

My research interests center primarily in the areas of Human-Computer Interaction (HCI) and Computer-Supported Cooperative Work (CSCW). In particular, I am interested in how people interact, communicate, and work with and through technology, and in assisting them maintain and improve their individual and group practices. My dissertation research focuses on the design and evaluation of computing technologies to support the development and training of teamwork skills in mediated environments, using dynamic visualizations of automated feedback derived from the language used by team members. The main contribution of my research is advancing an understanding of the interconnections between teamwork, communicative behavior, and feedback in technology-mediated environments. My plans for future research include applying these techniques to new domains and technologies for supporting teamwork practices.

Personal Motivation and Approach to Research

After graduating with distinction from the Industrial Engineering and Management at the Technion in Israel, I spent six years in industry designing, developing, and evaluating user interfaces for groupware technologies—a mobile flight-deck information system for commercial B747 aircraft cockpit crews and multi-user geographical command and control systems for military use. Observing technology users in complicated environments such as (co-located) cockpits and (distributed) military training fields, I realized how difficult maintaining effective teamwork could be. Motivated to establish better understanding of these practices and how technology can facilitate teamwork interactions, I decided to continue graduate studies at the Human-Computer Interaction Lab in the Information Science Program at Cornell University.

I take two approaches to achieve my research goals: first, the empirical study and theorizing of human behavior and social interactions motivates me because it is crucial for providing insights for the design of technologies and for analyzing the interconnections between users, technology, and social systems. Second, from a technological standpoint, the specification, design, and evaluation of interactive technologies demonstrate that thoughtful design has the power to influence and change behavioral and social practices. This two-way approach to research requires me to reach out for collaborations and combine computer science and engineering techniques, interaction design, quantitative and qualitative empirical user studies, cognitive and social psychology, and communication theories.

My cross-disciplinary approach is reflected in two papers I recently presented at CHI'08. In the first I collaborated with computer scientists at IBM Almaden Research Center on end-user automation and sharing in an enterprise setting (Leshed, Haber, Matthews, & Lau, 2008). In the second I worked with a group to carry out an ethnographic study that illuminated issues of environmental interactions given in-car GPS navigation (Leshed et al., 2008). These two papers were nominated for and received best paper awards, respectively.

Current Research: Linguistic-Based Feedback for Teamwork Skill Development

A growing interest in supporting technology-mediated collaborations has led to the development of technologies that facilitate task performance, such as improved email clients and phone applications, systems for sharing information and knowledge, online meeting spaces, and so forth. But the implicit assumption that simply providing these tools is sufficient to improve computer-mediated group collaboration is problematic. In my view, a prerequisite to successful distributed team outcomes is the construction of effective teamwork practices, and unless teams are given guidance on the basics of effective teamwork behaviors, these tools may offer little benefit. For instance, if a design team needs to come up with a single design proposal, they must acquire consensus-building skills in order to successfully complete the task.

In my dissertation research, therefore, I seek to understand how collaboration technology can be used to illuminate social processes and behaviors within teams, allowing team members to reflect on them and learn to become better collaborators. Specifically, my approach is to echo back to team members a

visual representation of their linguistic behaviors, automatically processed from their conversations, while they work together. By receiving dynamic feedback about their communication patterns, team members have the opportunity to reflect on them, increase their awareness of the team process, and as a result change their language use and potentially acquire better collaborative skills (Bosworth, 1994).

My work uses automated analysis of language used in the team's conversations as a source of feedback on the group process. In many settings, teamwork consists of meetings and conversations—often mediated by technologies that can capture the conversation. In these cases, various natural language processing techniques, such as Latent Semantic Analysis (Foltz & Martin, 2004), machine learning approaches (Joshi & Rosé, 2007), and word-level analysis (Pennebaker, 2002), have shown that analysis of the contents of group communication could reveal much about a group's collaborative process.

A first step in using an automated analysis technique is to demonstrate that it can effectively generate attributes of language that correspond to desirable collaborative behaviors. To this end, I carried out an experiment in which teams completed a task through a chatroom and provided peer evaluations along widely used dimensions of teamwork behavior (Cohen & Bales, 1979) halfway through the session. Using the automated Linguistic Inquiry and Word Count tool (LIWC; Pennebaker, Francis, & Booth, 2001), I counted what percentage of words in the chat conversations fall into various content categories such as affect-laden words, references to self, and agreements. The results showed associations between language patterns and peer-rated collaborative dimensions (Leshed et al., 2007). For instance, collaborators who received high peer feedback used more words that represent achievement (e.g., best, solve, win), and fewer agreement words (e.g., yes, okay, agree), compared to poor collaborators. These findings provided initial support for the efficacy of language features as a source for feedback on teamwork behaviors.

Based these findings, I set out to design a tool to provide dynamic feedback based on automated linguistic analysis in teamwork settings (Leshed et al., 2006). I led a group of masters and undergraduate computer science students in developing GroupMeter, a web-based chatroom that presents dynamic feedback visualizations during the chat conversation. The system uses LIWC (Pennebaker et al., 2001) to provide near-real time feedback based on the chat contents. Following earlier work (Shami, Leshed, & Klein, 2005), I designed the visualizations in the periphery of the chat interface in order to help teams balance attention and cognitive load between the primary team task and the secondary feedback information. The modular approach of GroupMeter allows me to easily modify variables such as the linguistic metrics it presents, the language analysis technique, and the specific design of the visualizations. Figure 1 shows an example of one interface design, using bar graphs to present the feedback information.

My work on GroupMeter, as an exemplar of technologies that help people improve their language use and teamwork skills, highlights two key questions:

1. Does automated language-based feedback cause people to reflect on and change their use of language?
2. Does automated feedback about language use distract team members from their primary team task?

To address these questions I carried out Experiments 1 and 2 in which teams interacted through the GroupMeter chatroom to complete problem-solving and decision-making tasks and received automated linguistic feedback through the visualizations. Regarding the first research question, the results of both experiments revealed that the feedback made people more reflective about their choice of words and increased their focus on language use

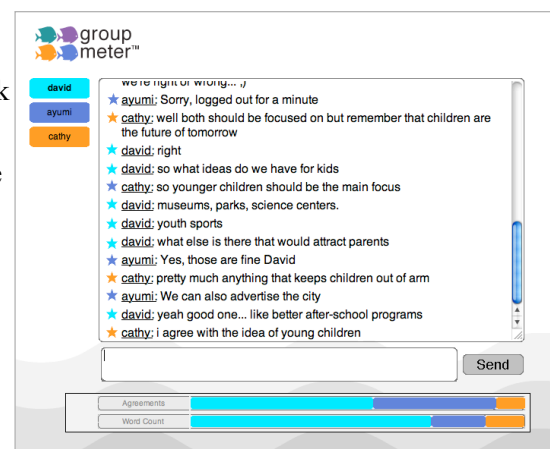


Figure 1. The GroupMeter chat interface with bar graphs feedback visualization. Each team member is represented by a color in the chatroom and the feedback visualization. In this implementation, length of bars represents members' word count and proportion of agreement words.

compared to not receiving feedback. Further, in Experiment 2, two very different visualizations of percentage of agreement words led to the expression of more agreement in teams' conversations as compared to when not receiving any feedback (Leshed et al., 2009). As for the second question, participants in both experiments 1 and 2 felt a tension between attending to the feedback and to the team task, and in Experiment 2 the design itself had an effect on distracting them from the primary team task – a more ambiguous, playful interface drew more attention than a straightforward, glanceable design.

The results of these experiments also suggested that more direction in interpreting the linguistic feedback seems to be important for translating the feedback into communicative actions within the team. For example, when receiving feedback about self-references (e.g., I, me) and agreements (e.g., yes, ok) participants were not sure if they should be referring to themselves more or less when talking with their team members, and whether they should express more or less agreement, respectively. I am currently examining how explicit guidance on effective language use in teamwork situations can facilitate reflective changes of behaviors toward successful collaborative practices.

My dissertation demonstrates the important role of designing technology for teamwork environments to facilitate social practices and behaviors beyond merely accomplishing team tasks. These efforts promote an understanding of how to visualize feedback on communication behaviors to augment team members' reflection, increase their awareness of teamwork practices, and potentially guide them to develop better collaboration skills.

Future Directions: Supporting Teamwork in Technology-Rich Environments

As an immediate extension of my dissertation research, I plan to advance a more general understanding of the interconnections between feedback, communicative behavior, and teamwork in technology-mediated environments, by expanding to additional communication media, organizational settings, and team configurations. These could include, for example, field studies of workforce teams interacting through email, videoconferencing, cell phones, and face-to-face. These kinds of studies can be used to specify ways to provide effective feedback to students preparing to work in distributed teams in different organizational and technological environments.

Another direction I am interested in pursuing is using more advanced language processing techniques as a source of feedback on teamwork behaviors. The word-level category-based approach produces timely linguistic results with low computational needs. State-of-the-art natural language techniques, such as Latent Semantic Analysis, rule-based approaches, and machine learning techniques, can be useful for providing feedback on individuals' and teams' social behaviors.

Further, I believe that the design of interactive technologies can influence individual users' behaviors and possibly improve social interactions around them. A commercial aircraft cockpit crew, a military battalion headquarters, an academic research group, and an office staff, all need to work together in an ever-increasing technological environment. Thoughtful design of interactive systems can improve individuals' awareness of their own and their colleagues' actions and activities and as such provide direction for enhanced teamwork experience and performance. Without compromising usability, usefulness, and aesthetics principles of human-computer interaction, I will continue designing technologies that allow people to be aware of their social interactions and achieve their individual, small group, organizational, and societal goals within a technological world.

Reaching out to collaborate with faculty and students in other disciplines enabled me to augment my dissertation research with areas such as computer science and engineering, natural language processing, design, social psychology, and organizational behavior. As a researcher in the interdisciplinary field of human-computer interaction, I will continue to seek active collaboration with other researchers and professionals, bridging between engineering, computer science and information systems, and social and behavioral science to ensure that my work has a meaningful and practical impact. I will continue to be fascinated and inspired by combining both technological and human aspects to improve and enrich social experiences in technology-rich environments.

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