

XIV. Head Trauma and Stroke

Motor Copy Procedures in Improving Function of the Upper Extremities of Stroke and Traumatic Head Injury Patients

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Sponsor: National Institute of
Handicapped Research

Purpose—The approach investigated in this project relies upon muscle activity from the “uninvolved” side to serve as a template against which the patient could “match” muscle activity from the homologous-involved muscle or muscle group. Use of microprocessors with capabilities for storage of representatives of muscle activity from each arm is to enable patients to more effectively use bilateral descending motor systems in an integral part. This combination will result in a functional improvement that is cost effective and superior to existing therapeutic procedures. The patient can rely more upon his own neural substrates rather than the additional time consumption necessitated by constant interface with the clinician.

Progress—The first objective is to determine whether application of a motor copy technique can produce quantified improvement in an upper extremity function among target groups when members of these groups are interfaced to a commercially available device with capabilities for processing electromyographic activity.

This project randomly places patients in either the motor copy (experimental) or target muscle training (control) group. Each patient undergoes five baseline evaluations followed by 10 treatments to the involved shoulder region, and a similar number of treatments to the elbow and finally to the wrist and hand. Between each sequence of 10 treatment sessions, another evaluation is undertaken. Thereafter, follow-up evaluations occur at 3-month intervals. These evaluations consist of quantification of electromyographic activity and active range of motion for most muscle groups of the involved upper extremity. In addition, 21 functional tasks based upon time or force are assessed.

It is clear that of five patients in the experimental group and receiving treatment or in the follow-up phase to their baseline measures, all show slight improvement in range of motion, muscle activity, and function during acquisition of baseline data. During specific treatment of a limb segment, each of the five patients has shown appropriate changes in muscle activity and increases in active range of motion at each joint segment. Hyperactive muscles show reduced responses to stretch and increased activity during shortening while weak antagonist muscles have shown an increase in muscle activity. The most outstanding observation thus far is that treatment at one specific joint segment appears to cause a generalization of effect to those limb segments not as yet treated.

The second objective is to determine whether this motor copy approach is superior to a strategy enabling target group members to interact with the same commercial device by following recommended guidelines without using a motor copy technique.

Of eight patients receiving the motor copy procedure, all of the target muscle training participants showed some incremental performance during base-line measures. The small improvements occurred in the functional tasks as well as the electromyographic and active range of motion measures.

The third objective is to determine whether either approach leads to functional improvement generalizing from the limb segment under treatment to other limb segments or to the entire manipulative ability of the upper extremity.

Preliminary Results—A clear difference is beginning to emerge when the neuromuscular changes between the two groups are compared. Those individuals undergoing the experimental procedure appear to show a generalizing effect from specific treatment of one limb segment to the entire limb. Those patients in the target muscle (control) group show activity changes that are specific to the limb segment being treated—there is no generalizing effect. Individuals in both groups are showing improved manipulative ability (improvements in functional tasks). The magnitude of improvement and the speed with which such improvements occur between individuals in these two groups only can be ascertained as these sample sizes increase.

Patterns of Recovery in Traumatic Brain Injury and Stroke Patients in Two Different Service Systems

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Sponsor: National Institute of
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Purpose—Research has not yet clearly defined patterns of recovery in traumatically brain injured and stroke populations. Also not clearly defined are optimum therapeutic interventions and timing of these interventions for maximum functional outcomes. We propose to use departmental inpatient data and research data from current projects to assist in this documentation.

The objectives of this research are: 1) to chart recovery and plateau of function in all areas: cognition, motor, language, psychosocial, vocational; 2) to identify optimum times for therapeutic intervention; 3) to identify those variables that appear to predict potential and functional outcomes; 4) to delineate patterns of discharge status and identify reasons for discharge disposition; 5) to demonstrate the interrelationship of recovery and plateaus among the major indices of function; 6) to identify with VR personnel the timeliness, mode and consequences of VR intervention; and 7) to identify the fitness levels of traumatic brain injury and stroke, investigating implications for independent living and employment.

Progress—Achieving major objectives of this project is dependent upon data collected in research projects R2-R10, and the Department of Rehabilitation Medicine. Adaptation of PECS (Patient Evaluation Conference System) to the needs of the Department of Rehabilitation Medicine at the CRM has been completed and implemented. All departments requested some changes based on their experiences with this evaluation strategy. These changes included more specificity of some items, and additions and deletions of other items. These modifications were done within the general guidelines given by Dr. Richard Harvey, one of the developers of the instrument.

Future Plans—The work plan for the next year includes: 1) analysis and study of the data collected with the revised PECS form; 2) begin collating data relevant to recovery of function from other research projects which are now in the data collection stage; 3) begin work on the fitness index; 4) continue review of possible analytic approaches beyond descriptive statistics and initiate pilot testing of these methods with the data collected; and 5) continue review of the literature and contacts with other RTCs investigating the problems of the head injured and the stroke populations.

Spasticity Treatment and Motor Control: A Comprehensive Re-Examination

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Purpose—Notwithstanding extensive research on spasticity, there have been very few studies directly comparing spasticity reducing treatments in the same patients or systematically exploring for subtle changes in motor control which may accompany reduced spasticity. This project compares the effects of several short-acting spasticity treatments (ice packs, antagonist vibration, benzocaine topical spray, drugs in single doses, or xylocaine motor point blocks) on spasticity and motor control in spastic hemiparetic victims of stroke or traumatic brain injury.

Passive arm motion is controlled by a modified Cybex Isokinetic Dynamometer so that spasticity is evoked by a controlled muscle stretch stimulus. The Cybex also provides resistance during tests of active motion. Spasticity and voluntary control of elbow and wrist flexors and extensors are quantified by means of integrated EMG from surface electrodes.

One goal of the project is to discover means by which physicians and therapists can identify those patients most likely to benefit from a combination of spasticity treatment and neuromuscular re-education, while avoiding unnecessary treatment in patients where reducing spasticity is not feasible or has no influence on elements of voluntary motor control. The project is in the early stages of data collection.

Retraining Proprioception Using Artificial Joint Angle Feedback and Stimulus Fading

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Purpose—After stroke or traumatic brain injury, a persisting proprioceptive deficit may limit use of the affected arm even when recovery of motor control is sufficient for reach and grasp under visual guidance. In this project, an attempt is made to retrain proprioception using artificial joint angle feedback.

The patient practices limb positioning and the artificial feedback stimulus is gradually withdrawn (stimulus fading) to help the patient make an error-free transition to reliance on internal proprioceptive cues.

Preliminary Results—Results obtained thus far suggest that some proprioception-deficient patients can master the training task through a pure motor strategy, without improving in use of proprioceptive cues. These patients improve with

practice in active limb positioning accuracy, but when the limb is positioned passively, their ability to estimate its position does not improve. The feedback training task appears to benefit patients' ability to reliably produce extension or flexion movements as required, and perhaps to reduce involuntary drift when trying to hold one position.

Forced Use in Improving Function of Upper Extremities in Traumatic Head-Injured and Stroke Patients

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Purpose—Most clinicians agree that a patient's inability to spontaneously or volitionally move a hemiparetic upper extremity during functional activity may be the result of a learned non-use of the affected extremity rather than specific motor deficits. This concern needs to be validated in a quantified manner. If, in fact, a patient has not learned to use an involved upper extremity, forcing him to activate that limb could result in learning functional consequences. The notion of forced use, therefore, may be a relatively simple yet effective vehicle to facilitate upper extremity function and ultimately maximal potential use of the involved arm and hand.

Progress—The first objective is to determine if forced use of the hemiparetic upper extremity results in a significant increase in patient self-reports of functional behavior.

At the present time, nine of the 16 patients being seen have completed the forced use interval and are in at least the 4-month follow-up phase. We have self-report scores on these patients taken for the week prior to the forced use interval, during the 2 weeks of forced use, and 1 week thereafter. Statistical analyses of these data will be done after all of our patients have completed their involvement in the forced use interval. A review of the numerical changes, however, clearly indicates that of the 17 tasks monitored in the home environment, an increased frequency of attempts for each of these tasks clearly occurs during the forced use 2-week period and is maintained during the 1 week following forced use. We believe that this tendency will continue to exist as all of our patients progress through the forced use interval.

The second objective is to determine if the forced use procedure improved the quality and speed of movement in a series of functional tasks.

Normal individuals showed comparatively consistent performance during each of the 4 weeks when their efforts were repeated. The magnitude of change in experimental subjects was substantially greater than in a normal subject sample and the amount of improvement appears to become greater for tasks that involve use of the entire limb rather than isolated segments (shoulder or elbow). These data will be subjected to statistical analyses after more patients have completed the forced use interval and more follow-up data are obtained. Nonetheless, a preliminary application of a multiple comparison test (Bonferroni Multiple T Test) suggests that significant improvement occurs for all tasks beginning during the forced use interval and, in many instances, continuing during the follow-up phases.

Rehabilitation of Cognitive Deficits with Interactive Computer Assistance

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Purpose—Some of the most frequent sequelae of closed head injury are problems in attention, memory, visuospatial skills as well as planning and organizational skills. This project is developing a flexible and dynamic retraining system for the head-injured person, focusing on the deficit areas using a microcomputer as the therapeutic medium.

The objectives are as follows: 1) to design and develop cognitive rehabilitation procedures in attention, visuospatial skills, memory, and planning and organizational skills in microcomputer format; 2) to test and validate these procedures on groups of normals and head-injured patients; and 3) to disseminate these procedures to health professionals for use with their brain-injured clientele.

Progress—As of mid-April, the Attention Module had been debugged and its program code modified where necessary to correct any faulty functioning. A full programmer run-through was completed to ensure that each exercise in the module functioned correctly both independently and as part of the controlling framework, the master control program. Final adjustments were made to that part of the program which controls the videocassette recorder so that the audio instructions to the patients were correctly synchronized with the computerized exercises.

Future Plans—The remaining part of this quarter will be spent on author review. The author of the Attention Module will view the entire module and ensure that the program does indeed accomplish the goals delineated to the programmer.

There are four primary goals for the next quarter: 1) to complete the author review of the Attention module; 2) to modify the Attention Module as deemed necessary by the author from her review of the program; 3) to begin testing the Attention Module, both with an able-bodied group and with a group of head-injured patients; and 4) to design and structure the master control program for the Visuospatial Module and begin the programming for it.

The Relationship Between Cognitive Status, Objective Language Skills, and Functional Language During Recovery from Severe Head Injury

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Purpose—Specific language deficits and motor speech impairments have been found to underlie many of the communication disorders which result from closed head injury. A review of the literature suggests that a better appreciation of the relationships between cognitive functioning and language usage, especially as they pertain to conversational competence, is necessary to fully characterize the nature of the communication disabilities of these patients. The impact of such findings provides strongly needed input into developing more effective treatment techniques for these problems. Based upon these needs, this project was developed to: 1) examine the clinicopathologic correlations among closed head injury patients distinguished by neurological variables (site of lesion, presence or absence of hematoma, duration of coma, etc.) and speech/language and

psychological test performance; 2) determine the relationship among objective speech/language and psychological test scores and measures of communication competence; 3) describe patterns of recovery in communication and thinking during the first 24 months after severe head injury; and 4) describe the long-term outcome of severe head injury on communication and thinking abilities.

In order to achieve these objectives, two groups of patients are being studied. A longitudinal group tested at 6, 12, and 18 months after injury and a long-term group at 24 months or greater after injury. These patients, aged 17 to 50 years, have a documented period of coma greater than 24 hours and a hospital admission, at least a seventh-grade education or evidence of ability to read and write, a history of employment, as well as no history of previous heavy use of alcohol or drugs, and no psychiatric hospital admissions. Restrictions in variables such as sex or race have been determined to be unnecessary. The test battery is composed of standardized speech/language and psychological tests. Videotaped conversational interactions provide the basis for gathering pragmatic data from observational techniques. The conversational samples are then analyzed by means of a protocol rating pragmatic behaviors which encompass verbal and non-verbal aspects of the patient's utterances, the formal linguistic parameters of the utterances with respect to meaning and context, and the success with which patients communicate their intentions by accepted standards of conversational interaction.

The project is in the data collection stage at the present time. Anticipated analyses, in addition to descriptive statistics, include repeated measure analyses of variance and multiple regression.

Future Plans — Future goals of the project include completion of data collection procedures, and subsequent data analysis. Results will be disseminated through appropriate publications and other training activities.

Social Skills Training as a Facilitator of Adjustment to Traumatic Head Injury _____

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Purpose — Although medical advances have increased survival rates for closed head injury patients, existing interventions are insufficient in meeting their needs. Frequently, rehabilitation programs do not effectively address the documented interpersonal perception and social skills deficits which have been shown to hinder progress in the patient's rehabilitation. The long-term effects of such deficits include low rates of employability and increased social isolation. The proposed study will augment the rehabilitation process for closed head injury patients through the application of a social skills training package proven effective with other populations.

The objectives are to: 1) develop the Emory Rehabilitation Adjustment Scale (ERAS); 2) document component social skill deficits in CHI patients; and 3) perform and assess social skills training with six CHI patients.

The target groups are patients with closed head injuries and the expected outcome is 1) an effective measure of social adjustment; and 2) a program for remediating social skills deficits in CHI patients.

Progress—To supplement the original construct validity data on 50 outpatient CHI individuals, 3 residential treatment facilities (1 in Texas, 1 in Massachusetts, and 1 in New Hampshire) have committed themselves to collecting and providing validity data on approximately 60 CHI inpatients. An alternative Professionals' Form of the ERAS has been developed, and professionals' ratings of patients on the ERAS are being compared with team consensus judgments of adjustment as the criterion. The reliability of the ERAS will also be established with this sample. Forms and detailed instructions for administration have been mailed to the identified residential facilities.

Patients trained during the current grant period were selected based partially on the presence of social skills deficits documented by trained raters. The patients were observed in videotaped scenario enactments, as well as during unstructured free social interaction. Data obtained from family interviews, clinical observations, and ERAS ratings also were used for preliminary screening.

An additional four CHI patients have completed social skills training during this grant period, bringing the total to eight patients. There are two more patients than the six previously projected. Preliminary results based on "blind" ratings of the videotaped free interactions indicate significant training effects in each patient. Three of the four patients showed significant training effects in two or more of the target behaviors.

Nutritional Assessment of Closed Head Injury Patients (on Hold)

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Purpose—The high incidence of malnutrition after closed head injury is currently unexplained. A large percentage of the patient population upon admission to the Rehabilitation Unit are determined to be in a severe state of malnutrition of an unknown cause. This is complicated by the need to increase the activity level, to recover from other injuries, and to learn new functional and cognitive skills. The severe degree of malnutrition in the Rehabilitation Program may impair physical recovery and cognitive recovery.

There is a need to learn the relationship between malnutrition and the degree of recovery in functional and cognitive skills. Since the expense of aggressive protein, calorie, or zinc nutrition is minimal, the benefit will be tremendous if this protocol is effective and improves cognitive and functional outcome.

The objectives are as follows: 1) to confirm, using direct calorimetry, the work of Haide showing an increased metabolic rate after head injury; 2) to better define the etiology of malnutrition after head injury; 3) to assess the effects of malnutrition on rehabilitation outcome measuring cognitive deficits, functional levels, medical complication rates and length of stay in an inpatient rehabilitation facility; 4) to develop an optimum clinical treatment protocol for protein calorie malnutrition in these patients; and 5) to conduct a double blind controlled trial of improved protein, calorie, nutritional status and assess its effectiveness in improving rehabilitation outcome.

Progress—A series of patients admitted to EUH Center for Rehabilitation Medicine with the diagnosis of closed head injury will comprise the sample of the

study. Subsequent postdischarge follow-up exams are scheduled to evaluate progress to 1-year postdischarge. The inpatients are divided into two groups: 1) malnourished; and 2) normally nourished. The malnourished group is then divided into two subgroups for treatment. One malnourished group receives the standard protocol of nutritional therapy and the second malnourished group receives a more intense therapy containing 1.5 caloric/cc of nutrients. Nutritional, functional, neuropsychological, and neurological status are measured regularly.

Increased Self-Control in Closed Head Injury Patterns in Multiple Environments with Family Intervention

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Sponsor: National Institute of
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Purpose—Patients who have suffered a closed head injury and the resulting multiple disabilities in the areas of social, cognitive, and emotional functioning often find treatment for these problems unavailable in their local community or inappropriate to the specific needs of the head-injured individual. Traditional psychotherapy is often financially inaccessible and also frequently inadequate in effectively treating head-injured patients. Indeed, the complexities of the individual and family problems attendant to the head-injured require an indepth evaluation of the home setting and an understanding of the patient's functioning outside the environment of the therapist's office. This research was designed to demonstrate that group intervention in a camping environment coupled with family intervention can be highly therapeutic and a cost effective method of treating selected head-injured patients. This process is given the name of "Therapeutic Camping."

The objectives of this process are: 1) to provide a therapeutic program which allows head-injured individuals to remediate functional deficits that have resulted in behavioral, social, cognitive, and vocational problems; 2) to enhance the generalization and maintenance of newly acquired skills by using a family intervention program consistent with those interventions performed in the therapeutic environment; 3) to identify the therapeutically effective components of the camping experience versus "therapeutic camping" through the use of a "within subjects" single case experimental design; and 4) to develop a model program that can be utilized by treatment facilities that work with head-injured persons.

Progress—Twelve male closed head injury patients were included in this research. They met the following criteria: 1) All were between 17 and 49 years of age; 2) All had at least 7 days coma duration; 3) All were at least 24 months postinjury; 4) All had behavioral problems that interfered with their ability to function at home as documented via family report and interpretation of the ERAS; and 5) All were not actively involved in another treatment program. Persons selected were placed in one of three groups of four members each. The study utilized a single case experimental design to evaluate the hypotheses.

Preliminary Results—The results of this research provide significant implications for the treatment and behavioral remediation of closed head injury patients.

The main conclusions are that the use of the camping setting in the treatment of head-injured men provides an environment whereby persons involved in the treatment of head-injured individuals can provide in-depth therapeutic interventions in a setting which offers a variety of situations analogous to numerous tasks encountered by the head-injured individual in his daily life. This format allows an adequate amount (2 weeks plus follow-up) of time for a change in some severe maladaptive behaviors to occur. The therapeutic camping setting with family intervention provides the head-injured individual with a means of generalizing the skills learned in the campsite to the home environment.

Future Plans — Additional research with this intervention approach is indicated and needed. The therapeutic camping format provides a reasonable and cost effective method in providing impactful group and individual therapy for head-injured persons and should be used as such. The implementation of an intensive family therapy component with group and individual therapy provided in the therapeutic camping setting is critical in order for generalization to occur and should be included in similar interventions.

A Program for the Cognitive Rehabilitation of the Head-Injured

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Sponsor: The Frances and Augustus
Newman Foundation and
Head Injury Recovery Trust

Purpose — Rehabilitation of the brain damaged patient needs a co-ordinated program of assessment and training. While physical disability is easily identified and retraining programs can be devised easily, cognitive dysfunction such as fatigability, impoverished memory, diminished concentration, poor motivation, and a slowness of both thought and action are not measured easily and the retraining programs are difficult to devise and implement. Furthermore, the pattern of deficit is patient- and injury-specific and no universal retraining program can be expected.

Progress — Since 1978, a clinical research program has been conducted to evaluate the recording of brain electrical activity in the form of event-related potentials (ERPs) can make to the assessment of the functional state of the individual patient. The procedures are of two types; 1) 15-channel recordings of long-latency or 'cognitive' ERPs are obtained while the subject is performing a task and, 2) specific sensory systems are investigated, using records for examples of occipital pattern reversal visual and brain stem auditory responses.

These measures have been shown to be sensitive to brain damage and can be used as an index of recovery. It is not surprising that the potentials are more seriously disturbed in severe head injury (more than 7 days post-traumatic amnesia, PTA) but even a mild head injury (PTA less than 1 day) can lead to a disturbance of brain patterns that lasts months or years. As the patient recovers, the patterns return to normal (even though the time scale can be several years).

This is based on microcomputers because of cost-effectiveness in terms of 1) unlimited hours of reasonably structured stimulation; 2) flexibility in devising programs for particular patient needs; 3) retraining being done in the home; and 4) the high motivation that computer-presented materials engender. To increase

the number of patients on the program, to maximize the efficacy of the retraining, and to allow the continuous monitoring of performance, we have installed a 'network' linking the patients' computers to a central one at the Institute.

The next phase of this program is to validate the use of the micro-processor retraining program using the neurophysiological measures together with neurological, neuropsychiatric, and neuropsychological assessments as indices of recovery in two groups of patients and controls. The first group comprises patients with recent head injury where the improvement by retraining is superimposed on natural recovery and a second group comprises patients with long standing damage where natural recovery has ceased.

Computer Program for Brain Injury Evaluation

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Sponsor: Commonwealth
Department of Health

Purpose—This project is to develop and evaluate a computer program for assessment and retraining of verbal and visual short-term memory skills in brain-injured adults and post-C.V.A. patients. The computer program will be written according to our existing specifications. We will establish norms, reliability, and validity for the assessment component of the program and evaluate the effectiveness of the remedial component.

Efficacy of Computer-Assisted Rehabilitation of Brain Injuries

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Purpose—A number of disciplines such as Medicine, Neuropsychology, Audiology and Speech Pathology, as well as Occupational and Physical Therapy, have been involved in the remediation of problem sequelae of brain injury. Within the past several years, computers have been introduced as part of the rehabilitation process. However, despite a proliferation of computer-based "cognitive rehabilitation" clinics throughout the United States, which make offers of new hope to patients and their families concerning recovery from brain injury through micro-computer applications, as yet there are no controlled studies which show the effectiveness of these procedures. The present study will attempt to evaluate the outcome effectiveness of computer retraining through a controlled experimental study.

Subjects will consist of 60 inpatients referred from the Rehabilitation Medicine Service. In Experiment 1, 30 patients with right hemisphere CVA will be assigned randomly to either an experimental or control group, with 15 patients in each group. All subjects then will be evaluated by the Departments of Psychology and Occupational Therapy. Patients in the experimental group then will begin an 8-week computer retraining program, in addition to the traditional rehabilitation program. Subjects in the control group will enter the traditional rehabilitation program only. Computer retraining will consist of 2 hours per day of intervention with computer software for a total of 10 hours of cognitive retraining per week. Different software programs will be used each week, with each set of programs

targeted primarily to a specific deficit secondary to right hemisphere CVA. At the end of the 8-week retraining program, all patients will be reevaluated with the same assessments to measure improvement in target abilities. In addition, patients will be reevaluated in 3 months to assess changes in adaptive capabilities.

In Experiment 2, 30 patients with left hemisphere CVA will participate. This design is equivalent to Experiment 1, except that patients also will be evaluated by the Departments of Audiology and Speech Pathology, and computer retraining will focus on improvement of ability deficits characteristic of left hemisphere CVA. Again, patients will be reevaluated at the end of the eight-week retraining program and at a 3-month follow-up.

The following hypotheses will be tested: 1) patients who receive computer-based cognitive rehabilitation, in addition to traditional rehabilitation (experimental subjects) will show greater improvement on target deficits than patients who receive traditional rehabilitation alone (control subjects); and 2) experimental subjects will show greater improvement in activities of daily living and overall adaptive functioning than will control subjects, thus demonstrating greater generalization of skills beyond the clinic environment.

Family Factors and Work Adjustment of Handicapped Mexican American Disabled

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Purpose—There exists a paucity of quality research describing unique Hispanic cultural factors—such as, machismo, la palabra, la familia, and overprotectiveness—which influence the vocational rehabilitation process. Over a 36-month period, this South Texas research project will describe unique patterns of Mexican American family interaction, Mexican American family member attitudes toward disability, and these family member attitudes toward rehabilitation resource utilization for bilingual, bicultural, vocationally-handicapped Mexican Americans with disabling conditions caused by stroke or brain trauma.

All handicapped individuals (potential subjects) will have been: 1) medically rehabilitated; 2) certified eligible for vocational rehabilitation services by the Texas Rehabilitation Commission; and 3) determined to be bilingual/bicultural prior to selection as a subject, with their family selected additionally as subjects. After 3 months of vocational rehabilitation services, data will be analyzed to identify culturally-relevant family predictors of the development of competencies which promote attainment of vocational potential and work adjustment. As a result, during Year 2 of the project, a culturally-sensitive *Family Interventions Manual for Handicapped Mexican Americans* will be developed for modifiable factors, based on social learning theory and principles of operant learning, which promote patterns of family interaction and/or attitudes that facilitate the maintenance or development of the previously identified work adjustment competencies.

Finally, during Year 3, the effectiveness of these interventions will be evaluated experimentally through implementation of the family interventions as a part of the Individualized Written Rehabilitation Plan with Mexican American families of vocationally handicapped, bilingual, bicultural Mexican Americans disabled by stroke or brain trauma. Once documented as effective, training in the Mexican

American family intervention model will be provided to counselors of the Texas Rehabilitation Commission. Additionally, microcomputer software will be developed for use in identifying family "risk" factors and for making culturally appropriate family intervention recommendations to be used in conjunction with the McCarron-Dial Work Evaluation System. The results of the research also will be disseminated regionally and nationally during each year of the project.

Studies of Spasticity in Brain Injury Patients

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Sponsor: National Institutes of
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Purpose—Chronic electrical stimulation of the cerebellum has been performed to reduce spasticity in brain-damaged patients. The purpose of our proposed study is to investigate the physiology of spasticity and to evaluate the efficacy of electrical stimulation as a therapeutic procedure. We plan to define rigorously the elements of spasticity and evaluate motor control in cerebral palsy, spinal cord injury, and stroke patients. Tests of fine and gross motor control, simple tracking movements, and tests to elicit developmental reflexes, muscle rigidity, phasic stretch reflexes, and "long loop" late reflexes will be performed. The cerebellar implant patients also will be evaluated with these tests in our continuing double-blind studies.

We hope to relate the specific motor impairments in the patients with damage of the central nervous system to the underlying neurophysiological abnormalities. Furthermore, we hope to correlate any functional improvement which may occur with cerebellar stimulation to physiological changes.

Spasticity—Mechanisms and Quantification (Human)

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Sponsor: National Institutes of
Health

Purpose—Mechanisms of muscular hypertonia and weakness in spastic limbs will be studied using spastic-hemiparetic adult human subjects. Hypertonia is known to result from an abnormally responsive stretch reflex. The question to be addressed is whether this stretch reflex abnormality arises simply because stretch reflex threshold is reduced (a consequence of increased motoneuronal excitability), whether the inherent stiffness of the reflex response also is abnormally augmented or whether both abnormalities coexist. This distinction is fundamental for understanding the neurophysiological bases of spasticity and for designing techniques allowing quantification of this disorder.

Stiffness of normal and spastic limbs will be compared at comparable initial force and joint angle using controlled variations in load force or in limb position as test perturbations. Should differences in stiffness emerge, the reflex contributions of Ia, II, and Ib afferents will be assessed. Mechanisms of weakness in spastic muscles will be studied focusing on contributions provided by anomalously low rates of motor unit discharge. Spectral analysis of surface EMG recordings will focus on differences in power at low frequencies, the portion of spectrum where rate contributions become evident. Recorded differences will be studied using single unit intramuscular recordings. The role of cutaneous and small

diameter afferents from muscle groups III and IV in mediating the disorganization of motor unit recruitment and rate modulation will be studied by comparing the reflex response of muscles to cutaneous nerve muscle stimulation on normal and spastic sides of the same hemiparetic-spastic subject.

The studies on limb stiffness may provide techniques useful for the quantification of the severity of spasticity. Such techniques are necessary for accurate assessment of the response to various therapies (pharmacologic, surgical, or physical) and for charting the natural history of neurologic illnesses producing spasticity. The studies on weakness may provide an assessment of the importance of segmental afferent input in mediating the abnormal patterns of motor unit recruitment and rate modulation.

Computer-Assisted Neuropsychological Assessment

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Purpose—There is a rising demand for neuropsychological assessments because of an increasing recognition of the disabling effects of brain pathology, and because of the association of cognitive disabilities with age. With support from the VA's Rehabilitation Research and Development Service, we have been designing and planning the development of a microcomputer-based assessment system to: 1) present sophisticated automated tests; 2) make use of the results to guide the administration of further tests; and 3) develop an "expert system" to aid in the diagnosis of neuropsychologically impaired patients. Such a system would capitalize on advances in computer technology and artificial intelligence methods to significantly increase our capacity to diagnose and describe the disabling effects of brain injury. Finally, we propose to make use of a network of VA facilities to enable ongoing norming and validation of the proposed system.

Progress—To date, we have completed extensive reviews of the pertinent neuropsychological and cognitive literatures. We also have reviewed prior attempts at developing automated cognitive testing systems. The proposed system is designed to have the capacity for organic growth so it will be easy to modify or add tests as new knowledge about brain function is developed. It is an adaptive testing system wherein the difficulty of items is adjusted as a function of the patient's performance. The system will have two levels in respect to tasks: 1) a comprehensive set of already well validated tests which have available norms and which are already widely accepted by practicing neuropsychologists; and 2) a set of cognitive psychology tasks designed to uncover the specific performance underlying task failure. The pattern of test results will be analyzed by an "expert system" which will assist in forming a diagnosis.

Future Plans—In the next year, we propose to implement software development of the "front end" of the system (i.e., the testing component). This will consist of a task development and a task presentation component. The former will have subprograms that accept as input, pictures, text, speech and tones. It will have a way of specifying the parameters of each input presentation and of the associated response to be collected. The latter will consist of I/O primitives, a group of tasks,

and an outer shell program that would call and control the individual tasks. The I/O primitives will present auditory and visual stimuli, as well as read inputs via button press, touch screen, byte-pad, and voice key. Also included are procedures to read a real time clock. Following this initial phase, the development of the "expert system" component will proceed in concert with the validation and norming process. We anticipate experimental use of the testing system to begin within 18 months.

Establishment of a Central Nervous System Trauma Center

Lawrence F. Marshall
University of California
San Diego, CA 92103

Sponsor: National Institutes of Health

Purpose — The purpose of this project is to determine the cause of the decline in mortality from head injury observed during the last 2 years in San Diego County and to develop a comprehensive program for spinal cord injury patients to include acute care and rehabilitation. We also will continue to develop a head injury remediation center for San Diego County and participate in the multicenter collaborative trial of high dose barbiturate therapy for uncontrolled intracranial pressure. Finally, we will continue our clinical research on evoked responses and catecholamines in severely head-injured patients.

Establishment of a Central Nervous System Trauma Center

Kamran Tabaddor
Yeshiva University
Bronx, NY 10461

Sponsor: National Institutes of Health

Purpose — Data collection for a multicenter randomized, controlled double-blind clinical trial of barbiturate coma in intractable hypertension began on October 1, 1982. A study designed to derive a profile of the traumatic spinal cord injured patient began on January 1, 1983. Neuropsychological and psychosocial data are being collected on mildly head-injured patients to study the cognitive impact and subsequent natural history of mild head injury in different populations. Studies being continued or completed include: 1) an analysis of cognitive outcome of severe and moderate head injury; 2) analysis to characterize demographic and clinical features; and 3) the studies of the features influencing the outcome.

Establishment of a Central Nervous System Trauma Center (Human)

Ralph F. Frankowski
University of Texas
Health Science Center
Houston, TX 77711

Sponsor: National Institutes of Health

Purpose — The major new objective is to conduct a collaborative, single-blind, randomized clinical trial evaluating the use of high-dose pentobarbital therapy for the control of elevated intracranial pressure in persons who have sustained significant and life threatening head injuries. If effective, significant reductions in head injury mortality and disability are expected. Continuing objectives include the evaluation of acute and rehabilitative care, research on neuropsychological consequences of mild head injury, improvement of community care for the spinal injured, and research on methods for the control and prevention of significant head/spinal injuries.