

# XIII. Head Trauma and Stroke

## The Application of Microcomputers for the Treatment of Aphasic Adults

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Sponsor: VA Rehabilitation Research and Development Service

**Purpose**—The use of microcomputers in rehabilitation of brain damaged patients continues to win popularity in some clinical settings. Cost effectiveness, operational efficiency, and increased treatment-time allocations without additional human resources are the high tech features which bolster their acceptance and application. Yet database research in speech/language pathology concerning treatment efficacy remains sparse. In this age of high tech applications to almost every phase of our professional lives, there appears an urgent necessity to know the efficacy of treating patients with microcomputers. The field presently lacks convincing data as to the efficacy of using microcomputers for the rehabilitation of aphasic adults. It is unfortunate, however, that many clinicians are getting into the computer business without collecting this efficacy data first. The purpose, then, of the present study is to answer the following question: are microcomputers more effective in teaching a criterion performance than the same procedure presented by a clinician?

**Progress**—The study is being made up of 20 chronic aphasic patients who have sustained a single lesion to the left hemisphere. Each aphasic person within this study population will be in the mild-to-moderate range of aphasic severity. To study treatment effectiveness, an alternating treatment design with multiple probes (single case), is utilized. By using this type of design, baseline performance, the effects of treatment, maintenance of behavior, and generalization can easily be viewed. All patients receive two modes of treatment (clinician and microcomputer) daily, in a rapidly alternating fashion.

The microcomputer and clinician treatment packages are identical in terms of types of stimuli, modality and randomization of presentation, type of feedback, and scoring. The treatment itself is a

well established protocol which has been demonstrated to be effective with this population of patients. In this treatment approach, verbs are presented as pivots and wh-questions provide strategic cues to elicit sentences in an actor-action-object framework. There are six hierarchical levels to this program, ranging from copying a subject + verb combination to self-generation of subject + verb + object sequences. This treatment paradigm, in the traditional patient/clinician environment, is now being used nationally with adult brain-injured patients as well as with children with specific language and learning disabilities.

**Preliminary Results**—As of June 1, 1987, 12 of the 20 patient/subjects have been entered into the study and have completed the treatment package. For the subjects studied, the clinician-alone mode of treatment was more efficient in bringing most aphasic patients to criteria than was the computer mode. For those patients who responded better to the clinician mode, it took approximately twice as many sessions with the computer versus the clinician to complete the treatment package. It is noteworthy that although the clinician was far more efficient in terms of total visits, the microcomputer was shown to be an effective treatment tool for this particular treatment protocol. Maintenance of behaviors were observed across all clinician treatment levels and four of the six treatment levels via computer presentation. Generalization to standardized language tests was also observed. Statistically significant ( $p < 0.01$ ) improvement was noted between standardized overall test scores for treatment levels compared to the stable baselines in the clinician mode of treatment. These gains have been maintained by the patient/subjects for three months following termination of the treatment.

For those patients who showed no significant

differences ( $p < 0.05$ ) between modes of treatment, equal number of visits for each type of treatment were recorded. For these patients, maintenance of behaviors were observed as well as generalization to standardized language tests following each overall level. It does appear, however, that the treatment results for this group of patients is related to the severity and type of aphasia of each patient. Preliminary results indicate that some mild nonfluent aphasic adults show little difference in the treatment modes investigated in this study.

In addition to providing comparative results of clinician versus microcomputer, the present study also systematically replicates our previous work for the clinician mode of treatment, indicating this treatment approach is a viable protocol in the rehabilitation of brain injured aphasic adults.

**Future Plans/Implications**—Research needs to continue measuring the effects of this program with more subjects, more types of aphasia, and more severity levels of this disorder for both clinician and

computer modes of treatment. Additionally, cueing hierarchies for eliciting the actor-action-object framework needs to be explored further along this task continuum. This will enable the patient to receive the most efficacious cueing stimuli to maximize his/her output. These future efforts should make available a reliable, effective treatment program for both the microcomputer and clinician modes of treatment in the rehabilitation of aphasic adults to other facilities with similar case loads.

#### Publications Resulting from This Research

**Below the 50th Percentile: Application of the Verb as Core Model.** Selinger M, Loverso FL, Fuller K, *Clinical Aphasiology Conference*, Minneapolis, MN, BRK Publishers, 1987.

**Unfounded Expectations: Computers in Rehabilitation.** Loverso FL, *Aphasiology, An International, Interdisciplinary Journal*, Drs. Code and Muller (Eds.), Taylor & Francis Ltd., Publishers, 1987.

**Data Versus Intuition in Using Micro-computers for Aphasia Rehabilitation.** Loverso FL, Prescott TE, presented and published abstract from the American Speech-Language-Hearing Association National Convention, Detroit, MI, 1986.

### Biomechanical Measurements for Quantitative Assessment and Diagnosis of Dysphagia

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**Purpose**—Dysphagia is a disorder of swallowing resulting from neurological impairment and presents a major problem in the comprehensive rehabilitation of patients with stroke and other head injuries. Due to the lack of quantitative measurements of the strength of associated tissues, the course of recovery in the present clinical practice is tedious, and depends on trial and error. There are two important stages of swallowing: an oral phase and a pharyngeal phase involving contractions of the pharynx in coordination with the oral phase. We have developed procedures for quantitative measurement of these two phases of swallowing.

**Progress**—We have identified and developed techniques to measure several biomechanical parameters which aid in the quantitative assessment of the oral musculature in dysphagia. These parameters in-

clude: 1) lip closure pressure; 2) lip interface shear force; 3) tongue thrust in forward, backward and the two lateral directions; and, 4) swallow pressure.

We have placed two ultra-miniature accelerometers on the outside of the throat at a distance apart. In addition, we have monitored the swallow pressure with a catheter placed at the base of the tongue and connected to a pressure transducer. In both normal subjects and dysphagia patients, we have measured acceleration and swallow pressure simultaneously.

**Preliminary Results**—We have found statistically significant differences in the above parameters measured in normal and dysphagia patients. The first two parameters characterize the strength of the cheek muscles and the last two parameters characterize the tongue thrust. In current clinical practice, the strength of the oral musculature is assessed using

tongue depressors and "lollipops." The biomechanical parameters devised in the present investigation can aid the physician to objectively assess the dysphagia patient during recovery.

In normal individuals there was no time lag between the appearance of the pressure wave and the appearance of the acceleration wave characteristic of swallowing. In patients with loss of coordination of the swallowing mechanism, we have found significant lag times between the acceleration and pressure waveforms. Also, the acceleration wave form can reveal the coordination of the pharyngeal muscle contraction.

**Future Plans/Implications**—The biomechanical parameters identified and the measurement techniques developed in this study can be used for quantitative evaluation of the patient and for patient training to speed up the recovery process.

In the current rehabilitation practice, the pharyn-

geal phase and coordination are assessed using video-fluoroscopy (radiography) which is often very expensive. Our results on the dysphagia patients were consistent with the video-fluorography findings. Acceleration, when measured simultaneously with the swallow pressure measurement, gives a quantitative picture of the coordination of the swallowing mechanism and can be used in dysphagia diagnosis. However, a study on a larger population of patients is necessary.

#### Publications Resulting from This Research

**Biomechanics in Dysphagia.** Reddy NP, Costarella BC, Grotz RC, International Conference of Medical and Biological Engineering, Espoo, Finland, August, 1985; *Medical and Biological Engineering and Computing*, 23(S2):1243-1244, 1985.

**Biomechanical Measurements for Assessment and Diagnosis of Dysphagia.** Reddy NP, Rane MB, Canilang EP, Casterline J, *IEEE Ninth Annual EMBS Conference*, Boston, MA, 1987.

### Long-Term Effects of Topical Anesthesia in Stroke Patients: Measurement and Analysis of Neurophysiological Reflexes

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Sponsor: Liberty Mutual Insurance Company

**Progress**—Tests measuring the H-Reflex and Achilles Tendon Reflex were previously performed on nine patients suffering from stroke. The H-Reflex consisted of measuring the response of the muscle induced by an electrical stimulus. The recovery of the H-Reflex was determined by measuring the response to two identical electrical stimuli with a known time interval. The stimuli were applied to a nerve supplying the gastrocnemius and soleus muscle of the leg. The Achilles Tendon Reflex was measured by obtaining the muscle response to a short, mechanically induced, stretch of the muscle. By comparing the results of these reflexes, the activity of motorneurons was measured. Measurements were obtained during time periods before or

following the application of topical anesthesia or a placebo spray.

To facilitate analysis of these data, new software utilizing artificial intelligence techniques was developed. Prior to the development of this software, an extensive amount of time was necessary to determine reflex parameters. At the present time, we are able to decrease the analysis time significantly and increase the reliability of our estimates. The software aids in pre-screening the data, recognizes particular reflexes, and then calculates specific parameters. The data analyzed to date suggest that behavior of the long-term effect of topical anesthesia on the motor output of patients suffering from stroke is similar to the short-term effect.

## Development and Evaluation of a Videotape Teaching Module for Nursing Students in the Clinical Setting

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**Purpose**—The purpose of this project is to develop and evaluate an instructional videotape for nursing students working in the inpatient brain injury unit. In this clinical setting, nursing students often assist patients in performing activities of daily living, such as self-feeding. Yet traditional nursing education affords little exposure to brain-injured patients, or to the techniques that are required to assist these patients in learning to perform daily activities.

**Progress**—This project is being conducted in two phases: 1) development of the instructional videotape based on observations of student nurse-patient interactions in the actual clinical setting; and, 2) evaluation of the videotape using a randomized control group design with nursing students as subjects.

Development of the 20-minute videotape is based on the Cyrs model of systematic instructional design. Based on this model, learning objectives and content of the instructional videotape were taken directly from videotaped observations of nursing students doing self-feeding with actual patients. These observations revealed a number of teaching errors, including: doing too much for the patients; causing and/or not eliminating distractions; and using either verbal or nonverbal cues ineffectively. The instructional videotape addresses these and other errors using simulated self-feeding scenes. It also gives an introduction to brain injury and its diffuse effects on performance and learning ability.

Evaluation of the videotape will be based on two

measures: 1) a 15-item written knowledge test; and, 2) a 20-minute performance test using a simulated patient. Performance tests will be videotaped, then rated by expert reviewers using a 15-item checklist of performance objectives. Subjects who view the instructional videotape will be compared to a control group who receive the usual brief verbal instructions on how to approach a brain-injured patient.

**Preliminary Results**—The development phase of this project is now complete. Results of this phase point to both the validity and the complexity of producing an instructional videotape in the clinical setting. Complexity factors include: variability of brain-injured patients; heterogeneity of nursing students; and unpredictability of the clinical environment of the brain injury unit from day to day. However, by incorporating these factors, the instructional validity of the videotape was clearly increased.

Data from the evaluation phase will indicate the instructional effectiveness of this videotape. These data will also demonstrate the validity and reliability of the dual knowledge-performance testing process in the clinical setting.

**Future Plans/Implications**—Based on these results, the investigators will consider the use of videotape as an instructional tool in skill areas other than self-feeding. As such, videotape may prove a valuable and versatile tool for training nursing students, new staff, families, and others who serve as both caretakers and teachers of brain-injured patients.

## Computer-Aided Device Evaluation

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**Purpose**—The goal of this project is the testing of clinical feasibility and the further development in

response to testing results, of the Tufts-MIT Prescription Guide, developed by Dr. Goodenough-

Trepagnier and Dr. Michael J. Rosen of the Massachusetts Institute of Technology under a research and development contract from the National Institute of Neurological and Communicative Disorders and Stroke. This system is a computer-driven procedure involving cognitive, sensory needs and motor assessment of the client, and in-laboratory device assessment. Analysis software incorporated in the system then operates to produce scores representing, on the one hand, a representation of the relative overall benefit which each device resident in the system files offers for the client being evaluated; and on the other hand, scores representing predications of the maximum communication rate the client could achieve with each of these devices.

**Progress**—Components of the Prescription Guide were tested with approximately 40 people with neuromotor involvement severe enough to impair or abolish functional speech, as well as over 50 able-bodied subjects.

**Preliminary Results**—Preliminary results from comparison of predictions and measures of communicative function with 11 experienced communication-device users support the predictive validity both of the rate prediction and the Benefit score.

The subsequently revised system, in its December 1986 version, has been applied with eight patients. These and additional patients will be followed up in

order to acquire actual performance data for comparison with system predictions.

**Future Plans/Implications**—Plans are being carried out to implement the system in clinical settings in this country and abroad to provide further testing of clinical feasibility and improve client service in these settings. Options for commercialization of the system are being investigated.

#### Publications Resulting from This Research

**A Needs-Features Spreadsheet for Communication Device Prescription.** Goodenough-Trepagnier C, Rosen MJ, Minneman S, Allen C, Chen K, Felts T, Chung G, *Proceedings of the 8th Annual RESNA Conference*, 332-334, Memphis, TN, 1985.

**Assessment of Need and Prediction of Benefit in Prescription of Communication Devices for the Nonvocal.** Goodenough-Trepagnier C, Rosen MJ, *Proceedings of 8th Annual Conference of the Engineering in Medicine and Biology Society of the IEEE*, 1876-1879, 1986.

**Preliminary Validation of Prescription Guide for Selection of Communication Aids.** Goodenough-Trepagnier C, Rosen MJ, Jandura L, Getschow C, Genoese-Zerbi F, Felts T, Minneman S, *Proceedings of the 10th Annual RESNA Conference*, 100-102, San Jose, CA, June 1987.

**Quantification of Device Evaluation.** Rosen MJ, Goodenough-Trepagnier C, Felts T, Genoese-Zerbi F, *Proceedings of the 10th Annual RESNA Conference*, 180-182, San Jose, CA, June 1987.

**Predictive Value of an Augmentative Communication Prescription Guide.** Goodenough-Trepagnier C, Rosen MJ, presented at the American Academy for Cerebral Palsy & Developmental Medicine, 1987.

## Early Intervention with Globally Aphasic Stroke Patients Using a Computerized Visual Communication Technique

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**Purpose**—This project undertakes the controlled testing of a computerized visual communication system as an early intervention therapy for people with severe global aphasia resulting from cerebrovascular accident. The methodology is a large-sample, controlled, longitudinal group study. Patients will be enrolled within two weeks of their stroke, and the experimental and control therapies offered daily for a month. Patients will be re-assessed at intervals to assess the short and long-term effects of participation in the experimental therapy, and to identify predictors of recovery of language function.

The project began on September 1, 1987.

**Progress**—Use of the computerized visual communication system has proven helpful to functional communication and to recovery of language function in some cases, despite the fact that exposure to the technique was provided after recovery had appeared to have halted. The new project will provide the first test of the efficacy of this approach when offered at the time the recovery curve is steepest, within the first few weeks after the stroke.

## Stroke Clinical Center Grant: Remediation of Left-Sided Neglect

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Sponsor: *National Institutes of Health*

**Purpose**—This Stroke Clinical Center Grant is a new application representing a continuation and extension of investigations initiated by the Comprehensive Stroke Center Contract, National Institute of Neurological and Communicative Disorders and Stroke (NINCDS), Contract No. N01-NS-8-2387, June 1978 – June 1981. The major trust of this contract is to assess the community (the State of Oregon in our case) profile of strokes, primarily demographic in nature; this contract mobilized a broad interest in our stroke patient, which represents the centerpiece of this grant application. Our investigations emphasize therapies focused upon stroke patients in three broad areas of importance in the continuum of the problem: 1) preventive therapy; 2) acute medical treatments; and, 3) rehabilitation intervention for higher cortical impairment.

1) Preventive therapies are designed to assess

various risk and prognostic factors in stroke patients to develop better molecular handles on both acute therapy and prevention. Factors which may yield to better identification and therapy of risks are: mononuclear cell cholesterol ester hydrolase activity; glycosylated hemoglobin; cholesterol turnover in arteromatous plaques; and, physiochemical bases for platelet behavior in stroke.

2) Acute medical treatments focus initially upon the potentially beneficial assessment of prostacyclin infusion. In addition, staged, sequential evaluation of aminophylline/barbiturate and vasopressors will be continued in a prospective, randomized fashion.

3) Rehabilitative intervention for higher cortical impairment deals with neuropsychological and language impairments with compensatory learning strategies.

## Treatment of Affective Deficits in Stroke Rehabilitation

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Sponsor: *National Institutes of Health*

**Purpose**—Post-stroke affective disturbances are pervasive, i.e., they affect anywhere from 40-65 percent of stroke patients. The diagnosis and treatment of these disturbances in stroke patients is a major untreated problem facing the medical rehabilitation community. Traditional approaches to diagnosis that have relied exclusively on verbal self-report or nonverbal expressions of depression have not adequately addressed either the communication difficulties of aphasics or some of the other cognitive disturbances, i.e., aprosodia, minimization, and concrete thinking, which limit the cognitive capacities of stroke patients. Furthermore, the effectiveness

of various approaches to treatment has not been systematically studied in this population.

The aims of this proposed study are twofold: first, to validate a comprehensive diagnostic battery which permits an accurate examination of the affective disorders following stroke; and secondly, to evaluate the effectiveness of two approaches to treatment (anti-depressants and cognitive therapy) when administered singly or in combination. It is expected that greater accuracy in diagnosis and more aggressive treatment will significantly improve the quality of life of this subgroup of older Americans.

## Rehabilitative Software for Head Trauma Victims

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*Sponsor: National Institutes of Health*

**Purpose**—The goal of this effort is the development of an effective software package tailored to the needs of brain-injured patients relearning independent living skills; it will be designed to serve as a bridge between intensive therapeutic intervention and home-based support networks. The specific aims of Phase II include improvement and expansion of the existing software and a controlled study of its efficacy.

A team of healthcare professionals, educators, and computer specialists has been assembled for this 2-year undertaking. Approximately 10 months will be spent on software improvement and expansion, coupled with informal software evaluation by a panel of head-injured patients. The concluding 14 months will be devoted to a controlled study meas-

uring patients' neuropsychological, psychosocial, and academic status pre- and post-treatment. There will be 20 patients each in the control and experimental groups.

Technological innovations include: 1) provisions for parents/therapists to personalize the software to the individual patient's environment and abilities; 2) extensive record keeping in the software to track patient progress; and, 3) a variety of user interactive mechanisms tailored to the needs of patients with cognitive and/or motor impairments. No such software currently exists.

One of the outgrowths of this project will be a software authoring system suitable for creating programs for multiple rehabilitative and special education settings.

## Subthreshold Memory Phenomena

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*Sponsor: National Institutes of Health*

**Purpose**—The primary subthreshold-memory paradigm to be used during the proposed grant period is the feeling of knowing, although other subthreshold-memory paradigms also will be employed (e.g., relearning). The feeling of knowing refers to a person's predictions about subsequent memory performance on items that are below the threshold of a particular performance test (e.g., predicting subsequent recognition performance on nonrecalled items).

The proposed experiments are grouped into six conceptual themes. One overall goal of these themes is the development of an empirically sound theory of the feeling of knowing that will answer the

questions "What is the feeling of knowing based upon?" and "What is the predictive accuracy of the feeling of knowing?" Besides providing a theoretical understanding of the feeling of knowing and its role in the cognitive system, answers to these questions will help improve both the accuracy of the feeling of knowing and other cognitive processing that is mediated by the feeling of knowing (e.g., the allocation of study time during relearning). Such improvements have potentially important ramifications for mental health situations, including improved diagnosis of memory disorders and more efficient rehabilitation of victims of stroke and amnesia.

## Precursors of Stroke Incidence and Prognosis

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*Sponsor: National Institutes of Health*

**Purpose**—It is proposed to extend the prospective findings of the Framingham Study on stroke to 30 years of follow-up, including the age groups 75-84 years, and to examine a number of possible precursors for which there has been too little follow-up. These include the role of: arrhythmias as determined by one hour ECG monitoring; echocardiographic findings of valvular and myocardial dysfunction; lipid profiles including LDL and HDL cholesterol; physical activity status; menopausal status; psychosocial factors including Type A personality; carotid bruit; Ecolyzer confirmed smoking histories; and, glucose tolerance based on a glucose load.

Further studies of asymptomatic carotid bruits will be carried out by analyzing the continuous wave Doppler signal for its direction, mean frequency, and frequency content, as they are found at selected moments in the cardiac cycle, over the carotid arteries in the neck, and phonoangiography of carotid bruit in an attempt to identify those bruits which are true precursors of stroke. A more accurate delineation of the type of stroke will be accomplished using CT scan information in addition to clinical

findings. This should permit better definition of the frequency of different types of stroke and a more accurate determination of the epidemiologic features of each type. The stroke, its precursors and disability will be pursued focusing particularly in the elderly. Functional assessment of the patients' daily activities will be made at the time of stroke, and 3, 6, and 12 months later. Scores on recently standardized tests scales of activities of daily living (feeding, dressing, grooming, bathing, etc); assessments of function in the home and in society; and, the use of aids and appliances following stroke will be obtained by a rehabilitation nurse.

These data will permit detailed evaluation of disability following stroke in a general population sample. An attempt will be made to devise a more powerful predictive stroke risk profile using those ingredients identified above as independent contributors to stroke incidence. The decline in mortality rates from stroke has accelerated in recent years. Secular trends in incidence by stroke type will require more cases occurring over time and should be available as a byproduct of this proposal.

## Sensorimotor Interactions in Motor Unit Control

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*Sponsor: NeuroMuscular Research Center*

**Purpose**—This study is a continuation of previous work done at the Center investigating the modulatory effect of sensory input from the skin on motor control (cf. description of study entitled "Long-Term Effects of Topical Anesthesia in Stroke Patients: Measurement and Analysis of Neurophysiological Reflexes.") In the earlier studies, a topical anesthetic coupled with physical therapy was applied to the rigid and spastic muscles of patients with brain or spinal cord lesions. This procedure produced an increased range of movement in vital joints, in addition to revealing that the application of topical anesthetics changes the amplitude of the

H-reflex. The purpose of the present study is to clarify some aspects of the relationship between sensory input from the skin and motor output.

**Progress**—Myoelectric signals were detected for the First Dorsal Interosseous muscles while the subject generated an isometric contraction up to the 50 percent MVC level. Thereafter, the signals were decomposed into their constituent motor unit action potential trains. The recruitment force thresholds of the progressively recruited motor units were determined before and after the application of topical anesthetics.

**Results**—Initial results indicate that the recruitment force threshold levels of motor units recruited below 10 percent MVC level increase, while those of motor units recruited above 20 percent MVC decrease, due to skin desensitization. These effects are noted up to 45 minutes post-anesthetic application. It is suggested that the sensory input from the skin has

an excitatory effect on the small slow-twitch motor unit and an inhibitory effect on the large fast-twitch motor unit. Currently, we are further analyzing the data to substantiate the initial observations.

The results of this study were presented at the 16th Annual Meeting of the Society for Neuroscience, November 1986, in Washington, D.C.

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## Medication Effects on Attention and Arousal

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**Sponsor:** *Tufts New England Medical Center and National Institute on Disability and Rehabilitation Research*

**Purpose**—Traumatic brain injury frequently results in deficits in arousal and attention. These deficits contribute to slowed progress in rehabilitation therapy and to impaired function in the naturalistic environment. The purpose of this research is to develop an assessment protocol for measuring the various components of the arousal/attention system, to validate these testing protocols, and to use them to measure the positive and negative effects of various medications on arousal and attention.

**Progress**—The first year of the project has been devoted to tool development. Five computer testing protocols have been written to assess different components of arousal and attention. These include critical flicker fusion to measure tonic arousal, a warned versus unwarned reaction time task to measure phasic arousal, a prolonged stimulus detection task to measure sustained attention, a distractor versus nondistractor reaction time task to measure distractibility, and a choice reaction time task to measure information processing speed. These tasks are now being piloted with normals and then with head-injured adults.

In addition to performing laboratory tasks, patients will participate in "research therapy" on and off medication with video-taped behavioral sampling. Tasks similar to those patients commonly engage in in therapy are being developed with alternate forms of equivalent difficulty. Eight block

designs have been developed and shown to be equal in difficulty, as measured by speed of completion.

Twenty short news stories were recorded on tape at standard speed. Auditory comprehension quizzes (to assess attentional lapses during listening) were developed for each. Sixteen of the 20 stories proved to be of comparable difficulty and will be suitable for use in the formal research. Eight pre-vocational sorting tasks are currently under development. Other tasks requiring no piloting have also been selected.

**Preliminary Results**—During the pilot phase the goals are: 1) to insure that each of the tasks is "doable" on its own; 2) that alternate forms of the task are of equivalent difficulty so that later changes in performance can be attributed to medication effects rather than task differences; and, 3) that each of the tasks demonstrates sensitivity to the variable (s) of interest. The first two of these have been demonstrated and the third is in progress.

**Future Plans/Implications**—Piloting will continue by demonstrating that normal subjects respond as predicted to the warnings, information loads, and distractions being tested. Next, head-injured subjects undergoing no medication changes will be tested to determine the stability (test-retest reliability) of performance scores in the absence of changes. Finally, medication testing will begin.