

The Relationship between Cognitive Impairment and Assistive Technology: Implications for Effective Aid Use

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Abstract: Assistive technology for cognition (ATC) can compensate for cognitive impairments, thereby having a large potential to improve independence, daily-life/work participation and overall quality of life. The aim of this paper is to incorporate research findings, experiences from clinical work, and findings from ATC-projects, and to give an account of factors that predict effective use of compensatory technological aids in cognitively impaired individuals. The implications of these factors for future standardization initiatives in the field of ATC are discussed, and suggestions on how to develop assessment and implementation guidelines are proposed.

Keywords: Assistive technology for cognition, ATC, Cognitive impairment, Neuropsychological assessment, Standardization.

Introduction

There is an increasing number of technological aids available that may improve the ability to plan, organize and keep track of work-related and daily activities. A search for “organizer” in Apple app store yields almost 5000 hits, demonstrating the vast amount of potentially helpful aids commercially available. Most people use technological aids in their daily activities, such as keeping notes or creating reminders on their mobile phones. These simple aids, together with more sophisticated assistive technology for cognition (ATC), may be of particular help to individuals with cognitive impairments such as deficits in the ability to concentrate, think, comprehend, remember, plan and evaluate actions [1]. Advances in health care increases life expectancy and survival-rate after brain injury, subsequently leading to an increased overall prevalence of cognitive impairment. For instance, a national program for rapid identification and treatment of stroke has reduced Norwegian mortality rates [2], hence increasing the number of survivors with cognitive disability after brain injury. The rapid advances in technology and increasing call for ATC, points to a need for product-specific standardization and standardized guidelines on how to assess impairment and functional needs, how to merge person and technology (i.e. what works for whom), how to introduce and teach appropriate aid-use, and how to manage requirements for

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follow-up and support. The aim of this paper is to highlight factors that predict effective aid use and that should be addressed in future standardization initiatives.

1. The Implications of Cognitive Dysfunction in the Assessment, Selection and Use of Assistive Technology

1.1 Assessment

Cognitive impairment is a result of injury or disease that damages and/or alters the function of the brain, and is therefore a common feature of several patient populations, including acquired and congenital brain injury. Each year more than 15 000 Norwegians are hospitalized as a consequence of stroke [3], and one out of every 500 inhabitants are hospitalized annually due to traumatic brain injury [4,5,6]. Approximately 3-5 % of the population have attention deficit hyperactivity disorder (ADHD) [7]. These are only some of the illnesses and conditions that are associated with cognitive impairment, e.g. impairments of memory, time management, planning and lack of self-initiation. Assistive technology for cognition (ATC) can help individuals compensate for cognitive impairment, thereby having a large potential to improve daily-life and work participation, independence and overall quality of life. Empirical research and theoretical conceptualizations suggest a number of factors that predict the effective use of compensatory technological aids.

Evans [8] emphasizes the importance of age, severity of impairment and previous use of compensatory aids. Young people seem better able to compensate for cognitive deficits, whereas individuals with major deficits compensate less well. Moreover, previous familiarity with compensatory aids predicts more efficient use following brain injury. Wilson [1] suggests additional variables that are likely to influence aid use, namely insight and motivation, support from family members/work colleagues and absence/presence of sensory, motor and/or psychiatric disability. These findings illustrate the need for an exhaustive understanding of the ATC user and his or her prerequisites, if effective aid use is to be obtained. This information may be gathered through medical journals, from spouses, family and caregivers, and by systematic clinical assessment.

Experience from clinical work with persons with cognitive impairments underlines the importance of systematic assessment. At the Department of Vocational Rehabilitation – Brain Injury, Norwegian Labor and Welfare Administration, five separate procedures lead to the assessment of an individual's cognitive impairment. First, medical journals are reviewed by a multidisciplinary team consisting of psychologists, occupational therapists and educational therapists. A comprehensive neuropsychological examination is then carried out. Neuropsychological assessment offers a means of acquiring detailed knowledge about the aid users' cognitive profile, including preserved cognitive abilities and impairment severity across cognitive domains such as sensory-motor processing, attention, memory, language, visual-spatial processing and executive functions. A psychiatric evaluation is completed as part of the assessment, along with an estimation of the level of insight. Having established the cognitive profile, occupational or educational therapists then evaluate the individual's performance in a simulated work environment in order to gain ecologically valid information about level of functioning. The information gathered through the previous steps are then synthesized, and if needed, additional information is obtained. Finally, a

comprehensive report is written, consisting of a thorough description of preserved cognitive abilities, cognitive impairments, feasible compensatory strategies, environmental adaptation requirements, and suggestions with regard to ATC that could prove helpful to the individual. Perhaps most importantly, in light of the purpose of this paper, a description of how the cognitive profile may influence ATC skill acquisition is specified and possible pitfalls which may hamper effective aid use is addressed. In our experience, those who need ATC the most may have the greatest difficulty learning how to use them and therefore require extensive training and follow-up to be able to utilize the aid. For instance, an individual who is easily distracted due to attention difficulties may benefit from time management aids. However, learning how to use these aids may be hampered by the inherent attention difficulties, thereby requiring additional pedagogical interventions such as frequent repetitions and prompting, learning one aspect of ATC-use at a time and “overlearning” beyond the point of initial mastery so that skills become automatized. Moreover, in addition to aid use, environmental adaptations, such as elimination of possible distractors (e.g. noise, providing seating away from windows), could prove equally important for overall level of functioning.

A standardization of ATC implementation must take into account the complex interaction between cognitive impairment, potential for aid use, how the impairment affects aid skill-acquisition and required compensatory measures other than technological aids. One way of ensuring that this complexity is addressed in ATC provision is by developing guidelines emphasizing the importance of a comprehensive methodical assessment, and providing suggestions of questionnaires, structured interviews, checklists, observational procedures and assessment techniques that can prove informative. This way the integral needs of the individual can be fully comprehended.

1.2 ATC Implementation and Skill Acquisition

Studies have illustrated the importance of a systematic and structured training programme in ATC implementation [1]. Sohlberg [9] has conceptualized distinct phases of ATC implementation with explicit key objectives in each phase:

- Acquisition phase: establishing motivation (“How can ATC be of help to me?” “Do I see myself using it?”) and mastery of basic ATC skills (“How is the aid used?”)
- Mastery and generalization phase: Strengthen skills, increase user independence and expand aid use in various contexts. Evaluate and overcome difficulties.
- Maintenance phase: Scheduling follow-ups on a regular basis. Revise aid use and adapt to changing circumstances if needed.

Each ATC implementation phase requires training plans, support and follow-up carefully tailored to the user’s individual cognitive profile and needs. For example, skill acquisition may be hampered due to memory impairments, which may imply a prolonged acquisition phase. In contrast, difficulties with self-initiation may disrupt the ability to execute independent aid use (mastery and generalization phase), even though mastery of basic skills has been achieved in the acquisition phase [9].

Findings from projects at the Department of Vocational Rehabilitation involving ATC utilization trials, e.g. “Smart phones as facilitators of vocational mastery” [10] and “Mobile phones as cognitive aids in ADHD or Asperger Syndrome” [11], are in accordance with the above suggestions, highlighting the importance of adequate and appropriate individualized training to ensure that the cognitive aid is used in a purposeful and effective manner. In the most recent project, eight students with ADHD or Asperger Syndrome were followed over a two-year period. They were provided with an ordinary smart phone that would function as a “cognitive assistant” in their daily lives. As part of the aid acquisition and mastery phase, each student took part in monthly two and a half-hour workshops together with three fellow students and two supervisors. Only two of the students were using personal organizers/daily planners at project startup, and all of them were reporting significant daily stress in relation to remembering appointments and prioritizing activities. At the end of the study, all students were using smart phones as daily organizers. One of the project’s aims was to assess whether using a smart phone as a cognitive aid could reduce daily stress-related issues (e.g. loss of control, missing appointments or social difficulties). All of the students reported that the smart phone significantly reduced feelings of stress and increased feelings of control. Each student experienced that their smart phone had become an important part of their daily routine. However, perhaps the most important lesson learned from the project, was that it took a considerable amount of time, practice and extensive follow up before the students developed these routines. Paradoxically, some of the students reported increased feelings of stress and frustration associated with smart phone use in the second semester, as a consequence of being insecure about learning new technology, managing software updates, synchronizing their smart phone and computer and so on. To be able to employ the aid efficiently, it proved necessary to radically change daily habits, which required a considerable amount of time, effort and practice.

The findings from this project are in line with research underscoring the importance of systematic and extensive training to change current behavioral patterns and to generalize aid use to various contexts [1]. The project also illustrates the need to understand how motivational issues influence aid use. Models of health behavior change, such as the Transtheoretical model [12], can provide a framework for understanding how self-efficacy and motivation will influence ATC skill acquisition and mastery over time when assessing an individual’s readiness to act on new behaviors.

2. The Need for Standardization of ATC Assessment and Implementation Procedures

Development of standardized guidelines will facilitate a systematic approach to the issues outlined above, increasing the likelihood of successful and functional aid use, which in turn may increase vocational participation, psychosocial functioning and overall quality of life. The challenge of developing a standard for the implementation of ATC is that the implementation process nevertheless must be tailored to individual factors (i.e. cognitive profile, motivation, expectations, level of insight, and previous experience with aids). Guidelines must be well-defined, but flexible enough to accommodate heterogeneity and individual variation. Thus, the goal of standardization work should be to develop a set of guidelines that ensure adequate assessment of the

individual, that the appropriate aid is provided, and that the person is introduced to the aid in such a way as to maximize the possibility of effective use over time and across contexts.

2.1 Suggestions on How Current Theoretical Conceptualizations Can Inform Future Standardization Initiatives

Development of standardized guidelines for ATC assessment and implementation should be considered within a biopsychosocial framework, taking into account physical, psychological and social domains of functioning and how factors related to these domains might influence aid use. As highlighted above, effective aid use is contingent on environmental and social factors such as social support and alteration of the physical environment. Scherer and colleagues have incorporated these aspects into a framework for predicting assistive technology device outcomes [13]. The framework describes factors relevant to short-term and long-term outcomes, while taking into account the influence of moderating factors such as concurrent interventions, comorbidity and person-context interaction. This outcome-oriented model, together with classification methodologies (e.g. International Classification of Functioning, Disability and Health [14]) and system modeling methods (e.g. Human Activity Assistive Technology [15]) could serve as starting points for developing standardized and practically applicable guidelines for assessment and implementation of ATC. Moreover, guidelines should be evidence-based, i.e. research on aid effectiveness and empirically supported training programs should be taken into account. Cicerone [16] has reviewed cognitive rehabilitation methods and suggested empirically validated interventions for specific classes of cognitive impairments. An example can illustrate how findings from these lines of research can be informative in the context of ATC-implementation: In individuals with severe memory impairments, errorless learning is empirically validated as effective when learning novel tasks. This finding demonstrates how a specific aid should be introduced to individuals with substantial difficulties remembering, i.e. by principles of errorless learning rather than being taught aid use by trial and error. In our opinion, it is essential that a standardization of assessment and ATC implementation procedures incorporate such findings to ensure that practice recommendations are evidence-based and appropriate. Thus, standardized ATC guidelines should include descriptions and examples of various cognitive impairments and adaptational requirements, such as need for structure, repetition, multimodal learning, prolonged comprehension time, and so on.

3. Conclusions

Research findings, clinical experience and knowledge gained through ATC project trials converge on the importance of thorough assessment, along with systematic and structured training adapted to the individual's needs, if ATC use is to be effective. From the authors' point of view, an in-depth understanding of the cognitive profile of the individual is paramount when selecting and implementing a technological aid. The complex and multifactorial nature of cognitive impairment, along with rapid technological advancement, demonstrates the need for developing standardized guidelines. From our perspective, such guidelines are necessary in order to help

professionals working in the field of ATC and to ensure effective use of technological aids in cognitively impaired individuals.

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