their examination from the moment they see the patient as they walked into the consultation room. They checked a number of bodily signals related to walking, sitting, and talking style that patients communicated unconsciously. For example, in session 2 (face-to-face), Phil noticed Anna's posture as she sat cuddling to her front for the entire session. Similarly, in session 7 (face-to-face), Phil noticed that Laura did not rest her feet on the floor, whereas her feet were dispersed away from each other with only toes touching the floor. These body postures of Anna and Laura respectively indicated pain severity in their ribs and ankles. Clinicians also checked how the patient took their seat e.g., did they hesitate in sitting down because of pain. Furthermore, they checked the spatial arrangement of the patients with respect to others e.g., if they preferred to sit closer to their mother or father. From these observations, clinicians gained information related to the behavioral and emotional state of the patient.

On the other hand, a video consultation was more direct as the clinician saw the patient directly sitting in front of the camera. Consequently, clinicians failed to see some crucial bodily movements of the patient related to walking and sitting. However, clinicians then utilized other cues that were available over video such as body posture and orientation, to understand emotional and physical state of the patient. For instance, in session 9, Jenny sat in a way that she could see Paul (over video) but not her mother

(sitting next to her), as she had her back towards her. This body orientation of Jenny illustrated emotional struggle between Jenny and her mother. Paul picked up this cue and tried to make Jenny aware of her responsibilities towards her parents.

*C2: Limited Opportunities for Small Talk*
We found that during face-to-face consultations, clinicians tried to build rapport with patients by initiating small talk around different topics such as weather, journey and their appearance. Clinicians introduced most of the informal conversation when the patient was entering or settling down in the consultation room. Having small talk not only helped the patient to open up with the clinician, but also provided information to the clinician related to the patient's emotional state. For instance, in session 3 (face-to-face), Phil gave Anna a complement on her new hair-style and tried to remember how the new style was different from her earlier one. Anna described how she changed her hair-style using hand gestures to show hair length, "*I do a change every time my pain gets severe. Earlier I had very long hair, then it was medium and now it is very short.*" With this, Phil understood that Anna's pain had not changed much and that she was using different strategies to overcome her pain. Similarly, during session 7, the pain consultant invoked conversations around Laura's height by saying, "*Laura, have you grown up a bit? You look tall today.*" Everyone started having a cheerful conversation on how she was looking in her last visit.

However, during video consultations, as everyone had already taken up their seats, there was a sense that clinicians should directly discuss the purpose of their meeting. Additionally, as the complete view of the patient was not available, clinicians did not get significant cues related to body movements, or (full body) appearance of the patient to spontaneously introduce small talk. Moreover, instead of having informal conversations, the video consultation started by making sure that the technology was working properly. And if there were issues, clinicians had to make alternate arrangements. Consequently, clinicians remained occupied and stressed in the beginning of the session, which, in turn, did not leave sufficient room to introduce short talk. However, clinicians tried to create a friendly environment by making jokes around the technical issues. For instance, in session 6 (video), Phil realized the delay in video streaming at Anna's end as he was getting his voice back. He then responded, "*Now if I tell you a joke, I will have to wait for a while to hear the laughter.*" At other times, clinicians inquired about the technical issues in a funny way. For instance, in session 8, the telehealth manager asked Camilla about the video quality, "*How clear is the video? Can you see the wrinkles on my face?*".

**Phase 2: History Taking**
During this phase, the essential bodily cues are facial expressions, tone of speech, hand gestures, eye contact and fine-details of body movements.

| Phase No. | Phase | Bodily cues in face-to-face consultation | Bodily cues in video consultation |
|---|---|---|---|
| 1 | Opening | • Movement (walking, sitting)<br>• Posture<br>• Orientation<br>• Appearance (**full body**) | • N/A<br>• Posture<br>• Orientation<br>• Appearance (**upper torso**) |
| 2 | History Taking | • Facial expressions (**tears, red cheeks,** tensed eyes**)**<br>• Tone of speech (hesitation, pitch)<br>• Hand gestures<br>• Eye contact (for encouragement)<br>• Body movements (range of movement, smoothness, **weight distribution, depth of squats**, **fatigue**) | • Facial expressions (tensed eyes)<br>• Tone of speech (hesitation, pitch)<br>• Hand gestures<br>• Eye contact (for encouragement, **willingness to engage**)<br>• Body movements (range of movement, smoothness) |
| 3, 4 | Examination & Diagnosis | • Touch (**to patient's body**)<br>• Tactile feedback (body tightness, inflammation, skin temperature)<br>• Response to touch (fear, protective spasm**)**<br>• N/A | • Touch (**to own body**)<br>• N/A<br><br>• N/A<br>• Body Movements |
| 5 | Treatment | • Full body posture<br>• Gestures (**to others**)<br>• Touch (**to patient's body**)<br>• Tone of speech (emphasis)<br>• Body movement (fatigue)<br>• Facial expressions | • N/A<br>• Gestures (**to own body**)<br>• Touch (**to own body**)<br>• Tone of speech (emphasis, **pitch**)<br>• N/A<br>• N/A |
| 6 | Closing | • Facial expressions<br>• Body language | • Facial expressions<br>• N/A |

**Table 2: Bodily cues are communicated differently across 6 phases of face-to-face and video consultations. Text written in bold indicates the difference in bodily cues, while the text 'N/A' signifies the absence of a bodily cue.**

*C3: Elaborating Symptoms Require Vocal Expertise*
During face-to-face consultations, clinician looked for different bodily cues that patient communicated while describing their symptoms. Phil explained that since pain is subjective, description of the same symptoms vary for different people. As a result, clinicians gave more emphasis to patient's bodily information than their vocal explanation. For instance, in session 2 (face-to-face), when Phil asked Anna about her pain, she said, "*Not so good*". She could not say anything more as she got overwhelmed. Her cheeks got red, her eyes were filled with tears, and her tone suddenly got heavy. Seeing these cues, Phil understood that her pain severity has not changed much.

However, the fine-grained details of the patients' facial expressions and other bodily cues were not always available over video. Clinicians therefore, majorly relied on the verbal explanation of the patient (or caregiver). For instance, during session 1 (video), Anna described her pain as fifty-fifty. She did not say anything else, but looked down. Anna's mother then described her pain symptoms with hand gestures. She moved her left hand up and down with great intensity and high frequency, to illustrate her pain characteristics. However, her hand movements did not completely fall in the camera range and thus were missed. Phil got a fair understanding of Anna's health through the verbal explanation and hand gestures of her mother. This

limitation of video complicated the situation for patients who were not good in explaining things verbally. For instance, Laura was very shy and never participated in any conversation with Phil. Her expressions were always limited to binary answers on whether she was having pain in certain body parts or not. Phil, therefore, relied on her mother's verbal description. Although Laura's mother did a good job in describing her health issue, but Phil always missed the subjective information from Laura. As a result, Phil was reluctant in seeing Laura over video.

*C4: Performing Certain Exercises Feel Awkward*
During face-to-face consultations, patient showed a variety of exercises that they had been following from their last consultation. For instance, in session 7 (face-to-face), Laura performed a range of exercises that required her to lie down on the plinth, sat on the floor, laid on the floor against the wall, and bending against the wall. While the patients were performing the exercises, clinicians encouraged the patients by maintaining constant eye contact. At times, they also performed exercises with patients to make them comfortable. For instance, in session 7 (face-to-face), Phil realized that the presence of multiple clinicians could be intimidating for Laura as she was bit introverted. Therefore, to comfort her, they performed all the exercises together. As Laura was doing the exercises, Phil looked for the required bodily cues to check her improvement.

In video consultations, patients did not demonstrate all the exercises. They only showed a couple of them that clinicians asked for. Majorly, patients only performed the standing exercises such as tip-toes, and squats. However, there were instances when patients felt awkward to perform some particular exercises over video. For example, in session 8 (video), Phil asked Camilla to show her shoulder exercises that required her lying down on the bed. Camilla initially showed reluctance in doing the exercise and then bargained with Phil on the number of repetitions. Later in the conversation with observer, Camilla mentioned that she felt awkward to lie down on her bed during video consultation, which she thought was perfectly fine in face-to-face consultations. She then described that over video she did not get any proper feedback on how she was visible on camera as she was away from the camera. This unease was possibly because she was not sure if the camera was capturing her whole body or if it was more focused on certain body part. Additionally, as she was making the video call from her bedroom in the absence of any parent, the private setting might have added more to her awkwardness.

*C5: Subtle Differences in the Exercises are Difficult to Observe*
During face-to-face consultations, a clinician looks for subtle differences in the exercises of the patient e.g., depth of squats, range of arm movement, and weight distribution across different body parts. To this end, they moved around the patient to understand the angular differences, or the body postures. For instance, in session 3 (face-to-face), when Anna was doing squats against the wall, Phil moved from his chair and stood sideways to see how far she was bending. For other exercises that Anna was performing while sitting on the chair, Phil changed Anna's back from tilted to straight by pressing it while she continued doing the exercise. Similarly in session 7 (face-to-face), when Laura performed tiptoes, Phil checked fatigue in her legs through shivering and weight distribution over legs.

However, over video, observing subtle differences in the exercises was not straight-forward for the clinicians. Most of the times, patients changed their camera arrangement to communicate the required information to the clinician. For instance, in session 8 (video), when Camilla was showing the shoulder and hand exercises by lying down on her bed, Phil wanted to check the range of her hands and shoulder movements. However, he could not get that information as Camilla's laptop (camera) was kept away from the bed. Later in the session, Phil asked Camilla to demonstrate another set of hand movements, while sitting on the chair. This time Phil guided Camilla about how to position the camera so that he could get a good view of her hand movements. Following the instructions, Camilla sat sideways on the chair and Phil could then see the range of and smoothness in her hand movements, and facial expressions (e.g., eyes closed and stressed).

On the other hand, checking Laura's improvement in her ankle was not easy for Phil to check over video. Since her exercises were related to ankles, checking the subtle differences required the camera to be more focused on her ankles. Additionally, at some times, Phil also wanted to check her full-body posture and weight distribution with different exercises. However, he could not observe that fine-grained information related to her movements over video. Consequently, Phil decided not to organize video consultations for her, and rather meet face-to-face.

**Phase 3 & 4: Examination and Diagnosis**
In this phase, the essential bodily cues are tactile characteristics, response to touch, touch and body movements.

*C6: Hands-on Examination is Not Possible*
During face-to-face consultations, clinicians performed physical examination of the patients by pressing, touching and feeling different body parts. For instance, in session 2 (face-to-face), Phil performed Anna's examination, while she was lying on the plinth. Phil pressed the area around her stomach and ribs to figure out the location of pain. While he was pressing, Anna kept her hands near her rib to respond to any touch that could create more pain (protective spasm). Phil inquired about the pain intensity as he continued on pressing. Since Anna had inflammation near her ribs, Phil asked her to feel his ribs first and then describe him how it feels different in her body. In this way, both Phil and Anna touched each other ribs to gain good understanding of Anna's health. Physical examination, therefore, not only provided tactile feedback related to the feel (tightness) of her tissue, body inflammation, and skin temperature but also provided information related to her emotional state.

As one can imagine, conducting hands-on examination was not possible over video. However, clinicians tried to conduct the oral examination whenever required in the video consultations. For instance, in session 1 (video), Pain consultant asked different questions from Anna, *"Is it sensitive to touch on your body?", "Is your t-shirt tolerable?"* Anna replied to these questions and described verbally about her health condition. Later, Phil also orally examined the pain points of Anna through different ways. In this regard, he adjusted his t-shirt to show his ribs to Anna over video and asked her to follow him from top of her t-shirt. Following Phil, Anna pressed the area around her ribs and told him the pain points. Additionally, Phil also inquired pain location associated with different movements such as bending his neck sideways, twisting to one side and breathing patterns. Anna repeated these movements and described pain points. Although Anna followed what Phil suggested but she was afraid to touch her body because of the extreme pain. Consequently, Phil could not get sufficient information of Anna's issue, and therefore, he scheduled the next consultation as face-to-face.

## C7: Environmental Probes are Out-of-View

During face-to-face consultations, clinicians sometimes examined the patient's health issue by asking them to do certain tasks in the immediate environment. They interleaved such tasks within their conversation such that patient did not realize them as specific tasks. The intention behind these tasks was to check the spontaneous reaction of the patient without giving much time to them to ponder and alter their body movements. For instance, in session 3 (face-to-face), Phil wanted to check Anna's decision making power as she was shortly resuming her schooling. Phil asked Anna to stand up on the plinth in the flow of their conversation. Anna thought for a while and then did not do it. Phil was happy on Anna's decision, as it could have hurt her knees. Since Phil was available in the room, it was easy for him to stop Anna if she were to try it.

During video consultations, clinicians did not have any information related to the patient's immediate surroundings. The webcam at both ends was mainly focused on the face and covered the upper torso of the participants. Such an arrangement although supported eye contact between clinician and patient, but restrained the clinicians in examining unconscious actions of the patient with different artifacts in the surrounding.

## Phase 5: Treatment

In this phase, the essential cues for clinicians are body postures, hand gestures, touch, tone of speech, body movements and facial expressions.

## C8: Limited Scope to Recommend New Exercises

During face-to-face consultations, clinicians suggested new exercises to patients after seeing their progress. These exercises sometimes were completely different from what patients were already following, while at other times, they were slightly modified. The important aspect of the exercises was to follow the correct body posture so as to gain the necessary outcome. In this regard, clinicians first demonstrated the new exercise to the patient and then asked the patient to perform it together. For instance, in session 7 (face-to-face), Phil demonstrated a new exercise to Laura where he crossed his legs, and bent down to touch the floor with his hands. As Laura was following Phil, he guided her how to maintain the correct posture. He also laid emphasis on the correct posture by touching her back and using hand gestures to describe the body parts that will be under stress during the exercise. Additionally, clinicians paid attention to patient's fatigue and facial expressions to check their capability of doing the recommended exercise. Sometimes, after showing all new exercises, clinicians also made another physical examination to check if the exercises had caused any inflammation or had alleviated her pain.

During video consultations, clinicians never suggested a completely new exercise to the patient as they were unsure of getting a good understanding of the patient's postures over video. To this end, the clinicians limited the treatment only to slightly tweaking the already suggested exercises. Although clinicians always wanted to explain the exercises along with a short demonstration, however, the technical issues related to video and audio quality sometimes enforced them to describe the exercises orally. For instance, in session 8 (video), after reviewing Camilla's progress, Phil wanted to show her a new exercise of standing push-ups against wall. However, Camilla reported that Phil's video on her side was blurred. As a result, Phil verbally described the exercise and stressed on the required body posture through hand gesture. Using hand as an emblem, he repeated the posture twice in a low pitch. Camilla was familiar with the exercise and thus grasped it very quickly. Phil still wanted to check her posture, therefore, asked her to show it by standing against the wall. The bad video quality further restricted him to see her complete posture. And at the end, he had to verbally confirm that Camilla was following the posture correctly.

## Phase 6: Ending

In this phase, clinicians checked patient's facial expressions and body language to understand their emotional state.

## C9: No Room to Accommodate After Thoughts

To schedule the next appointment during face-to-face consultations, clinicians opened up their calendar and shared the desktop screen with the patient (and caregiver) to find a suitable date. While discussing the possible dates, patients and caregivers talked about their plans that sometimes opened up new topics for immediate discussion. For instance, during session 3 (face-to-face), Anna talked about the school trip in which she was very much interested to go. Phil got bit worried on how would she handle her pain during the trip. They then discussed the strategies and made a plan for the trip. Additionally, there were opportunities for patients to bring after-thoughts of the consultation, while leaving the room. Clinicians also introduced small talk related to their journey back home and other school activities, as they walked out together. While patients were leaving the room, clinicians looked for the patients' facial expressions and body language to understand their emotional state after the consultation. Phil described that when patients are happy with the consultation, they walk and talk more confidently and smile more as they leave the consultation room.

Ending of a video consultation was very short and direct. Clinicians could not observe patient's body language as everyone continued sitting in front of the camera and then they directly disconnected the call. Additionally, since there was no shared calendar, both ends checked their personal calendar to schedule the next appointment. Such scheduling not only took clinician's attention away from the patient but also did not allow any new topic to surface up. Finally, in the absence of any opportunistic conversations, clinicians vocally confirmed if the patient had any other concerns to discuss.

## DISCUSSION

Our study illustrated that clinicians rely on a wide range of bodily information across different phases of a consultation. These cues are naturally available for clinicians during face-to-face consultations, however, a wide-range of bodily cues were not present during video consultations. Table 3 summarizes the challenges faced by clinicians during video consultations. Some of these cues got missed because of the different structure that video consultations follow. For instance, the incidental cues related to walking and talking style of the patient were missed (C1), as the video consultation started and ended with patients sitting in front of the camera. On the other hand, some bodily cues were not available during video consultations because of the limitation of video technology. For instance, subtle differences in the exercises such as depth of squats, and range of movements were not distinguishable over video (C5). Similarly, tactile information related to patient's body and their response to touch was missed because of the limitation of video technology in supporting hands-on examination (C6).

There were instances when the limited access to bodily cues over video posed severe challenges to clinicians in appropriately assessing the patient's health condition. In such scenarios, clinicians scheduled next appointment as face-to-face so that they can conduct the necessary examination. For instance, when Phil did not get a complete understanding of Anna's health over video, he called her for a face-to-face consultation. Additionally, video consultation did not prove beneficial for patients like Laura who were shy in elaborating their symptoms and where the improvement was not noticeable over video (C3). In this regard, factors like visibility of health issue over video and patient's ability in narrating their experience influenced the success of a video consultation. As such, clinicians mainly used video consultations to organize follow-up consultations for patients with whom they have already established a good rapport after a couple of face-to-face consultations. Moreover, they often switched from video to face-to-face consultations to perform timely examination as well as to recommend required treatment (new exercises). To this end, video consultations were not treated as the replacement of face-to-face consultations, but rather they were organized in adjunct to face-to-face consultations.

In the current practices of video consultations, technology carries a strong voice where participants arranged their interactions to address the technological limitations in supporting bodily communication. In the lack of bodily cues, clinicians adopted new practices to obtain the required information. For instance, clinicians introduced a show-and-tell strategy where they demonstrated different activities by referring to their body, while patients followed the actions and described the required information. Similarly, patients changed their orientation depending upon the arrangement and capability of the underlying technology. The dominance of technology in clinical

| Phases | Challenges encountered during video consultations |
|--------|---------------------------------------------------|
| Opening | C1: Limited availability of incidental cues |
| | C2: Limited opportunities for small talk |
| History Taking | C3: Elaborating symptoms require vocal expertise |
| | C4: Performing certain exercises feel awkward |
| | C5: Subtle differences in the exercises are difficult to observe |
| Examination & Diagnosis | C6: Hands-on examination is not possible |
| | C7: Environmental probes are out-of-view |
| Treatment | C8: Limited scope to recommend new exercises |
| Ending | C9: No room to accommodate after thoughts |

**Table 3: Challenges encountered during video consultations.**

consultations has also raised concerns of depersonalizing clinician-patient relationship [30] and drowning out the voice of patients with technology [40]. Future technologies for video consultations should therefore be designed to support the essential bodily communication so that the relationship between clinician and patient can be nurtured.

## DESIGN SENSITIVITIES

To inform the work of researchers and designers creating applications for video consultations, we articulate our understanding of bodily communication as four *design sensitivities*. Design sensitivity guides designers to consider key relevant areas, while designing technologies for the given context [9]. Design sensitivity does not prescribe any strict guidelines or solutions, but rather inspire creative design thinking by defining areas for discussion.

### Visual Acuity

Visual acuity is the ability of eye to visually discriminate between different forms [10]. In the context of physiotherapy, visual acuity is related to the clinician's ability to discern subtle changes in the exercises of a patient, e.g., depth of squats, range of arm movement, point of balance, and weight distribution [4,28]. We found that during video consultations, clinicians could not observe the subtle differences in the exercises of the patients (C5), which were easily accessible in face-to-face consultations. Gaver [17] explained the reason behind the limited visual acuity of video systems. He described that the level of details on video is always fixed at pixel size. And since video communicates high-frequency 3D information in one frame, even the sharpest pixel will only provide the structure but not the real details of the scene.

Instead of improving the visual quality of the video technology, we suggest to augment video consultations beyond visual acuity. In this regard, squeezable interfaces [44] and wearable technologies [48] have the potential to capture fine-details of the patient's movements such as

weight distribution and range of movements. Additionally, Microsoft Kinect based systems [47] and Vicon Tracking system e.g., [41] could also be utilized to get orientation and posture related information of the patient. Since these technologies provide information in abstract visualization, patient's privacy can also be maintained.

### Field-of-view

Field-of-view is the extent of a physical space that can be seen at a given time. In our study, we found that clinicians were restricted by the single view of the patient's space. For instance, since the webcam remained focused on the upper torso, clinicians could not see the patient's body language during conversation. The single and constrained view also limited their access to patient's environmental probes, which they typically utilize to perform covert examination (C7). Having a single field-of-view also limited their understanding of the patient's body movements; consequently they refrained to suggest new exercises over video (C8).

We believe that video consultations will greatly benefit by expanding the spatial information of the patient end. One plausible solution is to make the video call on a bigger screen with a wide-angle webcam. Additionally, field-of-view can also be widened by installing multiple cameras at the patient's end, as illustrated by [18,26,39]. However, to address the issue of patient's discomfort discussed earlier, the data captured from multiple cameras need not be presented as video to the clinicians. Rather it could be abstract visualizations such as graphs of angular movements, as explored by Tang et al. [41]. As such, the visualization should offer quick facts to the clinicians regarding the patient's body movements so that they can continue with the main purpose of the consultation.

### Clinical Asymmetries

Our findings speak to two types of asymmetries described in the literature: 1) *Institutional asymmetry* [42] defines the asymmetry in the roles and responsibilities during the clinical consultations where clinicians leverage higher authority than patients. 2) *Communicative asymmetry* [23] describes the varied use of the communication resources to support co-participation. In the context of video consultations, we found that these asymmetries were intertwined where the authority held by the clinicians guided patient's interactions with technology. For example, during video consultations, clinicians requested the patients to reposition the camera to clearly see the patient's movements and other activities. Patients, on the other hand, followed the instructions but hesitated to make such requests when clinicians demonstrated new exercises.

We found that video technology further magnified the responsibilities and needs of the participants by limiting a variety of bodily cues. For instance, in the beginning of a video consultation, clinicians were pre-occupied in making the technology work smoothly; thus they did not get opportunities to introduce small talk (C2). While clinicians struggled to get complete information of the patient's bodily cues, patients struggled in getting higher mobility with the underlying technology. These attempts also raised concerns at the patient end where they felt uncomfortable in performing certain types of exercises over video (C4). The current systems for video consultations are not designed according to the specific needs of clinicians and patients. For instance, these systems provide the same interface to patients and clinicians and offer similar functionalities as provided by any other video platforms for non-clinical purposes. As also iterated by [2,12], we make a call to design technology that accommodates clinical asymmetries and fulfils the different needs accordingly. For example, during video consultations, clinician needs detailed information about patient's movement to support diagnosis, while patient requires comfort to capture their movements.

### Time Sequence

We found that a video consultation also followed a streamlined timeline where participants occupied their seat before starting the consultation and remained seated until the end. As a result, clinicians did not get incidental cues related to patient's movements (C1) as well as their emotions after the consultation (C9). We suggest expanding video consultations in terms of time sequence such that incidental cues become available to clinicians. One potential way could be to start a video call right from the time when the patient is making arrangements for the consultation e.g., taking up their seat, placing the technology, and arranging the chairs. Similarly, the ending phase of the video consultation could be stretched a bit longer such that the clinicians can see how patients feel at the end of the session. Although this is more of a practice guideline than a technological implication, but technology needs to be designed carefully such that the extension blends well with the overall consultation.

### CONCLUSION

In this paper, we presented clinician's perspective on the importance of bodily communication for physiotherapy related video consultations. Our study indicates that despite the challenges of communicating bodily cues during video consultations, clinicians find video consultations beneficial, particularly for follow-up consultations as it save patients trips to the hospital and their disruptions to schooling. We reflected on our findings as four design sensitivities, which speak to designing video technology beyond visual acuity, expanding the field-of-view, accommodating asymmetries of the clinical setting, and extending the temporality of video consultations. Although we studied people with chronic pain undergoing physiotherapy, the proposed sensitivities could also be helpful in other domains that rely on bodily communication e.g., rehabilitation. Further research is required to study if video consultations for other clinical domains also progresses through 6 phases; and to investigate if the importance of bodily communication is similarly acute with conditions that do not involve pain.

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