Leveraging Visual Feedback from Social Signal Processing to Enhance Clinicians' Nonverbal Skills

Rupa A. Patel
University of Washington
1959 NE Pacific St., Box 357240
Seattle, WA 98195-7240 USA
rupatel@uw.edu

Wanda Pratt
University of Washington
MGH 330L, Box 352840
Seattle, WA 98195-8240 USA
wpratt@uw.edu

Andrea Hartzler
University of Washington
Box 352840
Seattle, WA 98195-8240 USA
andreah@uw.edu

Anthony L. Back
University of Washington
Seattle Cancer Care Alliance
825 Eastlake Ave E, G4810
tonyback@uw.edu

Mary P. Czerwinski
Microsoft Research
1 Microsoft Way
Redmond, WA 98052 USA
marycz@microsoft.com

Asta Roseway
Microsoft Research
1 Microsoft Way
Redmond, WA 98052 USA
astar@uw.edu

Abstract
Nonverbal communication between patients and clinicians affects the delivery of empathic patient-centered care and patient outcomes. To be effective communicators, clinicians must appropriately encode, decode, and regulate nonverbal cues, such as speech rate, pitch, facial expression, and body language. Yet, few efforts to develop tools for enhancing clinician communication have focused on nonverbal aspects of the clinical encounter. To address this gap, we describe a novel solution that both uses social signal processing technology (SSP) to capture nonverbal cues in real time and displays instant visual feedback. In this paper, we examine the theoretical underpinnings of nonverbal cues and their critical role in clinical encounters. We then describe opportunities for capturing nonverbal cues with SSP and explore visual designs for feeding back those social signals to enhance clinicians' nonverbal communication.

CHI 2013 Extended Abstracts, April 27–May 2, 2013, Paris, France.
ACM 978-1-4503-1952-2/13/04.

Author Keywords
Nonverbal communication; patient-clinician communication; social signal processing.

ACM Classification Keywords
H.5. Information interfaces and presentation; J.3. Life and medical sciences.

Introduction
The ability to understand and convey nonverbal signals is essential for clinicians to form empathic relationships

with patients [9]. Specifically, nonverbal cues, such as voice tone, body movement, and facial expression, link to important patient outcomes [16], such as patient satisfaction [7] and adherence to medication [19]. Nonverbal cues are particularly effective at communicating emotional messages, establishing rapport, and facilitating patient comprehension of complex concepts in clinical settings [1,8,9,12]. These nonverbal cues often provide a more powerful signal of one's internal state and perceptions than verbal communication alone [2,14].

In addition to speaking clearly and avoiding jargon, skilled "bedside manner" encompasses nonverbal competencies [12]. Traditional clinical communication training lacks specificity, using directives such as "offer empathy in greeting" [4]. Because such training typically takes place outside the context of the clinical encounter, clinicians struggle to transfer skills from training or to learn new skills at the point of care.

Researchers use diverse approaches to study clinicians' nonverbal communication in the context of clinical encounters. Such approaches involve intensive coding from observations of clinicians' nonverbal cues [5,12], judging clinicians' communication style [13], and self-report questionnaires completed by clinicians or patients [9]. Of these, coding video-recorded clinical encounters provides the most direct and granular view into clinicians' nonverbal communication. Yet, manual coding relies on frequency counts of cues—such as nodding and pitch change—that require extensive training and are time-consuming to code. Thus, emerging technologies that automatically capture and analyze nonverbal cues in real time provides an opportunity to overcome these limitations.

Social Signal Processing as a Solution

Social signal processing technologies (SSP) perform "automatic sensing and interpretation of social signals, which are complex aggregates of nonverbal behaviors through which individuals express their attitudes towards other human (and virtual) participants in the current social context" [1]. Essentially, SSP detects nonverbal signaling cues in social interactions. One theoretical framework for grouping these cues is Pentland's "honest signals" [14], in which nonverbal cues signal internal states and attitudes across four dimensions: activity, consistency, influence, and mimicry. Underlying our work is an SSP videoconferencing system that applies this honest signals framework to accurately predict different types of conversation (e.g., active listening, negotiation) [3]. We adapt this work to patient-clinician communication in our system called *Entendre.*

Entendre processes nonverbal cues in audio and video streams and generates rich visual feedback to enhance patient-clinician communication. The system captures raw audio and video data from each individual head-on. The classification of low-level audio and video cues into higher-level nonverbal features is described in [3]. Examples of nonverbal cues detected by Entendre include talk time, turn-taking cues, pitch, speech rate, and head and shoulder activity. These cues are then mapped to relational signals evident in the communication literature, such as control and affiliation. As detection of specific cues increases, so does the strength of the corresponding relational signal and visual feedback. We anticipate that real-time visual feedback on these signals will enhance clinicians' self-awareness and encourage an empathic patient-centered communication style.

Category	Nonverbal Cue	AFFILIATION			CONTROL		
		Rapport	Trust	Warmth	Dominance	Influence	Authority
Haptics	Pat on shoulder			(+)		(+)	
	Hug		(+)	(+)	(+)		
Kinesics	Smile	+	+	+	-	-	(+/-)
	Active gesturing	+/-	-	+/-			(+)
	Nodding	+	+	+	(+)		(+)
Proxemics	Close proximal distance	+	+	+	(-)	(+)	(+)
	Direct body orientation	+	+	+	-		(+)
Vocalics	Varied pitch	+	(+)			(+)	
	Verbal tempo	+	(+)			(+)	
	Verbal fluency					(+)	(+)
Relational	Coordinated turn-taking	+			-		
	Mimicry of cues	+	+	+	-		

KEY

+	Evidence of positive relationship clinically
(+)	Evidence of positive relationship generally
-	Evidence of inverse relationship clinically
(-)	Evidence of inverse relationship generally
	Favorable outcome
	Unfavorable outcome
	Mixed outcome

Table 1. Matrix of research evidence and outcomes for relationships between selected individual and relational nonverbal cues and concepts related to control and affiliation [1,2,6,8,10,12,13].

Visual feedback can also influence conversational dynamics in real time. Kim [11] and Sturm [17] have used SSP to generate visual feedback in mobile and peripheral displays to balance small group conversation among dominant and submissive participants. By deploying Entendre in clinical settings, we anticipate that real-time visual feedback on nonverbal signals will enhance clinicians' self-awareness and encourage an empathic patient-centered communication style.

Nonverbal Communication in Clinical Care

Reflecting visual, real-time feedback to assist clinicians during clinical encounters requires that we first conceptualize the mapping of nonverbal cues to effective communication associated with empathic, patient-centered care. During training, clinicians learn to use touch, proximity, orientation, posture, and paralanguage during clinical encounters to help regulate communication, provide patients with feedback, convey emotion, foster the clinician-patient relationship, enhance patient comprehension, and persuade patients to follow recommendations [6].

Individual nonverbal communication cues can be divided into four major categories: (1) *kinesics*, or body movements, such as facial expression and gesture, (2) *vocalics*, or non-linguistic vocal cues, such as speech tempo, pitch or pauses, (3) *haptics*, or touch such as a hand shake or pat on the shoulder, and (4) *proxemics*, or spatial and distancing cues, such as body orientation, lean of the trunk or conversational distance [2]. Combinations of nonverbal cues are associated with desirable patient-clinician communication [2]. Direct body orientation (a proxemic cue) and minimizing talk time (a vocalic cue) indicate involvement and approachability, and a smile (a kinesic cue) indicates warmth and likability [1,2]. Mimicking such cues further builds rapport and increased trust [1,14]. In contrast, indirect body orientation, frequent interrupts, and uneven speaking turns by clinicians are associated with a dominating influence that can inhibit patient participation [1,13].

Nonverbal cues, individually or in combination, can form relational messages that help define the nature of empathic communication. Two important types of relational signaling—*affiliation* (reflecting interpersonal warmth and connection, trust, and rapport) and *control* (reflecting dominance, influence, and power)—make up core dimensions of interest to researchers who study nonverbal communication [2,3,9,10]. These dimensions show polarity and can vary in strength along a

continuum. Affiliative and more controlling styles are prevalent communication patterns exhibited by clinicians [2,10].

Combinations of nonverbal cues indicate various levels of affiliation and control, two consistent dimensions of importance in conversational interaction [3]. The communication literature groups similar concepts using different terms, such as "immediacy" [1,2], "caring" [13], or "positivity" [8] that correspond with affiliation, and "dominance", "influence", "persuasion", or "power" [1,2,8,12] that correspond with control. Table 1 lists examples of nonverbal cues that are prevalent in clinician settings and their mapping to dimensions of affiliation and control based on the literature. These cues can be adapted for use by SSP, such as Entendre, to capture and provide feedback about informative social signals that can encourage empathic patient-centered communication.

Design Exploration for Nonverbal Communication Feedback

Given arguments for using control and affiliation as core dimensions of nonverbal communication in clinical care, we explored the design space to present these concepts as real-time visual feedback to clinicians.

A number of choices in this design space can illustrate changes in the strength and polarity of affiliation and control over the course of a clinical encounter. For example, traditional charts and graphs (e.g., pie charts, bar graphs) can incorporate attributes like color, shape, and size to portray temporal or relational patterns in these nonverbal communication signals. Other design choices can leverage pictographs or visual metaphors. Simple line graphs, for example, can serve as timelines of turn-taking behavior between conversational partners, as Byun's system demonstrates [4]. Another design alternative is a scatterplot with axes corresponding to communication dimensions of interest. The clinicians' nonverbal cues would map to the ball at particular levels of affiliation (x-axis) and control (y-axis). The ball could change color (i.e. red, yellow, green), and shift with temporal changes in communication pattern to help guide the clinicians' communication style in real time. Yet another option is a bull's eye design that monitors whether communication behavior is "on target" given recommended nonverbal cues for effective patient-clinician interaction [2].

We also explore use of visual metaphors that represent familiar themes in pictorial form, such the shifts in a speedometer or color of a traffic light. Although visual metaphors are useful because they leverage our shared common ground to communicate more complex concepts, the ultimate design choice for these visualizations may require different levels of cognitive processing for interpretation during actual clinic visits. Next, we describe two sample visual metaphors that we plan to further validate with clinicians.

Separate Sun/Moon and Seesaw Visualization

This visualization juxtaposes two separate visual measures of affiliation and control, which change in real-time (Figure 1). A sun/moon graphic represents changes in affiliation, becoming large and yellow to indicate high affiliation and small and blue to indicate low affiliation. A seesaw represents the control dimension, with high dominance represented by the ball rolling to the left side near the clinician (i.e., "You")

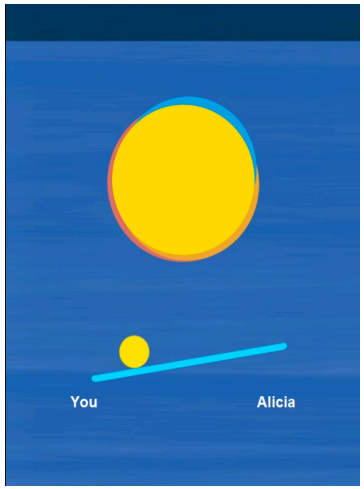

Figure 1. Sun-moon and seesaw visualization.

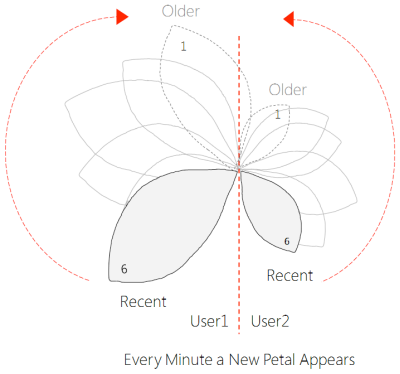

Figure 2. Diagram of the lotus flower visualization, showing a user on either side of the red axis and the movement in time of each pair of petals.

and low dominance represented by the ball rolling to the right side near the patient's name (i.e., "Alicia").

Composite Lotus Flower Visualization

The inspiration for this composite visualization stemmed from the idea of seeing the current state of a dialogue, combining signals of affiliation and control, between two parties while visualizing the entire dialogue as an abstraction over time (Figure 2). We selected a lotus flower because each pair of petals could represent a segment of time captured between two people. We designed the lotus to split in half on a vertical axis, with one side reflecting the clinician's behavior (i.e., "User 1") and the other side reflecting the patient's (i.e., "User 2"). After one minute of exchange, a new petal appears on each side at the base of the flower. The size of the petals indicates the level of control of each user in the interaction. The color indicates each user's level of affiliation.

Future Work

Despite the long tradition of studying frequency counts of nonverbal cues through manual coding of recorded encounters, exploring the real-time implications of visual social signal feedback can shed new light on ways to enhance clinicians' communication skills. Nevertheless, facilitating communication through SSP presents a number of challenges. For example, SSP is specialized to capture nonverbal, rather than linguistic cues that are also important to effective communication [5,7]. Furthermore, the types and frequencies of nonverbal cues people exhibit are known to vary from person to person, as well as by gender and culture [2]. These intricacies may require a nuanced approach that accounts for individual variability, functional interaction, and context, rather than a generalized approach that depends on absolute counts of a narrow set of individual cues [2].

Despite these limitations, SSP is ripe for application in settings where communication is paramount, such as cancer care. The approach we are developing has potential to help clinicians enhance their nonverbal skills, and could be extended to facilitate communication in other settings, such as teaching or coaching programs or enhancing remote teleconferencing systems with novel nonverbal signals.

In the future, we will gather clinicians' perceptions of real-time visual feedback to determine its feasibility and utility, as well as iterate on the design of the feedback. Furthermore, we plan to investigate our approach to inform clinical empathic awareness with an implementation of Entendre in clinic settings.

Conclusion

Empathic nonverbal patient-clinician communication is central to the delivery of patient-centered care and affects patient outcomes. Real-time, automatic detection of nonverbal cues using SSP enables us to move beyond self-report questionnaires, limited ratings that trained observers apply globally to the entire clinic encounter, and labor-intensive coding processes. SSP could speed up the process of nonverbal cue detection and is likely to be more objective than human observers. In addition, SSP enables us to map from detected cues to important dimensions of clinical communication, including social signals of affiliation and control, which can be fed back to the clinician in real time through informative visualizations and used as a tool for reflection afterwards. Visual SSP feedback holds promise for providing insight and fostering self-

awareness of clinicians' empathic communication skills during and after the clinical encounter.

References

[1] Buller, D.B., Street, R.L. Physician-patient relationships. In R.S. Feldman (Ed.), Applications of nonverbal theories and research. London, Psychology Press, 1992.

[2] Burgoon, J.K., Guerrero, L.K., Floyd, K. Nonverbal Communication. Saddle River, NJ, Pearson, 2010.

[3] Byun, B., Awasthi, A., Chou, P. A., Kapoor, A., Lee, B., Czerwinski, M. Honest signals in video conferencing. *Proc. IEEE ICME*, (2011), 1-6.

[4] Cegala, D.J., Broz, S.L. Physician communication skills training: a review of theoretical, background, objectives, and skills. *Med Educ, 36* (2002), 1004-16.

[5] D'Agostino, T.A., Bylund, C.L. The nonverbal accommodation analysis system (NAAS): Initial application and evaluation. *Patient Educ Couns 85*, 1 (2011), 33-9.

[6] Dickson, D.A., Hargie, O., Morrow, N.C. Communication skills training for health professionals. London, Nelson Thornes, 2003.

[7] DiMatteo, M.R., Taranta. T., Friedman, H.S., Prince L.M. Predicting patient satisfaction from physicians' nonverbal communication skills. *Med Care 19,* 4 (1980), 173-87.

[8] Hall J.A., Harrigan, J.A., Rosenthal, R. Nonverbal behavior in clinician-patient interaction. *Appl Prev Psych 4* (1995), 21-37.

[9] Hojat, M. Empathy in clinical care: antecedents, development, measurement, and outcomes. New York, Springer, 2007.

[10] Kiesler, D.J., Auerbach, S.M. Integrating measurement of control and affiliation in studies of physician-patient interaction: The interpersonal circumplex. *Soc Sci Med 57,* 9 (2003), 1707-22.

[11] Kim T., Chang A., Holland L., Pentland, A.S. Meeting Mediator: enhancing group collaboration using sociometric feedback. *Proc. ACM Conference on Computer-supported Cooperative Work*, (2008), 457-66

[12] Martin, L., Friedman, H.S. Nonverbal communication in health care (pp. 3-16). In Riggio, R.E. & Feldman, R.S. (Eds.) Applications of nonverbal communication. London, Lawrence Erlbaum, 2005.

[13] Mast, M.S., Hall J.A., Roter, D.L. Caring and dominance affect participants' perceptions and behaviors during a virtual medical visit. *J Gen Intern Med 23*, 5 (2008), 523–7.

[14] Pentland, A. Honest signals: How they shape our world. Cambridge: MIT Press, 2008.

[15] Roter, D., Larson, S. The Roter Interaction Analysis System: utility and flexibility for analysis of medical interactions. *Patient Educ Couns 46*, 4 (2002), 243-251.

[16] Street, R.L., Makoul, G., Arora, N.K., Epstein R.M. How does communication heal? Pathways linking clinician-patient communication to health outcomes. *Patient Educ Couns 74,* 3 (2009), 295-301.

[17] Sturm, J., Herwijnen, O.H., Eyck A., Terken, J. Influencing social dynamics in meetings through a peripheral display. *Proc. IEEE ICME*, (2007), 263-70.

[18] Vinciarelli. A., Pantic, M. Social signal processing: Survey of an emerging domain. *Image and Vision Computing 27*, 12 (2009), 1743-59.

[19] Zolnierek, K.B., DiMatteo, M.R. Physician communication and patient adherence to treatment: A meta-analysis. *Med Care 47*, 8 (2009), 826-34.