HCI for People with Cognitive Disabilities

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The top value for many people with cognitive disabilities is social inclusion.

The self-advocacy movement (Dybwad & Bersani, 1996) grew out of resistance to oppressive practices of institutionalization (and worse) for people with cognitive disabilities. Moving beyond the worst abuses, people with cognitive disabilities seek as full participation in society as possible.

Access to information is critical to social inclusion and increasingly reliant on technology.

The Web has greatly increased access to information for many people, and in the process has become an indispensable avenue of participation (see National Council on Disability, 1996, for a thorough discussion of the importance of the Web.) As Ivan Illich observed (1976), the automobile has made it impossible to walk. Similarly, the Web has created demands beyond those of simple literacy because it is so useful for those who can access it.

Limited research shows that people with cognitive disabilities have the same kind of problems with websites as other people, but with greater severity.

For example, many people are annoyed to find that the BACK button does not work when a Web page has opened in a new window; this annoyance becomes a serious obstacle for people with cognitive disabilities (Small *et al.*, 2005). Pilot work with a modified browser (Davies *et al.*, 2001) suggests that some of these difficulties can be eased by increased attention to accessibility in browser design, work that should be pursued.

Access to textual information, whether on the Web or elsewhere, is difficult.

Some people with cognitive disabilities are wholly illiterate, while others have difficulty with complex sentence structure, and/or have limited vocabulary.

Advances in language technology should be applied to text simplification.

Recent developments in statistical modeling of very large corpora have led to rapid progress in language engineering, including machine translation (see e.g. http://www.nist.gov/speech/tests/mt/mt05eval_official_results_release_20050801_v3.html). While these methods cannot be applied directly to automatic text simplification, because of the lack of large parallel corpora of raw and simplified text, there are possible approaches to be explored. These include studying the behavior of full language models when restricted to subset vocabularies, the use of vector space meaning models to select bags of words in a limited vocabulary whose meaning approximates a target text, and the development of a language model for simplified text based on selecting simplified text from the Web.

A theoretical framework for the simplification of conceptual content is needed.

Besides changing the language of expression, editing material by hand for increased cognitive accessibility requires judicious simplification of content. It would be useful to have theoretical guidance for such simplification, both to support possible automation, and to improve the quality and reduce the cost of manually edited materials.

Communication systems not relying on text should be more fully explored.

As already mentioned, some people with cognitive disabilities are wholly illiterate. A variety of communication schemes using simple pictures have been in use for years, but understanding of what characteristics of the pictures are crucial, or of well-founded ways of using them to express abstract ideas, is lacking. Cathy Bodine (personal communication) has found that, in some situations, abstract symbols can be very effective for people generally thought to be dependent on very concrete pictures.

Task prompting systems, for example those developed by AbleLink Technologies (http://www.ablelinktech.com), use pictorial prompts to guide users through the steps of workplace or daily living tasks. Here again, knowledge of what attributes pictures should have for particular users’ needs is lacking.

Recently Swedish researchers (Danielsson & Jönsson, 2001) have developed innovative systems using large volumes of digital images to support communication, and, given the increasing ease of capturing, storing, and managing images, these ideas should be further developed.

Modern life is very demanding cognitively.

The book, In Over our Heads: The Mental Demands of Modern Life (Kegan, 1994), documents many of the challenges of life in a rapidly changing, increasingly competitive society. Sadly, people with cognitive disabilities, who once might have been protected by friends and family in a simpler, overwhelmingly agrarian society, are now vulnerable to many forms of exploitation, as well as having difficulty taking on many of the roles that modern society offers.

Access to human companionship and support is important.

To cope with these dangers, and these limitations, people with cognitive disabilities rely on supportive relationships with other people. Supportive relationships are a vital part of life for almost everyone, intrinsically rewarding as well as instrumentally valuable, but they are even more important for many people with cognitive disabilities.

New communication technologies may help.

New communication technologies in the US, and more strikingly in Asia and Europe, are greatly increasing people’s ability to be constantly in touch. Mobile phones allow people to be in communication almost anywhere, any time. Text messaging allows communication silently and unobtrusively, even in settings in which a telephone conversation would not be workable. Versions of these technologies, including such features as picture dialing and picture messages, may allow people with cognitive technologies to be more independent, while retaining access to support when needed.

Variants of these technologies can provide more direct support, by enabling a caregiver to monitor a person's environment. Ned Kirsch and colleagues at the University of Michigan (Kirsch *et al.*, 2004) have developed a system that allows a clinician to monitor the conversation of a person with a brain injury, who has trouble controlling excessive volubility. The clinician can issue a simple prompt, "Be brief," that helps this person exert appropriate control.

Always-on communication could provide assistance with problems of ordinary life. The mother of a young man with Down syndrome tells of an incident (Trainer, 1991) in which her son returned very upset from a trip to the movies with friends. His friend celebrated a birthday by (unexpectedly) buying the tickets for the party, but then refused to share her popcorn, which was very distressing to the son. When the mother pointed out that the son could have bought popcorn using the money he had saved on his ticket, the son recognized that that was so. But, at the time, at the theater, he had not had that idea, and his disappointment over the popcorn spoiled his evening. With always-on communication, the son could have gotten help while at the theater, either by requesting it, in response to being upset, or (potentially) by the mother being able to detect that he was upset remotely.

Technology that detects everyday life problems and provides guidance may be a long-term possibility; short term in some cases.

It is already feasible to provide automated monitoring for some situations, including the "Be brief" situation, and another common effect of brain injury, difficult-to-control profanity. It is within the state of the art to train a monitoring system to detect the need for prompts in situations like these. Eventually, emotional upset such as occurred in the popcorn incident could be detected, so that human assistance could be invoked, and, in the much longer term, systems that could actually diagnose such problems, or detect problematic exchanges with strangers, may become possible.

Moving to the meta level, HCI has not been a focus in cognitive assistive technology work.

Neither HCI nor related terms occur in Dave Edyburn's literature review (2004) of the special education technology literature.

HCI for people with cognitive disabilities is at the guideline stage.

Around 1980 the state of the art in user interface design was the application of any of large numbers of design guidelines. These suffered from being vague, in many cases ("use familiar language") and insufficiently sensitive to context. Appropriate use of color, for example, depends on many contextual factors that can't be captured effectively in guidelines. Current advice on cognitive accessibility is at an analogous stage; see e.g. Bohman & Anderson 2005, Hudson *et al*. (2005), or Mirchanandi, 2003.

Like HCI generally, it needs to be based on theoretical models and empirical methods.

Progress in HCI after 1980 was driven by the development of useful theoretical models, such as Card, Moran, and Newell's model human processor (1983) or the Kieras and Polson Cognitive Complexity Theory model (1985), and, perhaps even more, by the emergence of effective empirical methods for evaluating and improving user interfaces.

Theory is a major challenge.

There is reason to doubt that a "model human processor"-like model is feasible for people with disabilities. Studies of intelligence (see Deary, 2000) argue against any simple architectural account of even specific disabilities, let alone the whole spectrum of disabilities. The chromosomal abnormality that causes Down syndrome produces scores of known changes in brain structures, some of them quite sweeping (Pennington & Bennetto, 1998). At the same time, efforts to isolate specific contributions to intelligence, or deficits in it, have foundered on the general finding of correlations among performances in virtually all mental tasks, however simple, rather than (as many hoped) evidence of differences in simple, identifiable mechanisms. Despite these disappointments, continued progress in the development of architectural frameworks like ACT-R (Anderson *et al.*, 2004) justifies investment in studies of individual differences, especially cognitive disabilities, from that perspective. Results would have implications for HCI.

Quasi-theoretical methods like PUMs and Cognitive Walkthrough require understanding of cognitive processing by people with cognitive disabilities that we do not have.

These methods (see Young *et al.*, 1989, and Wharton *et al.*, 1994) have proven useful in mainstream HCI. But they rely on our having a working knowledge of how users respond to common situations that arise in HCI. We lack this for people with cognitive disabilities. A complicating factor is increased variability, as Sutcliffe *et al.* (2003) found in studies of email use.

People with cognitive disabilities need to be included in user testing panels.

The biggest reason for our ignorance is there have been so few studies of people with cognitive disabilities in usability tests. Discussion of this omission suggests that an important reason for it is uncertainty about how to obtain human subjects review approval for working with such participants. This appears to be soluble problem, in that appropriate protocol treatments could be developed and shared among research groups.

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