

Use of Memory Aids as Cognitive Prostheses in Schizophrenia: An Untapped Potential?

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A considerable body of research has indicated that impairments in the ability to store and retrieve verbal information are common features of schizophrenia. The current paper seeks to discuss how strategies developed for other groups with significant memory loss might be applied to help persons with schizophrenia. In particular we concentrate on strategies yet to be applied to schizophrenia which focus on compensating for memory loss through the use of technologies or external aids. These approaches, in contrast to remediation approaches that are already starting to be applied to schizophrenia, do not aim to repair memory loss but instead seek to help persons live with their deficits by providing them with devices that function conceptually as cognitive prostheses. We propose that such devices, if appropriately configured, could be used to increase medication adherence, reduce behavioral disturbances, assist with cognitive self-monitoring and facilitate work function in schizophrenia. Implications for future research are discussed.

Verbal Memory and Schizophrenia

A considerable body of research has indicated that impairments in the ability to store and retrieve verbal information are common features of schizophrenia (Stirling, Hellewell, & Hewitt, 1997). These impairments are often more severe than other neurocognitive deficits (Gold, Randolph, Carpenter, Goldberg, & Weinberger, 1992) and are stable across the course of the illness (Cantor-Graae, Warkentin, & Nillson, 1995). Impairments in verbal memory affect learning (i.e., Kenny et al., 1997), recall, and recognition (Paulsen et al., 1995) and may be closely related to failures of semantic organization (Brebion, Smith, Amador, Malaspina, & Gorman, 1997) as well as difficulties screening out intrusion errors (Paulsen et al., 1995).

Beyond their theoretical significance, impairments in verbal memory in schizophrenia are of practical importance given their logical associations with daily functioning. By definition, impairments in verbal learning should make it difficult for persons with schizophrenia to learn new behaviors and to determine when, where, and how to apply learned behaviors in the future. Furthermore, impairments in the ability to remember the context of daily events are likely to disturb how well one is able to link present, past, and future expectations – links necessary for the evolution of a personal sense of history (Lysaker, Bryson, Greig, & Bell, 2000). Consistent with these

conjectures, research has found that deficits in verbal memory in schizophrenia are related to social and vocational function (Addington & Addington, 1998; Bryson, Bell, Kaplan, & Greig, 1998; Mueser, Bellack, Douglas, & Wade, 1992), symptom levels (Berman et al., 1997; Brebion et al., 1997; Lysaker et al., 2000), and coping preferences (Lysaker, Bryson, Marks, Greig, & Bell, in press).

Schizophrenia and Other Sources of Verbal Memory Loss

While the full extent of verbal memory loss in schizophrenia has been recognized only recently, many other conditions have, for far longer, been known to result in profound impairments in the ability to learn and retain verbal information. Relevant to this paper, memory loss associated with other conditions, such as head injuries, strokes, and Alzheimer's disease has spurred on the development of widely varying and elaborate treatment strategies to both ameliorate and compensate for memory loss (e.g., Charness & Holley, 2001).

The current paper seeks to propose some concrete applications of treatment strategies for verbal memory loss that have yet to be applied to schizophrenia. In particular, we will discuss hypothetical applications of a distinct group of interventions that focus on compensating for memory loss through the use of tech-

nologies or external aids. These approaches, in contrast to other strategies such as remediation approaches which aim to repair memory loss, seek to help persons live with their deficits by providing them with devices that function conceptually as cognitive prostheses. In other words, these approaches endeavor to create and employ devices that might metaphorically "fill in" for memory deficits, much as an artificial limb might "fill in" for a missing limb.

To discuss the potential of compensatory interventions for persons with verbal memory impairments and schizophrenia, this paper will first focus on the history of devices that have been used to assist other groups in the same manner. Second, based on this review we will propose four different ways in which technology might be applied in the psychosocial rehabilitation of persons with schizophrenia and offer hypothetical illustrations. We lastly suggest some potential research strategies.

Cognitive Prostheses: Existent Applications

The notion of cognitive prostheses suggests a consistent and dependable artificial procedure that enhances behavior by imitating the function of an intact or ideal cognitive capability (Charness & Holley, 2001). The appointment book, for instance, is a very simple external cognitive aid that might serve a person who often forgets scheduled appointments made hours earlier. For individuals with significant memory impairments, the functions served by cognitive prosthetic devices become a matter of far greater importance, especially in cases where remediation is not possible. External cognitive aids may be of invaluable service to memory-impaired persons who struggle to function independently, as the aid may enable them to perform essential daily tasks. Furthermore, the person with a head injury who successfully utilizes a device to gain autonomy incurs obvious benefits, and a number of less immediate benefits result, including time and money saved and reduced burden on family and caregivers.

To date, a multitude of simple devices has been utilized to complement memory (Parente & Stapleton, 1993). The most basic cognitive prostheses include checklists, notebooks, organizers, calendars, and appointment books. Simple checklists for instance, may help a memory-impaired person buy groceries while advanced uses of checklists may provide procedural guidelines, wherein a multi-stage process such as going to work is broken down into a step-by-step list of operations (Parente & Anderson-Parente, 1989; Parente & Herrmann, 1996; Parente & Stapleton, 1993). Though similar to checklists, notebooks, appointment books, and calendars can fulfill different needs by

maintaining records of both the individual's future appointments and past activities. These devices not only remind the individual of commitments, but also may be referenced in order to cue remembrance of past engagements and events. Similarly, most organizers (Herrmann & Petro, 1990; Parente & Herrmann, 1996) seek to facilitate easy retrieval of belongings and to prevent possessions from being misplaced. The organizers also help impaired persons maintain a sense of order and consistency, cataloging a myriad of objects and helping persons keep track of a multitude of medications which may differ according to when and under what conditions one is to take them.

More advanced external memory aids have also been developed, including watches with alarms and microcassette recorders that preserve individual thoughts and information such as where one's car was parked that morning (Herrmann & Petro, 1990; Parente & Anderson-Parente, 1989; Parente, Stapleton, & Wheatley, 1991). An eclectic assortment of electronic devices also has been used to track appointments and catalog personal data (Parente & Herrmann, 1996; Parente & Stapleton, 1993). Recently, computers have been used to aid the cognitively impaired across a variety of tasks, including most all of those attended to by any single-purpose electronic device. Although computers represent the most promising and comprehensive electronic prostheses, the majority of the literature written about incorporating computers into treatment plans for the cognitively impaired emphasizes retraining. The notion that a computer might function as a prosthetic device has been underestimated and underinvestigated. Research on the topic has progressed relatively slowly, most likely because of financial and time-related constraints associated with authoring and adapting software for the impaired user (Chute & Bliss, 1994; Chute, Conn, Dipasquale, & Hoag, 1988).

One significant advance, however, is Bergman's (2000) development of computer software for cognitively impaired individuals that contains six modules: a journal, an address book, a phone log, a module for savings management, a checkbook module, and an appointment book. In a sample of 41 brain-injured persons, 36 were able to achieve "mastery" of at least four of the modules following only a brief four-sentence introduction. Thirty-nine of the study's participants were able to master at least one of the modules. Although the study was uncontrolled, Bergman's data has the potential to dispel one of the most pervasive assumptions about computers as cognitive prosthetics, namely that cognitively impaired individuals cannot learn how to use the devices.

Bergman's (2000) findings are notably consistent with a number of case studies. Bergman and Kemmerer (1991) created a program that allowed a brain-injured woman to communicate in writing, enhancing both her ability to perform tasks of daily living and her emotional sense of well being. Demonstrative of the vocational applications of computers as prostheses, Parente et al. (1991) used specialized computer software as part of a regimen of prosthetic devices that allowed a man to return to work following a head injury. The computer software guided the man through cognitive processes that he had been rendered incapable of performing, and without the device he would not have been able to return to work. In a more contrived scenario, Kirsch, Levine, Fallon-Krueger, and Jaros (1987) developed a computer program to lead a head-injured woman who exhibited verbal memory impairments comparable to those seen in people with schizophrenia, through a multi-step process that involved baking cookies and making icing. Without the aid of the software, the woman was judged to have made 4.3 errors while performing the cooking procedures. The woman made just one error during a trial with the computer, and a second trial without the computer's assistance resulted in 5.3 errors. And in yet another case study with a brain-injured person, a palm device with an alarm allowed a usually unreliable man to arrive for his appointments and ask for his medications on schedule (Kim, Burke, Dowds, & George, 1999). As in other cases this particular subject reported both improvement in function and in personal sense of empowerment. In summary, despite their limited data and lack of control, these studies suggest that the applications of computers in cognitive prostheses may become more widespread as software becomes more amenable to customization and adaptation.

Cognitive Prostheses for Persons with Schizophrenia: Potential Applications

Given the success of compensatory interventions for people with memory losses in general, it seems natural to next ask how might these devices meet the needs of persons with schizophrenia. To begin to answer this we will propose four potential ways in which such devices might be concretely applied to persons with schizophrenia based on our current research and clinical practice. Our intention here is to propose both areas of application and specific outcomes that might result from such an application. This list is intended to spur on conversation and is not intended to be comprehensive.

Medication Adherence and Appointment Attendance

Perhaps more than any other behavior, medication adherence is closely linked to outcome in schizophrenia (e.g., Svarstad, Shireman, & Sweeney, 2001). As persons with schizophrenia fail to adhere to medication, their symptoms worsen, psychosocial function deteriorates, and a vicious cycle intuitively ensues. While adherence has been linked to issues such as awareness of illness (Cuffel, Alford, Fischer, & Owen, 1996), clearly memory impairments are also a barrier to persons taking medications as prescribed. Memory impairments must similarly be a barrier to attending appointments during which the effectiveness of prescribed medications is evaluated, and counseling and professional support are offered. Thus we wonder whether persons with schizophrenia might benefit from electronic devices which have an alarm which reminds them when to take medication and when to attend appointments. Such devices might offer simple auditory signals telling the individual to depress a certain key that relays a message to them (e.g., take medication "AA" now). A similar approach might involve a pager worn by the individual that relates a preprogrammed message at a specific time from a case manager which might tell the person, for instance, what medications to take or give a reminder regarding an upcoming appointment. Such devices might also contain a key that the person could depress to indicate that they took the medication, thus creating a record that documents adherence. The data from successfully depressing the key denoting adherence might also be tied to a reinforcement of some kind. Outcomes that might accompany the successful use of such a device might include fewer missed appointments, reductions in symptoms, and fewer inpatient hospitalization stays.

Behavioral Modification

Persons with schizophrenia are often prone to behavioral disturbances, including difficulties with anger, anxiety, and ambivalence. While these behaviors are no doubt multidetermined, they are also most likely linked, at least indirectly, to memory. For instance, remembering why one should inhibit a behavior may enhance the individual's ability to inhibit it. To follow one course of behavior, an individual must be able to remember both the nuances of that course and the reasons that gave birth to it. To benefit from relaxation one has to remember what it is and how to use it. Thus we wonder whether an electronic device could be used to help persons correct behavioral patterns they see as maladaptive. For example, consider the hypothetical case of BB, a

woman who experiences considerable ambivalence about school. Might not she benefit from a device that could remind her of a relaxation exercise when she was anxious? Perhaps every time she felt the urge to quit school, the device could remind her of what she has to gain by not quitting at that moment or what would be lost if she exploded and she kicked her professor in the shins.

Alternately, consider the hypothetical case of CC, an individual who tends to be easily angered under stress and rapidly withdraws. Perhaps CC and his counselor might program the steps of an individually tailored anger management program into a hand held device which CC could access when he notices certain signs that he may be becoming angry (e.g., problems concentrating or faster breathing). For example, if CC becomes angry when he feels DD, a neighbor, has criticized him with an off the cuff comment, CC might depress a key on the programmed device, and a strategy for responding to the perceived insult could be displayed. Perhaps the device could display a note that urges CC to think about other possible explanations of the meaning of DD's comments that are beyond CC's idiosyncratic interpretation.

In the case of BB and CC, an individually tailored cognitive behavior plan made immediately accessible by a device might improve social outcomes. These procedures might also instill in BB and CC a greater sense of well being and empowerment. Perhaps a sense of ownership and control would ensue from the fact that the prosthetic advice is literally carried by the client and elicited only at their own prompting.

Cognitive Self-monitoring

Continuing from a therapeutic standpoint, a reminding device could also facilitate a person with schizophrenia to foster a greater awareness of his or her thoughts. If the reminding device was scheduled to randomly alert the person just a few times each day, the person could use the reminder as a cue to monitor his or her thoughts. By recording thoughts in writing when prompted by the device, the person would be forced to consider his or her thoughts several times daily. The written thought record might help the individual to discover dysfunctional or maladaptive thoughts of which he or she was otherwise unaware. The record could also give both individual and counselor a gauge of the frequency of dysfunctional thinking. Take for example, EE, another hypothetical person with schizophrenia who is far-removed from his own thoughts and unable to recall any instances of dysfunctional thinking when probed in therapy. After a week of spontaneously recording thoughts when prompted by the device, however, perhaps EE might

find that 80% of his recorded thoughts included the idea "I am a failure." This might open up the issue to intervention. Implied in this vignette is that some form of cognitive prostheses could facilitate metacognition, or thinking about thinking in schizophrenia. Expected outcomes from such interventions could include enhanced self-esteem and reductions in symptoms of emotional discomfort.

Vocational Functioning and Learning New Work Behavior

In the first three examples we have suggested how cognitive prostheses could be employed to combat general problems in the areas of medication adherence, and the monitoring of maladaptive behaviors and cognitions. Another, though certainly not the final, possible application of compensatory interventions, could involve helping persons negotiate the complexities of work. In case studies noted above, one brain-injured person was able to return to work with the help of a checklist (Parente & Herrmann, 1996), and another returned to an old job with the help of a computer and software specialized to fit his work tasks (Parente et al., 1991). Might not people with schizophrenia attempting to function in a vocational capacity benefit from these same types of cognitive aids? In our present research we commonly place persons with schizophrenia in work placements in a medical center (c.f. Bell & Lysaker, 1997). One of the most anxiety-provoking work placements is the Supply Processing and Distribution (SPD) center. SPD workers must pull requested supplies from a basement warehouse and distribute the supplies to appropriate locations throughout the medical center. When they begin working at SPD, persons with schizophrenia typically experience distress and anxiety concerning the locations of supplies in the warehouse, and many complain that they cannot remember where supplies are stored in the warehouse. In this instance, a simple paper map or list of supplies' locations might serve as a cognitive prosthetic, alleviating anxiety and distress and improving work function. A more advanced solution for the same dilemma could include using a computer with software customized to help the person find locations. The Kirsch et al. (1987) program broke tasks into stages and offered options appropriate to the stage of the task that was being performed. A similar program for a person with schizophrenia assigned to SPD could include choices appropriate to their search for supplies, ultimately directing the person to the correct warehouse location. In such paradigms one would expect vocational outcomes to be improved and, as a consequence, secondary clinical gains might also be anticipated.

Summary and Potential Research

Cognitive prostheses like those that have been used to aid other cognitively impaired persons could greatly improve the quality of life of people with schizophrenia. Palm devices in particular represent a great potential to provide a comprehensive prosthetic, capable of guiding the person through any number of tasks including those related to daily living and vocational function. For a person with schizophrenia, a palm device could incorporate all of the potential treatment applications mentioned above into a comprehensive cognitive prosthetic. As software becomes easier to manipulate, the customizability of the device will become virtually unlimited. Since it stands to reason that some physical features may enhance or reduce a device's usability, research is necessary to determine the optimal characteristics of palm devices.

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