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Incorporating Multimodality in the Design of Interventions for Communication Disorders

Melanie Baljko
melanie@cs.utoronto.ca

Department of Computer Science, University of Toronto
Toronto, Ontario, M5S 3G4, Canada

Augmentative and Alternative Communication (AAC) is a clinical research area that focuses on the understanding of communication disorders and the development of interventions for them. All interventions can be described in terms of an abstraction called an *AAC system*. A component of many AAC systems is an *AAC device* — a physical entity that must be designed and constructed, which provides another *mode* of communication to its user (albeit an *aided* mode of communication). There is a wide range of technical sophistication in AAC devices, ranging from a laminated piece of printed cardboard to a high-end laptop or tablet running sophisticated software. In many cases, technical sophistication is not correlated with the actual usefulness of the device. Furthermore, the usefulness of all devices or systems, in at least some instances for their users, is still quite unsatisfactory, since face-to-face linguistic communication is frequently much too slow, and the breakdown of communication is commonplace. These problems have long been acknowledged (Shein et al., 1990), and the research goal remains to gain insight into the complex interrelationship between the modes of communication and the types of communicative processes supported by them.

One hypothesized improvement is to support the use of multiple modes rather than to improve incrementally the rate or quality of input that users currently supply to AAC devices. But the objective of supporting "the use of multiple modes" is ambiguous: should the number of input modes to the device be increased to widen the "information bandwidth", or should the design of the AAC device — which provides access to a previously-unavailable, linguistic mode of communication — be modified to improve the effectiveness of the *overall* repertoire of modes? In this paper, the latter interpretation, rather than the former, is advocated, and an approach to this redesign is presented.

Existing computer-based and linguistically-sophisticated AAC devices (see Newell (1995) for an overview) — even those employing sophisticated natural language processing (NLP) techniques (Copestake, 1997; McCoy *et al.,* 1998) — implicitly espouse a greedy approach to the number and complexity of input actions required; the more input that can be provided, the "better" the aided mode (e.g., longer and/or more complex synthesized spoken utterances can be produced). The communication device is often physically fatiguing to use. Also, the style of interaction demanded by the devices requires the use of unaided modes of communication, *even when that mode could be used instead to communicate unaided.* For example, to produce his or her next communication act in a timely manner, an aided communicator must anticipate his or her next turn and start to compose the next utterance. To do so, he or she must look down at the display of the AAC device (which is typically held in front of the user, placed on a table top, or mounted to the wheelchair frame). But to do so interferes with another important use of the mode of eye gaze — to regulate the discourse function of turn taking. The fact that the use of a mode for one purpose (e.g., to provide input actions to the AAC device) can interfere with another important use of that same mode (e.g., to regulate turn-taking) is an obstacle that interventions for communication disorders must overcome. The adequate availability of modes of communication is essential to support communicative processes. With insufficient support, linguistic communication is not possible; with worse support, communication processes can break down completely. But here is the paradox for AAC designers: to gain support for communicative processes (e.g., in the form of an aided mode), the erosion of existing support is required (e.g., the undermining of the use of the unaided modes). Effective communication is best accomplished by the use of a repertoire of modes working in concert together — including both the aided mode and the "native" (unaided) modes; it is sub-optimal for the device interface to require the use of certain modes at certain times, if that requirement conflicts and competes with other uses of the communication modes.

The perspective taken here is that these trade-offs can be formalized, and the interrelationship between (1) the modes of communication that an individual can use (including both aided and unaided modes) and (2) the types

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of communicative processes that are supported can be modeled computationally. We have defined formally a representation for multimodal communicative acts and have developed a methodology for coding multimodal, face-to-face communication for analysis. The representation was designed to be descriptive of data collected empirically as well as data produced by computational simulations. A formal, abstract model has been developed with parameters to represent:

- the semantic content to be conveyed;
- the pragmatic goals of the communicative turn;
- the characteristics of the modes available for communication;
- the interdependencies among the various modes of communication.

The implementation of this formal model has been used in a simulation to produce characterizations of the types of potential multimodal utterances an AAC system-user might produce under the conditions specified by the parameter values (Baljko, 2000). These characterizations are represented by sets of the representations described above. Furthermore, what is intuitively described as synergy in multimodal communication can be formally defined in terms of particular characteristics in these representations of multimodal communicative acts (and which arise under the expected circumstances). The formal model was implemented using constraint satisfaction programming. In the research presented here, it is shown how by varying the parameter values (in particular, those related to the modes of communication), these simulations can reveal the impact of various AAC devices on the supported communicative processes.

To date, we have met our primary goal that the model be descriptive — that it accounts for the empirical data that we have gathered and the findings from the relevant research literature. The validity of the model is currently under evaluation, through a comparison of the data produced by the model with empirical data gathered from digitized video that has been hand-coded by multiple judges.

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References

Melanie Baljko. 2000. The Computational Simulation of Multimodal, Face-to-Face Communication Constrained by Physical Disabilities. In *Proceedings of ESSLLI 2000 Workshop Integrating Information from Different Channels in Multi-Media-Contexts*, pages 1–10, August 6–10, Birmingham, UK. European Association for Logic, Language, and Information.

Ann Copestake. 1997. Augmented and Alternative NLP techniques for augmentative and alternative communication. In Ann Copestake, Stefan Langer and Sira Palazuelos-Cagigas, editors, *Natural Language Processing for Communication Aids, Proceedings of a Workshop Sponsored by the Association for Computational Linguistics*, pages 37–42, Madrid, Spain.

Kathleen F. McCoy and Christopher A. Pennington and Arlene Luberoff Badman. 1998. Compansion: From research prototype to practical integration. *Natural Language Engineering*, **4**(1):73–95, March.

Alan F. Newell, John L. Arnott, Alistair Y. Cairns, Ian W. Ricketts, and Peter Gregor. 1995. Intelligent systems for speech and language impaired people: A portfolio of research. In Alistair D. N. Edwards, editor, *Extra-Ordinary Human-Computer Interaction: Interfaces for Users with Disabilities*, chapter 5, pages 83–101. Cambridge University Press.

Fraser Shein, Nicholas Brownlow, Jutta Treviranus, and Penny Parnes. 1990. Climbing Out of the Rut: The Future of Interface Technology. In B. Mineo, editor, *Proceedings of the Visions Conference: Augmentative and Alternative Communication in the Next Decade*, pages 37–40, University of Delaware/Alfred I. duPont Institute, Wilmington, DE.