Some Novel Aspects of Health Communication from a Dialogue Systems Perspective

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Abstract

Automated health communication dialogue represents an area of research with enormous potential impact on society, a plethora of interesting research problems for dialogue system and health intervention researchers, and a host of unique challenges. In this review we discuss some of the ways in which health communication is fundamentally different from other application domains for automated dialogue systems.

Introduction

This paper is a preliminary attempt to identify the aspects of health communication that are both novel and provide interesting challenges for current work in dialogue systems research.

Communication between human healthcare providers and their patients is one of the most widely-studied domains of communication research. Just within the field of physician-patient communication, one source lists over 3,000 articles in print (Parks and Floyd 1996), and there are volumes written on the dialogue that occurs during psychotherapy sessions. It is easy to see why such a large volume of research has been focused in this area: health communication is at once extraordinarily important and yet still far from perfect. Patients frequently do not take their medication or follow other instructions given to them by health professionals. Consumers do not follow the health guidelines on exercise, diet and smoking published by the Centers for Disease Control and Prevention and other public health entities. A large percentage of the population living with chronic disease has a poor understanding of their condition. Improving health communication is one of the primary means to address the 60% of the $1.2 trillion per year spent on healthcare in the U.S. that is attributable to behavioral problems (Prochaska 2001).

Although many of the observations made in this paper have certainly been made by other researchers based on their experiences with other systems, our examples will be drawn from the health dialogue systems that we have the most experience with, namely the FitTrack exercise advisor (an animated exercise trainer) (Bickmore, Gruber et al. to apear; Bickmore and Picard to appear), the various Telephone Linked Care (TLC) systems (telephone-based health behavior change and chronic disease management systems)(Friedman, Stollerman et al. 1997; Friedman 1998), and the Homey Hypertension Management Dialog System (Giorgino, Quaglini et al. 2004).

The "Gold Standard" for Health Communication

The "gold standard" for health communication remains one-on-one, face-to-face interaction with an expert human health provider, who has at his or her disposal a range of health knowledge and theory-based behavioral interventions they can deploy based on the needs of the patient and the conversational context. Not only must the counselor be expert in the use of these interventions, but he or she must also be adept at managing the interpersonal aspects of the interaction (such as maintaining a therapeutic alliance over time (Horvath and Luborsky 1993)), in addition to the basic ability to use language and social conventions to engage in a conversation and effectively communicate with a patient.

Unfortunately, one-on-one human interventions only have the potential to reach a very small portion of the population, resulting in very low impact (efficacy multiplied by recruitment rate (Velicer, Prochaska et al. 1999)).

To reach a larger audience, a wide range of media-based and automated health behavior change interventions have been developed over the last two decades. Of these, the ones that come closest to the "gold standard" are those that autonomously communicate with patients using natural language dialogue, emulating the behavior of an expert health provider as closely as possible.

The State of the Art

A number of natural language-based automated systems to affect health behavior change and health education have been developed and successfully evaluated (Friedman, Stollerman et al. 1997; Hirst, DiMarco et al. 1997; Brug, Glanz et al. 1998; Friedman 1998; Marcus, Owen et al. 1998; Delichatsios, Friedman et al. 2001; Lennox, Osman et al. 2001; Revere and Dunbar 2001). These systems provide health behavior change information to users based on a wide variety of health behavior theories (e.g., the stages of change model (Prochaska and Marcus 1994), the

health belief model (Glanz, Lewis et al. 1997), and social cognitive theory (Bandura 1997)), using a variety of communication media to provide the information (desktop computers, automatically tailored print, mobile devices, and telecommunications), and have been applied to a number of behaviors (physical activity promotion, diet adherence, medication regimen adherence, smoking cessation, chronic disease self-management, and others). Overall, these systems have been shown to be effective in a number of randomized clinical trials.

Most health dialogue systems that have been developed and evaluated in randomized clinical trials to date have used relatively simple dialogue models, including linear scripts, finite state machines, or augmented transition networks, with very shallow computerized knowledge representations of their application domain, the behavior change theories they are based on, and user models.

While this approach has proven adequate for building relatively small applications, it has fundamental limitations in scalability and tailorability (human script writers can only keep a small number of variables and dialogue fragments in mind at one time) as well as portability and reusability. Addressing these shortcomings requires dynamic planning of system dialogue, so that the production of messages can be tied directly to underlying models of theory, user characteristics, and conversational context. There are a few examples of dialogue systems in this category—in domains such as the application of clinical guidelines,(Beveridge and Millward 2003) the automatic generation of reminders for older adults with cognitive impairment,(Pollack, Brown et al. 2003) and for medication advice(Ferguson, Allen et al. 2002) –but this remains a largely unexplored area of dialogue systems research.

What's Unique About Health Dialogue?

In this section we look at a number of factors that make health communications a particularly novel and challenging application domain for dialogue systems researchers.

Criticality

Few application domains can be considered more "life critical" than health care. Although making erroneous dietary recommendations is probably not going to cause a life threatening emergency, many health dialogue systems have the potential to be used in emergency situations, and the authors of applications that perform seemingly innocuous tasks (like dietary recommendations) may find themselves subjects of litigation if their system is the cause of any adverse health outcomes.

This problem is especially significant in systems that assist patients with chronic disease self-management. TLC systems developed for this kind of application are designed to determine if the patient is having a life-threatening emergency as quickly as possible and either direct the patient to call 911 or immediately and automatically send the patient's primary care physician a page or fax alerting them to the situation (Finkelstein and Friedman 2000).

Privacy and Security

Privacy (preventing unauthorized disclosure of patient data) has been of major concerns to all developers of healthcare technology, especially since the advent of HIPAA regulations (the Health Insurance Portability and Accountability Act of 1996). It may seem that these issues are of more concern to IT departments fielding systems than to computational linguists working on health dialogue content. However, this is not entirely the case. Dialogue content and access modalities may need to be tailored based on user's context to address privacy issues. For example, developers of applications that involve disclosure of potentially stigmatizing conditions or information (e.g., psychotherapeutic or HIV regimen adherence applications) should be sensitive to the user's environment and tailor content accordingly. One candidate for the FitTrack study dropped out when they discovered that the system produced spoken feedback played over PC speakers and the only computer they had available to use was at their work site.

Continuity Over Multiple Interactions

Most health communication applications require multiple interactions with users over extended periods of time. Interaction frequencies can range from multiple times a day (e.g., in wearable monitoring applications) to daily (as in FitTrack) to one or more times per week (as in most TLC applications), to once every few months (as in many of the health behavior change applications that use tailored documents (Velicer and Prochaska 1999)). Durations of use can span from a month (FitTrack) to several months or a few years (most behavior change applications) to a lifetime (chronic disease monitoring and self-care). Further, these interactions are not isolated, stateless sessions (such as a database question answering system), but require extensive information to be kept persistently between sessions for a given user with subsequent dialogue tailored on the basis of the earlier conversations.

This requirement for continuity over multiple interactions is found in few dialogue system application domains outside of healthcare (multi-session intelligent tutoring systems being the other notable example). This requirement also drives several interesting research problems, such as determining the form and content of dialogue history that is maintained between sessions, and the generation and resolution of expressions that refer to past interactions.

Language Change Over Time In human health provider-patient interactions language use naturally evolves over the course of several interactions. Several studies have noted that task talk becomes more concise and takes less time as the interactants' knowledge of each other increases, while their use of social dialogue generally increases as their

relationship grows (Graugaard, Holgersen et al. 2004). Dialogue systems that do not adapt their language use in this way risk being perceived as unnatural (what would you think if your hairdresser said *exactly* the same thing to you every time you visited him or her?) and send the relational message that they are always socially distant "strangers" to their users.

Some specific examples of the ways in which health behavior change dialogue can evolve include: making use of information about the user's state to set behavior goals and give feedback; progressively disclosing more information about the user's condition; gradually making task language more precise; gradually phasing out introductory how-to instructions and help messages. Maximizing conciseness in spoken output is especially important since it takes more time to communicate information in speech than in text, and it can be difficult to interrupt speech output (Kuppevelt and Heid 2000).

Language change is also important just to maintain user engagement in the system. In the FitTrack study, several subjects mentioned that repetitiveness in the system's dialogue content was responsible for their losing motivation to continue working with the system and following its recommendations:

> In the beginning I was extremely motivated to do whatever Laura asked of me, because I thought that every response was a new response. Whereas, towards the end I could tell what she was going to say to a couple of my responses.

Language evolution in health dialogue systems is generally hard-coded and typically not explicitly planned in the development of dialogue scripts (e.g., in FitTrack, a schedule was developed for the amount and types of relational dialogue that would be used at different stages of the intervention as a script writer's guide). Generating these changes from first principles remains an interesting and important research problem.

Managing Patterns of Use One of the interesting but important ramifications of interacting with users over multiple sessions is that users' patterns of use of the system is itself is an important object of study, and may require as extensive tracking and management as the content of the intervention and the user's health behavior. Determining the optimal patterns of use for a given intervention is a difficult problem, but must be derived before the system can try to manage users' interactions with it. What is the dose-response relationship between user-system contacts and outcomes (Velicer, Prochaska et al. 1999)? Is more frequent user-system contact always better? Is a regular contact schedule (vs. as-needed by the user or as-dictated by sensor data and other information) always best? The optimal usage pattern will drive the language used by the system both in its intervention content and in motivating the user to continue using it (e.g., the differences between a wearable smoking cessation system that talks to the user every time they light a cigarette vs. a system that interacts with them at the end of every week vs. a system that they can access when they feel they need help and support).

Even in relatively simple medical monitoring applications, dealing with user psychology in order to maintain their motivation to use the system is important, since there is often no immediate, intrinsic reward to them for using the system.

Power, Initiative and Negotiation

At first it may seem that conversational initiative in health communication is one feature that actually works in favor of building simpler dialogue systems: as in most professional-client interactions, the professional maintains the initiative the vast majority of the time. While this is actually still the case in most physician-patient and therapist-patient interactions (physicians generally talk 50-100% more than patients (Graugaard, Holgersen et al. 2004)), contemporary health communication researchers have determined that the best way to get patients to adhere to prescribed regimens and/or change their health behavior is by moving away from this "paternalistic" style of interaction to one in which the health professional and the client work together on an equal footing to come up with a treatment plan that fits into the client's life: so-called "patient-centered" communication (Stewart, Belle et al. 1995; Bensing 2000). This is also reflected in psychotherapy in that two of the three components of the working alliance are taken to be the degree to which the patient and the therapist agree on the goals and tasks of the therapy (Horvath and Greenberg 1989). In Motivational Interviewing—a behavior change counseling technique that is currently in vogue—patients are encouraged to take the initiative, not only in the conversation but in setting their own goals and defining their own treatment plan (Miller and Rollnick 1985).

This style of interaction also has another crucial element that has not been addressed well in dialogue systems research, namely negotiation. Physicians and therapists are encouraged to actively negotiate treatment plans with their patients, making suggestions, listening to problems, concerns and objections, and making counter-suggestions as needed in order to maximize patient adherence to the treatment regimen.

User-Computer Relationship

The importance of quality relationships between health care providers and their patients is now widely recognized as a key factor in improving not only patient satisfaction, but treatment outcomes across a wide range of health care disciplines. The use of specific communication skills by physicians—including strategies for conducting patient-centered interviews and relationship development and maintenance—has been associated with improved adherence to treatment regimens (Becker and Mainman 1975; Haynes 1976; Garrity 1981; Becker and Rosenstock 1984) improved physiological outcomes (Shulman 1979; Kaplan, Greenfield et al. 1989; Stewart, Belle et al. 1995;

Kaplan, Greenfield et al. 1996), and increased patient satisfaction (Wooley, Kane et al. 1978; DiMatteo and Hays 1980; Bellet and Maloney 1991; Boon and Stewart 1998), leading to recommendations for training physicians in these skills (Squier 1990; Novack, Dube et al. 1992; Zinn 1993; Keller and Caroll 1994; Platt and Keller 1994; Winefield and Chur-Hansen 2000). Similar recommendations have been made for nurses (LaMonica, Carew et al. 1976; Wiseman 1996; Sourial 1997) and pharmacists (Hargie, Morrow et al. 2000). In psychotherapy, the positive effect of a good therapist-patient relationship on outcomes has been demonstrated in many studies, and has even been hypothesized to be *the* common factor underlying the many diverse approaches to psychotherapy that seem to provide approximately equivalent results (Gelso and Hayes 1998).

Several studies have demonstrated that people respond in relational ways to computers (and other media) when provided with the appropriate social cues, even though they are typically unconscious of this behavior. Examples of some of the effects found by these studies are that people tend to like computers more when the computers flatter them, match their personality, or use humor (Reeves and Nass 1996). Even in automated health behavior change interventions, subjects often anthropomorphize computers even when the designers did not intend this. In a qualitative study of user perceptions of a telecommunications-based intervention, Kaplan et al. found that users not only talked about the system using anthropomorphic terms (e.g., using personal pronouns), they described the system in ways indicative of having a personal relationship with it (e.g., "friend", "helper", "mentor") and seemed to be concerned about impression management (e.g., choosing to only interact with the system on days in which they met the system's health behavior goals) (Kaplan, Farzanfar et al. 2003). Milch, et al, found that several subjects in their pager-based medication adherence intervention talked about their pager as a "trusted friend" (Milch, Ziv et al. 1996).

Taken together, these results indicate that an effective automated health behavior change intervention must not only be able to deploy appropriate intervention messages at the appropriate time, but must also address social and relational issues in its communication with users. In scripted dialogue systems, human script writers tacitly address these issues in the scripts they create. However, as we move towards systems in which the dialogue is dynamically planned, the rules underlying these relational factors must be explicitly codified into the system. 'Relational agents' have been defined as computer agents that are designed to do this, and use these techniques to maintain long-term relationships with users (Bickmore and Picard to appear). Although relational agents could be constructed using a wide range of media, embodied conversational agents (Cassell, Sullivan et al. 2000)—those which simulate face-to-face conversation through the use of hand gesture, gaze, facial display and other nonverbal modalities—are particularly effective given that face-to-face conversation is the primary modality used to build human relationships (Duck 1995), and that many of the relational strategies that humans use within conversation are nonverbal (Andersen and Guerrero 1998).

Social Dialogue A significant part of on-going interactions between human health providers and their patients is spent in social dialogue (Graugaard, Holgersen et al. 2004), and social dialogue is one of the primary mechanisms that people use to build and maintain relationships. At least one dialogue system framework used social dialogue explicitly as a means to decrease social distance and increase trust with the user on the basis of a multi-dimensional model of the system-user relationship and the system's goals (Cassell and Bickmore 2003).

This "off task" talk presents many unique challenges for dialogue systems. Although it has been dealt with as a distinct conversational frame of interaction (Schneider 1988), all dialogue can be characterized by its degree of 'phaticity' (Coupland, Coupland et al. 1992), and relational communication can take place as extended pre-closing or inter-task sequences, individual turns, adjacency pairs, or short side sequences (Koester 2004). Dealing with the potentially unbounded scope of small talk is also a challenge, and it remains to be seen how effective such social dialogue can be when it is highly constrained, for example by having the system maintain the initiative or severely limiting what the user can say (as in FitTrack). In speech-based systems, switching into a social dialogue conversational frame can be seen by users as an invitation to also drop into an informal conversational speech register, replete with disfluencies that can cause recognizer accuracies to plummet.

Affective Dialogue

Dialogue to communicate affective state and empathy has recently been receiving an increasing amount of attention in the dialogue planning and autonomous agent communities (e.g., the AAAI Spring 2004 Symposium on Exploring Attitude and Affect in Text and the 2004 AAMAS workshop on Empathy in Human-Computer Interaction). In human health provider-patient interactions, the patient's perception of the provider's empathy for them has been shown to be a significant factor affecting not only patient satisfaction, but a physician's *lack* of empathy for a patient is the single most frequent source of complaints (Frankel 1995). Demonstration of empathy is also an important relational technique, and understanding one's partner's emotional states and being able to manage them is at the core of the art of handling relationships (Goleman 1995).

The first step in any of this work is recognizing the user's emotional state, but despite attempts at doing this based on physiological sensors (Picard 1997), speech intonation, and dialogue content, it remains a significant research problem. Responding to user emotional state has been explored in relatively simple scripted dialogue systems (e.g., Klein's CASPER (Klein, Moon et al. 2002)), but much more sophisticated responses can be synthesized

on the basis of communications studies on comforting messages (Burleson and Goldsmith 1998).

Challenges for Dialogue Planning

A dialogue planner for health communication—that attempts to emulate interactions with a human health provider, including social and affective dialogue—must be able to manage and pursue multiple conversational goals (Tracy and Coupland 1991), some or all of which may be persistent or non-discrete. For example, in small talk, where there are apparently no task goals being pursued, interlocutors are conscious, nevertheless, of multiple goals related to conversation initiation, regulation and maintenance (Cegala, Waldro et al. 1988). Even in task-oriented interactions, speakers may also have several interpersonal goals they are pursuing, such as developing a relationship (e.g., befriending, earning trust) or establishing their reputations or expertise. It is not sufficient that a discourse planner work on one goal at a time, since a properly selected utterance can, for example, satisfy a task goal by providing information to the user while also advancing the interpersonal goals of the agent. In addition, many goals, such as intimacy or face goals, are better represented by a model in which degrees of satisfaction can be planned for, rather than the discrete all-or-nothing goals typically addressed in AI planners (Hanks 1994).

Many of the high-level goals that counselors have are *maintenance* goals, such as *maintain recommended levels of physical activity*, *maintain intention to exercise*, *maintain working alliance with patient*, or *maintain patient engagement during a counseling session*, rather than being discrete, episodic, time-bounded goals.

Finally, many of the goals that counselors have when talking with patients are not explicitly shared with them for a variety of reasons. Many relational goals in face-to-face interaction (of any kind) are pursued in an unconscious manner according to social convention. For example demonstrations of empathy in order to build trust are usually not proceeded by an explicit agreement to improve the relationship ("Let's build some trust now."). In addition, during a session a counselor may intentionally choose to not make a therapeutic goal explicit in order to facilitate the overall intervention, such as in giving a new patient too many things to think about and work on in a first session. Thus, a health communication dialogue planner should be able to maintain both private and shared goals in a given interaction with a user.

Tailoring Dialogue Content

Although tailoring of dialogue content to user characteristics is a common function in dialogue systems, the effects of such tailoring on user perceptions and behavior is perhaps nowhere as well documented as in health communication. Tailoring of health behavior change content to user stage of change (behavior and intent) is the foundation of the transtheoretical model (Prochaska and Marcus 1994), and has been implemented in a number of fielded dialogue systems (Marcus, Brock et al. 1998; Velicer and Prochaska 1999; Velicer, Prochaska et al. 1999). In addition, tailoring dialogue content on the basis of information acquired from the user over time—including physiological variables and their trends, system contact patterns, errors, and information from the user's medical record—remains an important area of investigation.

Speech recognition issues

There is wide interest in the use of speech as an input modality for health dialogue systems, and several systems are now being fielded using commercial speech recognition software. For telephone conversations, this may replace touch-tone inputs, which restrict interactions to menu-based input and numeric quantities. Voice recognition systems may be put into operation that merely support question-by-question interactions (system initiative), or leave users to partially anticipate forthcoming answers (mixed initiative), to open prompts (Gorin, Riccardi et al. 1997; Walker, Frommer et al. 1998). Current speech recognition technology is reliable on numeric values or small-vocabulary grammars (of the order of hundreds of words, possibly concatenated).

Employing speech input however raises a number of additional issues. First of all, misrecognitions become possible. Error recovery is mostly performed with additional confirmation questions. A number of variations on the basic yes-no confirmation are known, including implicit confirmation and mixed initiative ("wrong, it is 94" or "confirm, and weight is 120"). Further, speech generally requires shorter turn lengths than text, since listening to long computer-generated speech becomes tiresome, and because listeners tend to retain and react only to the most recently heard information.

Conclusion

Building dialog systems for the medical domain poses several unique challenges with respect to other interactive application domains. In this paper we have tried to outline some of the more important challenges and interesting research questions.

A final issue, raised by Picard and Klein, is the ethic of building agents that pretend to care, understand and empathize, when, in fact, they have no real emotions of their own (Picard and Klein 2002). As observed by Turkle, people today seem quite comfortable with computational artifacts that only appear to have emotions (Turkle 1995) and, as confirmed by most users in the FitTrack study, the end seems to justify the means. As one subject put it:

> She's a computer character. I don't know if she cared about me. I don't know if she feels. She's a character and has a role, but I don't know if she has feelings. But, it worked for me and I'm happy

One way to address this issue is through proper meta-relational communication—having the agent be as clear as possible about what it can and can't do, and what expectations the user should have about their respective roles in the interaction. For example, in her first interaction with users, Laura states:

> I'm going to help you meet your exercise goals over the next month. I'm going to be your exercise advisor. My job is to help you set goals and overcome obstacles, and I'll also be giving you lots of tips on how to exercise. You need to keep in mind that I'm just a computer character with limited capabilities, so I hope you will understand if there are some things I cannot help you with.

References

Andersen, P. and L. Guerrero.1998. The Bright Side of Relational Communication: Interpersonal Warmth as a Social Emotion. *Handbook of Communication and Emotion*. P. Andersen and L. Guerrero. New York, Academic Press**:** 303-329.

Bandura, A.1997. Self-efficacy: toward a unifying theory of behavioral change. *Psychol Rev* 84: 191-215.

Becker, M. and L. Mainman.1975. Sociobehavioral determinants of compliance with health and medical care recommendations. *Med Care* 12: 10-24.

Becker, M. and I. Rosenstock.1984. Compliance and medical advice. *Health care and human behavior*. A. Matthews. London, Academic Press.

Bellet, P. and M. Maloney.1991. The importance of empathy as an interviewing skill in medicine. *JAMA* 266: 1831-2.

Bensing, J.2000. Bridging the gap. The separate worlds of evidence-based medicine and patient-centered medicine. *Patient Educ Couns* 39: 17-25.

Beveridge, M. and D. Millward.2003. *Combing Task Descriptions and Ontological Knowledge for Adaptive Dialogue*. Proceedings of the 6th International Conference on Text, Speech and Dialogue (TSD-03).

Bickmore, T., A. Gruber, et al.to apear. Establishing the computer-patient working alliance in automated health behavior change interventions. *Patient Educ Couns*.

Bickmore, T. and R. Picard.to appear. Establishing and Maintaining Long-Term Human-Computer Relationships. *ACM Transactions on Computer Human Interaction*.

Boon, H. and M. Stewart.1998. Patient-physician communication assessment instruments: 1986 to 1996 in review. *Patient Educ Couns* 35: 161-76.

Brug, J., K. Glanz, et al.1998. The impact of computer-tailored feedback and interative feedback on fruit and vegetable intake. *Health* 25: 517-531.

Burleson, B. and D. Goldsmith.1998. How the Comforting Process Works: Alleviating Emotional Distress through Conversationally Induced Reappraisals. *Handbook of Communication and Emotion*. P. Andersen and L. Guerrero. New York, Academic Press.

Cassell, J. and T. Bickmore.2003. Negotiated Collusion: Modeling Social Language and its Relationship Effects in Intellient Agents. *User Modeling and Adaptive Interfaces* 13(1-2): 89-132.

Cassell, J., J. Sullivan, et al., Eds.2000. *Embodied Conversational Agents*. Cambridge, MA, The MIT Press.

Cegala, D., V. Waldro, et al.1988. *A study of interactants' thoughts and feelings during conversation.* Ninth Annual Conference on Discourse Analysis, Philadelphia, PA.

Coupland, J., N. Coupland, et al.1992. "How are you?": Negotiating phatic communion. *Language in Society* 21: 207-230.

Delichatsios, H. K., R. Friedman, et al.2001. Randomized Trial of a "Talking Computer" to Improve Adults' Eating Habits. *American Journal of Health Promotion* 15(4): 215-224.

DiMatteo, M. and R. Hays.1980. The significance of patients' perceptions of physician conduct: a study of patient satisfaction in a family practice center. *J Community Health* 6: 18-34.

Duck, S.1995. Talking Relationships into Being. *Journal of Social and Personal Relationships* 12(4): 535-540.

Ferguson, G., J. Allen, et al.2002. The Medicaion Advisor Project Preliminary Report. Rochester, NY, Dept of Computer Science, University of Rochester.

Finkelstein, J. and R. Friedman.2000. Potential Role of Telecommunication Technologies in the Management of Chronic Health Conditions. *Dis Manage Health Outcomes* 8(2): 57-63.

Frankel, R.1995. Emotion and the Physician-Patient Relationship. *Motivation and Emotion* 19(3): 163-173.

Friedman, R.1998. Automated telephone conversations to asses health behavior and deliver behavioral interventions. *Journal of Medical Systems* 22: 95-102.

Friedman, R., J. Stollerman, et al.1997. The virtual visit: using telecommunications technology to take care of patients. *Journal of the American Medical Informatics Association* 4: 413-425.

Garrity, T.1981. Medical compliance and the clinician-patient relationship: a review. *Soc Sci Med* 15E: 215-222.

Gelso, C. and J. Hayes.1998. *The Psychotherapy Relationship: Theory, Research and Practice*. New York, John Wiley and Sons.

Giorgino, T., S. Quaglini, et al.2004. *Evaluation and Usage Patterns in the Homey Hypertension Management*

Dialog System. AAAI Fall Symposium on Dialogue Systems for Health Communication.

Glanz, K., F. Lewis, et al.1997. *Health Behavior and Health Education: Theory, Research, and Practice*. San Francisco, CA, Jossey-Bass.

Goleman, D.1995. *Emotional Intelligence*. New York, Bantam Books.

Gorin, A. L., G. Riccardi, et al.1997. How may I help you? *Speech Communication* 23(1-2): 113-127.

Graugaard, P. K., K. Holgersen, et al.2004. Changes in physician-patient communication from initial to return visits: a prospective study in a haematology outpatient clinic. *Patient Educ Couns* to appear.

Hanks, S.1994. *Discourse Planning: Technical Challenges for the Planning Community*. AAAI Workshop on Planning for Inter-Agent Communication.

Hargie, O., N. Morrow, et al.2000. +Pharmacists' evaluation of key communication skills in practice. *Patient Educ Couns* 39: 61-70.

Haynes, R.1976. A critical review of the 'determinants' of patient compliance with therapeutic regimens. *Compliance with therapeutic regimens*. R. Haynes. Baltimore, Johns Hopkins University Press.

Hirst, G., C. DiMarco, et al.1997. *Authoring and Generating Health-Education Documents That are Tailored to the Needs of the Individual Patient*. UM 97.

Horvath, A. and L. Greenberg.1989. Development and Validation of the Working Alliance Inventory. *Journal of Counseling Psychology* 36(2): 223-233.

Horvath, A. and L. Luborsky.1993. The Role of the Therapeutic Alliance in Psychotherapy. *Journal of Consulting and Clinical Psychology* 61(4): 561-573.

Kaplan, B., R. Farzanfar, et al.2003. Personal relationships with an intelligent interactive telephone health behavior advisor system: a multimethod study using surveys and ethnographic interviews. *International Journal of Medical Informatics* 71(1): 33-41.

Kaplan, S., S. Greenfield, et al.1996. Characteristics of physicians with participatory styles. *Ann Intern Med* 124: 497-504.

Kaplan, S., S. Greenfield, et al.1989. Assessing the effects of physician-patient interactions on the outcomes of chronic disease. *Med Care* 27: S110-S127.

Keller, V. and J. Caroll.1994. A new model for physician-patient communication. *Patient Educ Couns* 35: 121-40.

Klein, J., Y. Moon, et al.2002. This Computer Responds to User Frustration: Theory, Design, Results, and Implications. *Interacting with Computers* 14: 119-140.

Koester, A. J.2004. Relational sequences in workplace genres. *Journal of Pragmatics* 36: 1405-1428.

Kuppevelt, J. V. and U. Heid.2000. Best practice in spoken language dialogue systems engineering. *Natural Language Engineering* 6(3&4).

LaMonica, E., D. Carew, et al.1976. Empathy training as the major thrust of a staff development program. *Nurs Res* 192576: 447-451.

Lennox, A. S., L. M. Osman, et al.2001. Cost effectiveness of computer tailored and non-tailored smoking cessation letters in general practice: randomised controlled trial. *British Medical Journal* 322: 1-7.

Marcus, B., B. Brock, et al.1998. Efficacy of an individualized, motivationally-tailored physical activity intervention. *Annals of Behavioral Medicine* 20: 174-180.

Marcus, B., N. Owen, et al.1998. Physical Activity Interventions Using Mass Media, Print Media, and Information Technology. *AJPM* 15(4): 362-378.

Milch, R., L. Ziv, et al.1996. The effect of an alphanumeric paging system on patient compliance with medicinal regimens. *American J Hosp Palliat Care* 13: 46-48.

Miller, W. R. and S. Rollnick.1985. *Motivational interviewing*. New York, Guilford Press.

Novack, D., C. Dube, et al.1992. Teaching medical interviewing: a basic course on interviewing and the physician-patient relationship. *Arch Intern Med* 152: 1814-20.

Parks, M. and K. Floyd.1996. Meanings for Closeness and Intimacy in Friendship. *Journal of Social and Personal Relationships* 13(1): 85-107.

Picard, R.1997. *Affective Computing*. Cambridge, MA, MIT Press.

Picard, R. and J. Klein.2002. Computers that recognize and respond to user emotion: theoretical and practical implications. *Interacting with Computers* 14: 141-169.

Platt, F. and V. Keller.1994. Empathic communication: a teachable and learnable skill. *J Gen Intern Med* 9: 222-6.

Pollack, M. E., L. Brown, et al.2003. Autominder: An Intelligent Cognitive Orthotic System for People with Memory Impairment. *Robotics and Autonomous Systems* 44: 273-282.

Prochaska, J.2001. Helping Populations Progress Through Stages of Change. *Talk given at Boston University*. webcast http://www.bu.edu/cpr/webcast/change.html.

Prochaska, J. and B. Marcus.1994. The Transtheoretical Model: Applications to Exercise. *Advances in Exercise Adherence*. R. Dishman. Champaign, IL, Human Kinetics**:** 161-180.

Reeves, B. and C. Nass.1996. *The Media Equation*. Cambridge, Cambridge University Press.

Revere, D. and P. Dunbar.2001. Review of Computer-generated Outpatient Health Behavior Interventions: Clinical Encounters "in Absentia". *Journal of the American Medical Informatics Association* 8: 62-79.

Schneider, K. P.1988. *Small Talk: Analysing Phatic Discourse*. Marburg, Hitzeroth.

Shulman, B.1979. Active patient orientation and outcomes in hypertensive treatment. *Med Care* 17: 267-281.

Sourial, S.1997. An analysis of caring. *J Adv Nurs* 26: 1189-1192.

Squier, R.1990. A model of empathic understanding and adherence to treatment regimens in practitioner-patient relationships. *Soc Sci Med* 30: 325-39.

Stewart, M., B. Belle, et al.1995. *Patient-Centered Medicine: Transforming the Clinical Metho*. Thousand Oaks, CA, Sage.

Stewart, M., B. Belle, et al.1995. *Patient-Centered Medicine: Transforming the Clinical Method*. Thousand Oaks, CA, Sage.

Tracy, K. and N. Coupland.1991. Multiple goals in discourse: An overview of issues. *Multiple goals in discourse*. K. Tracy and N. Coupland. Clevedon, Multilingual Matters**:** 1-13.

Turkle, S.1995. *Life on the Screen: Identity in the Age of the Internet*. Englewood Cliffs, NJ, Simon & Schuster.

Velicer, W. and J. Prochaska.1999. An Expert System Intervention for Smoking Cessation. *Patient Education and Counseling* 36: 119-129.

Velicer, W., J. Prochaska, et al.1999. Interactive versus noninteractive interventions and dose-response relationships for stage-matched smoking cessation programs in a managed care setting. *Health Psychology* 18(1): 21-8.

Walker, M. A., J. Frommer, et al.1998. *Learning optimal dialogue strategies: A case study of a spoken dialogue agent for email*. COLING.

Winefield, H. and A. Chur-Hansen.2000. Evaluating the outcome of communication skill teaching for entry-level medical students: does knowledge of empathy increase? *Med Educ* 34: 90-4.

Wiseman, T.1996. A concept analysis of empathy. *J Adv Nurs* 23: 1162-1167.

Wooley, F., R. Kane, et al.1978. The effects of doctor-patient communication on satisfaction and outcome of care. *Soc Sci Med* 12: 123-128.

Zinn, W.1993. The empathic physician. *Arch Intern Med* 153: 306-12.