Introduction to Automated Neuropsychological Assessment Metrics (ANAM)

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Technology Transfer - ANAM

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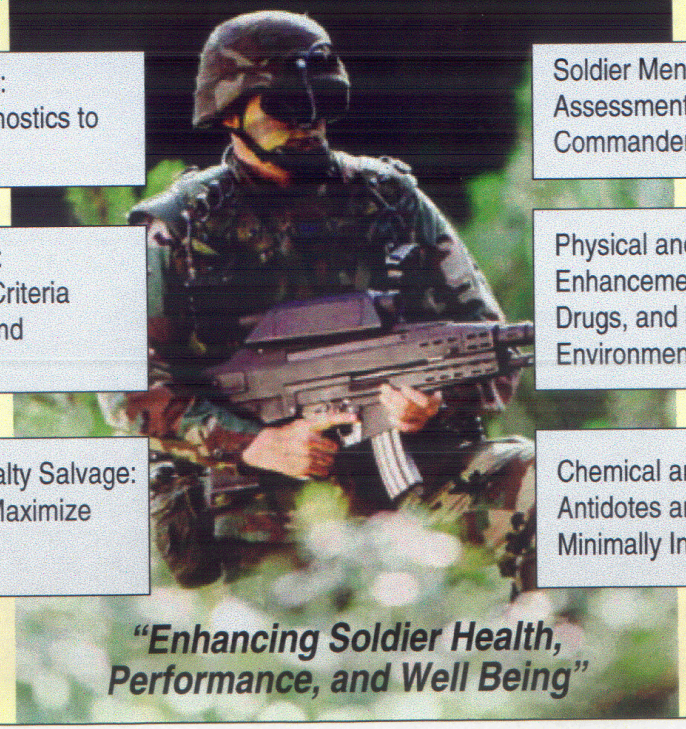

Natural Infectious Diseases: Vaccines, Drugs, and Diagnostics to Keep the Force Healthy

Combat Equipment Design: Human Tolerance Design Criteria to Optimize Performance and Maximize Survivability

Medical Products for Casualty Salvage: Minimize Evacuation and Maximize Quick Return to Duty

Soldier Mental and Physical Status Assessment: Monitoring and Commander Decision Assist

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Chemical and Biological Environments: Antidotes and Diagnostics to Allow Minimally Interrupted Operations

"Enhancing Soldier Health, Performance, and Well Being"

Chemical and Biological Environments: Antidotes and Diagnostics to Allow Minimally Interrupted Operations

- Chem Warfare Antidotes of the 1980's Degraded Mental Performance
- Needed a Method to Develop Improved Drugs and Pre-Treatment Agents
- Pharmacokinetics

National Aeronautics and
Space Administration
Lyndon B. Johnson Space Center
2101 NASA Road 1
Houston, Texas 77058-3696

Reply to Attn of: SD-00-428

Joseph Bleiberg, Ph.D.
National Rehabilitation Hospital
102 Irving St. NW
Washington D.C. 20010

Dear Dr. Bleiberg,

I wish to express a desire to obtain and use the scoring routine and database developed for National Rehabilitation Hospital for the Automate Neuropsychological Assessment Metrics (ANAM). We at NASA have a similar tool called the Space Flight Cognitive Assessment Tool for Windows (WinSCAT) that is composed of subtests from the ANAM.

Our test is given as follows: We give the test six times before an astronaut launches into space to obtain an individual baseline. The astronaut then takes the test every 30 days as part of their regular physical examination. The astronaut also has the option to take the test anytime to self-assess their own cognitive functioning (e.g. prior to an docking maneuver or space walk). The astronaut may also be asked to take the test after a neurological event (exposure to toxic gas, head trauma, or central nervous system decompression sickness). If there is a neurological event, the test results will be downlinked and compared not only to their own baseline, but to normal and clinical samples as well.

Obtaining your scoring routine and information from your database will allow NASA to easily score the astronauts' tests, but also compare their results to other normative samples.

If you have any questions, please contact the psychologist assisting me with this tool, Dr. Walter Sipes at 281-212-1394.

Sincerely,

Christopher F. Flynn, M.D.
Chief, Psychiatry, Medical Operations Branch

Go To SLE Poster

The Clinical Neuropsychologist
2000, Vol. 14, No. 3, pp. 287-294

1385-4046/00/1403-287$15.00

Factor Analysis of Computerized and Traditional Tests Used in Mild Brain Injury Research

Joseph Bleiberg[1], Robert L. Kane[2], Dennis L. Reeves[3], William S. Garmoe[1], and Ellen Halpern[1]
[1]National Rehabilitation Hospital, [2]VA Maryland Health Care System and University of Maryland, and [3]US Navy Medical Center, Guam

ABSTRACT

The present study examines the relation between a set of computerized neuropsychological measures, Automated Neuropsychological Assessment Metrics (ANAM), and a set of traditional clinical neuropsychological tests. Both sets of tests have been employed in recent studies of mild brain injury. Factor analysis and stepwise regression indicate that both sets of tests measure similar underlying constructs of cognitive processing speed, resistance to interference, and working memory. The present findings indicate strong concordance between computerized and traditional neuropsychological measures and support the construct validity of ANAM and similar procedures.

Construct Validity

- Initial efforts to provide construct validity for ANAM subtests used a high school and college athlete sample who received baseline and follow-up neuropsychological assessment with ANAM and a battery of traditional paper-and-pencil measures. Principal components analysis with varimax rotation revealed the following factors. (Bleiberg et al., 2000)

Component	I	II	III	IV
Stroop Color-Word	.804			
PASAT Total	.767			
ANAM MTH Throughput	.766			
Trails B	-.703			
ANAM SPD Throughput		.77		
ANAM STN Throughput		.661		
Consonant Trigrams Total		.535		
Block Design Raw Score			.864	
ANAM SRT Mean Reaction Time		-.590	-.599	
ANAM MSP				.902
HVLT Recall Total Trials 1-3				.549

ANAM: Reliability

- Daniel J, Olesniewicz M, Reeves D, Tam D, Bleiberg J, Thatcher R, Salazar A. Repeated measures of cognitive processing efficiency in adolescent athletes: implications for monitoring recovery from concussion. *Neuropsychiatry, Neuropsychology, and Behavioral Neurology*, 1999, 12(3):167-169.

- Over a three month testing interval, improvement from T1 to T2 is nearly universal - <u>not exceeding</u> the baseline is pathological

- Test-retest reliability is high

Poster presented at the annual meeting of the Congress of Rehabilitation Medicine
November 1992, San Francisco

A PROCEDURE FOR ASSESSING AND MONITORING COGNITIVE ENHANCEMENT AND COGNITIVE DEGRADATION SECONDARY TO PHARMACOTHERAPY

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Office of Military Performance Assessment Technology

J. Cederquist
George Washington University

Neuropsychiatry, Neuropsychology, and Behavioral Neurology
Vol. 6, No. 4, pp. 245–248

Effects of Dexedrine on Performance Consistency Following Brain Injury

A Double-Blind Placebo Crossover Case Study

*Joseph Bleiberg, Ph.D., *William Garmoe, Ph.D., †Jennifer Cederquist, B.A., ‡Dennis Reeves, Ph.D., and *Warren Lux, M.D.

**National Rehabilitation Hospital, and †George Washington University, Washington, DC; and ‡National Naval Medical Center, Bethesda, Maryland, U.S.A.*

INTERNATIONAL NEUROPSYCHOLOGICAL SOCIETY
TWENTY-FOURTH ANNUAL MEETING
CHICAGO, ILLINOIS, USA
February 14-17, 1996

V.N. Starbuck, R.C. Platenberg, J. Bleiberg, C.A. Eberle, C.S. Lin, K. Ward, & A.A. Hartley. fMRI of Working Memory: A Case Study of Signal Enhancement with D-Amphetamine Treatment Following Head Injury. Department of Neurology, Georgetown University School of Medicine, Washington, D.C. 20007, USA.

Functional magnetic resonance imaging (fMRI) was used to measure brain activation for a 54 year old male head-injured subject on two working memory tasks (Location and Identity) and a simple Motor Task. The subject was evaluated on and off d-amphetamine treatment. fMRI analysis demonstrated significantly greater activation when the subject was on drug. Drug effects were most salient for the Location task. The posterior slices yielded more differential fMRI activation compared to the anterior slices. Significant differential activation was also observed for the Motor Task. These findings support prior electrographic and behavioral studies of d-amphetamine-mediated performance changes. Findings also support Baddeley's model of working memory.

Neuropsychology and Behavioral Neurology
Vol. 8, No. 3, pp. 189–192

D-Amphetamine-Mediated Enhancement of the P300 ERP: A Placebo-Crossover Double-Blind Case Study

Victoria N. Starbuck, Ph.D., *Joseph Bleiberg, Ph.D., and Gary G. Kay, Ph.D.

*Department of Neurology, Georgetown University Medical School, and *Department of Psychology, National Rehabilitation Hospital, Washington, D.C., U.S.A.*

Summary: A double-blind placebo-crossover study using D-amphetamine in a head-injured subject indicated improved cognitive performance and improved P300 results in the D-amphetamine condition. Cognitive improvement consisted of selective enhancement of divided attention and response inhibition. P300 ERP improvement consisted of substantially increased amplitude and a simultaneous decrease in P300 variability. There was also evidence of topographic redistribution of the P300 ERP. **Key Words:** Event-related potentials—Head injury—P300—Cognition—D-Amphetamine. **NNBN 8:189–192, 1995**

"Non-Sedating Claritin"

Kay et al., *Arch Intern Med* 1997 Nov 10;157. **Initial and steady-state effects of diphenhydramine and loratadine on sedation, cognition, mood, and psychomotor performance.**

BACKGROUND: The classic, first-generation histamine1-receptor antagonists used to treat allergic disorders frequently cause sedation. In contrast, sedation is reduced or absent after administration of recommended doses of second-generation histamine1-receptor antagonists. We measured the initial and steady-state effects of diphenhydramine, a first-generation antihistamine, and loratadine, a second-generation antihistamine, by means of a comprehensive battery of psychometric tests that mirror real-world tasks. METHODS: Healthy volunteers (N = 98) were randomly assigned in a double-blind fashion to receive loratadine (n = 33), diphenhydramine (n = 32), or placebo (n = 33). A computerized test battery was administered at baseline, on day 1 after administration of the initial dose, and on days 3 and 5. RESULTS: After the initial dose, subjects taking diphenhydramine demonstrated poorer cognitive performance than subjects taking loratadine or placebo on tasks of **divided attention, working memory, speed, and vigilance**. Subjects taking diphenhydramine also reported greater **fatigue and sleepiness** and lower levels of motivation, and rated the quality of their performance as lower than subjects taking loratadine or placebo. On day 3, subjects taking diphenhydramine continued to show more fatigue and lower motivation, and rated the quality of their test performance as poorer than subjects taking loratadine or placebo. There were no differences between loratadine and placebo after the initial dose or steady-state (day 5) dosing for any measure of cognitive or psychomotor test performance, mood, or sedation. CONCLUSIONS: Patients taking diphenhydramine may be at risk of **lapses** and significant errors that may lead to potential hazards and decreased work productivity.

Headache 2000 Sep;40(8):657-61 A pilot study to measure cognitive efficiency during migraine. Farmer K, Cady R, Bleiberg J, Reeves D

Headache Care Center, Springfield, Mo (Drs Farmer and Cady); National Rehabilitation Hospital, Washington, DC (Dr Bleiberg); United States Navy, Guam (Dr Reeves).

BACKGROUND AND OBJECTIVES: The measurement of cognitive efficiency during migraine has produced conflicting results primarily due to the types of tests used. The objectives of this pilot study were two-fold: to measure cognitive efficiency during migraine, compared to a migraine-free period, and to evaluate the effects of therapy with a 5-HT1 agonist (sumatriptan injection, 6 mg) on the cognitive efficiency of migraineurs during a migraine. METHOD: The Headache Care Center-Automated Neuropsychological Assessment Metrics was administered to 10 migraineurs, three times without a migraine, once during a migraine, and three times after administration of sumatriptan injection (6 mg). RESULTS: The results demonstrated a significant drop in cognitive efficiency during migraine and recovery 15 minutes after therapeutic injection. CONCLUSIONS: This pilot study is the first to document a significant drop in cognitive functioning during migraine and recovery after administration of a migraine-specific medication.

Sumatriptan Nasal Spray and Cognitive Function During Migraine: Results of an Open-Label Study

Kathleen Farmer, PsyD; Roger Cady, MD; Joseph Bleiberg, PhD; Dennis Reeves, PhD; Gayla Putnam, MA; Stephen O'Quinn, PharmD; Alice Batenhorst, PharmD

Objective.—To examine measures of cognitive function during acute migraine, before and after treatment with sumatriptan nasal spray, 20 mg.

Background.—Migraineurs frequently report symptoms of cognitive impairment during migraine. The efficacy of sumatriptan for treatment of migraine-related cognitive impairment is undocumented.

Methods.—This open-label, single-attack study of 28 subjects used the Headache Care Center-Automated Neuropsychological Assessment Metrics, a computerized neuropsychological assessment battery, to measure cognitive function under three patient conditions: migraine-free, untreated migraine, and following sumatriptan (primary outcome). Headache response and pain-free response, percent effectiveness, and clinical disability were measured.

Results.—Cognitive function (simple reaction time, sustained attention/concentration, working memory, visual-spatial processing) and alertness/fatigue were adversely affected during migraine compared with migraine-free performance ($P<.05$), and rapidly restored following sumatriptan nasal spray, 20 mg ($P<.05$). Headache and pain-free response were 86% and 68%, respectively, at 135 minutes postdose. Changes in migraine pain severity, clinical disability, and percent effectiveness following treatment with sumatriptan nasal spray, 20 mg, were significantly correlated with cognitive function measures across all subtests ($P<.001$).

Conclusions.—Sumatriptan nasal spray, 20 mg, restored migraine-related cognitive function and clinical disability.

Key words: sumatriptan, cognitive function, migraine, disability

Abbreviations: ANAM Automated Neuropsychological Assessment Metrics, HCC-ANAM Health Care Center-Automated Neuropsychological Assessment Metrics, NS nasal spray, SRT simple reaction time, CPT continuous performance test, MTS matching to sample, MP mathematic processing, SSS Stanford Sleepiness Scale

(*Headache* 2001;41:377-384)

Environmental Research Section A 83, 168–180 (2000)
doi:10.1006/enrs.1999.4012, available online at http://www.idealibrary.com on IDEAL®

Health Effects of Depleted Uranium on Exposed Gulf War Veterans

Melissa A. McDiarmid,*,†,1 James P. Keogh,*,† Frank J. Hooper,† Kathleen McPhaul,† Katherine Squibb,§ Robert Kane,*,‡ Raymond DiPino,*,‡ Michael Kabat,*,‡ Bruce Kaup,*,‡ Larry Anderson,‖ Dennis Hoover,‖ Lawrence Brown,*,§ Matthew Hamilton,†† David Jacobson-Kram,** Belton Burrows,¶ and Mark Walsh¶

*Department of Veterans Affairs Medical Center, Baltimore, Maryland; †Department of Medicine, ‡Department of Psychiatry, §Department of Pathology, ‖Department of Anatomy and Neurobiology and Program of Human Health and the Environment, University of Maryland School of Medicine, Baltimore, Maryland; ¶Department of Veterans Affairs Medical Center, Boston, Massachussetts; and **MA BioServices and ††Armed Forces Radiobiology Research Institute, Bethesda, Maryland

Received May 7, 1999

A small group of Gulf War veterans possess retained fragments of depleted uranium (DU) shrapnel, the long-term health consequences of which are undetermined. We evaluated the clinical health effects of DU exposure in Gulf War veterans compared with nonexposed Gulf War veterans. History and follow-up medical examination were performed on 29 exposed veterans and 38 nonexposed veterans. Outcome measures employed were urinary uranium determinations, clinical laboratory values, and psychiatric and neurocognitive assessment. DU-exposed Gulf War veterans with retained metal shrapnel fragments are excreting elevated levels of urinary uranium 7 years after first exposure (range 0.01–30.7 μg/g creatinine vs 0.01–0.05 μg/g creatinine in the nonexposed). The persistence of the elevated urine uranium suggests on-going mobilization from a storage depot which results in a chronic systemic exposure. Adverse effects in the kidney, a presumed target organ, are not present at this time, though other effects are observed. Neurocognitive examinations demonstrated a statistical relationship between urine uranium levels and lowered performance on computerized tests assessing performance efficiency. Elevated urinary uranium was statistically related to a high prolactin level (>1.6 ng/ml; $P = 0.04$). More

Key Words: **uranium; health effects; Gulf War; toxicity; metals.**

INTRODUCTION

During the Gulf War, 15 Bradley Fighting Vehicles and nine Abrams tanks were mistakenly fired on and struck by munitions containing depleted uranium (DU), a by-product of the uranium enrichment process. DU possesses less of the most radioactive isotope ^{235}U and thus only about 60% of the radioactivity of natural uranium. It has been incorporated into both projectiles and armor by the military of the United States and other countries because of its density, availability, and low relative cost. Soldiers in struck vehicles may have inhaled airborne DU particles (or other combustion products), ingested DU particles, and/or experienced wound contamination by DU. Some crew members who survived were left with multiple tiny fragments of uranium scattered through their muscle and soft tissue. These survivors have since been followed medically to enable early detection of potential untoward health effects.

The health effects of concern relate only partially to the relatively low-intensity radiologic toxicity of

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Consistency of Within-Day and Across-Day Performance After Mild Brain Injury

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**National Rehabilitation Hospital, Medlantic Research Institute, Washington, DC, †Medlantic Research Institute, Washington, DC, ‡United States Naval Medical Center, San Diego, California, §Florida Hospital, Orlando, Florida, U.S.A.*

Acad Emerg Med 1999 Jul;6(7):758-60

Partridge RA, Shapiro MJ, Micalone M, Jenouri I, Woolard RH, Gifford DR

Rapid computerized cognitive assessment: performance of highly functional elder patients with minor traumatic injury in the emergency department.

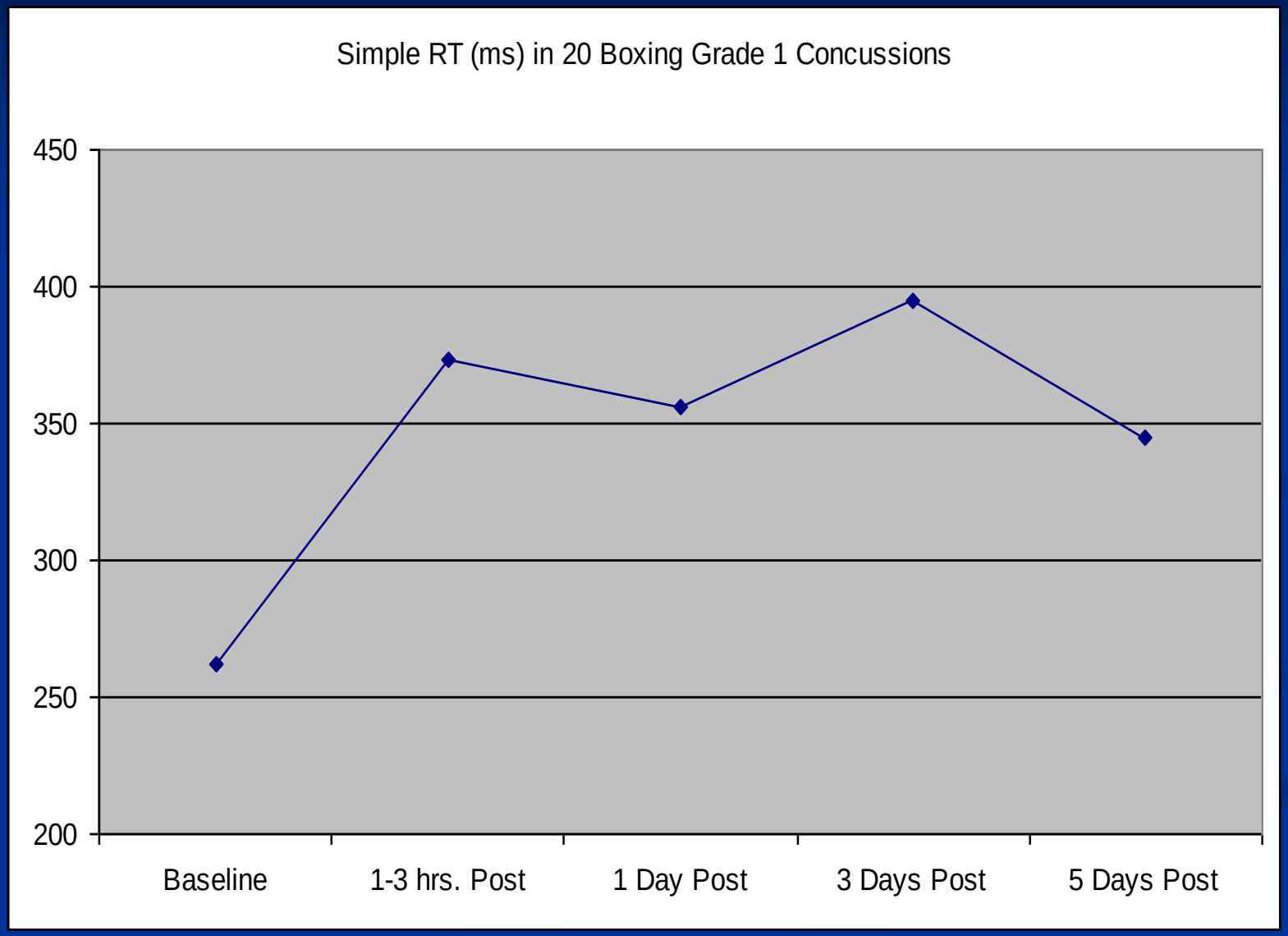
J Head Trauma Rehabil 1998 Apr;13(2):36-44
Future directions for the neuropsychological assessment of sports concussion. Bleiberg J, Halpern EL, Reeves D, Daniel JC

This article argues in favor of using newly developed computerized, complex reaction time (RT)-based neuropsychological procedures for the study of sports-related concussion. Recent studies show that by using these complex RT procedures, significant differences between concussed and control samples can be observed. ***The magnitude of RT differences is 200 ms or less, levels that are not meaningfully measured using stopwatch-based procedures***. RT-based procedures also have the advantage of permitting analysis of variability of RT, and several recent studies have shown that brain dysfunction is accompanied by erratic and inconsistent RT.

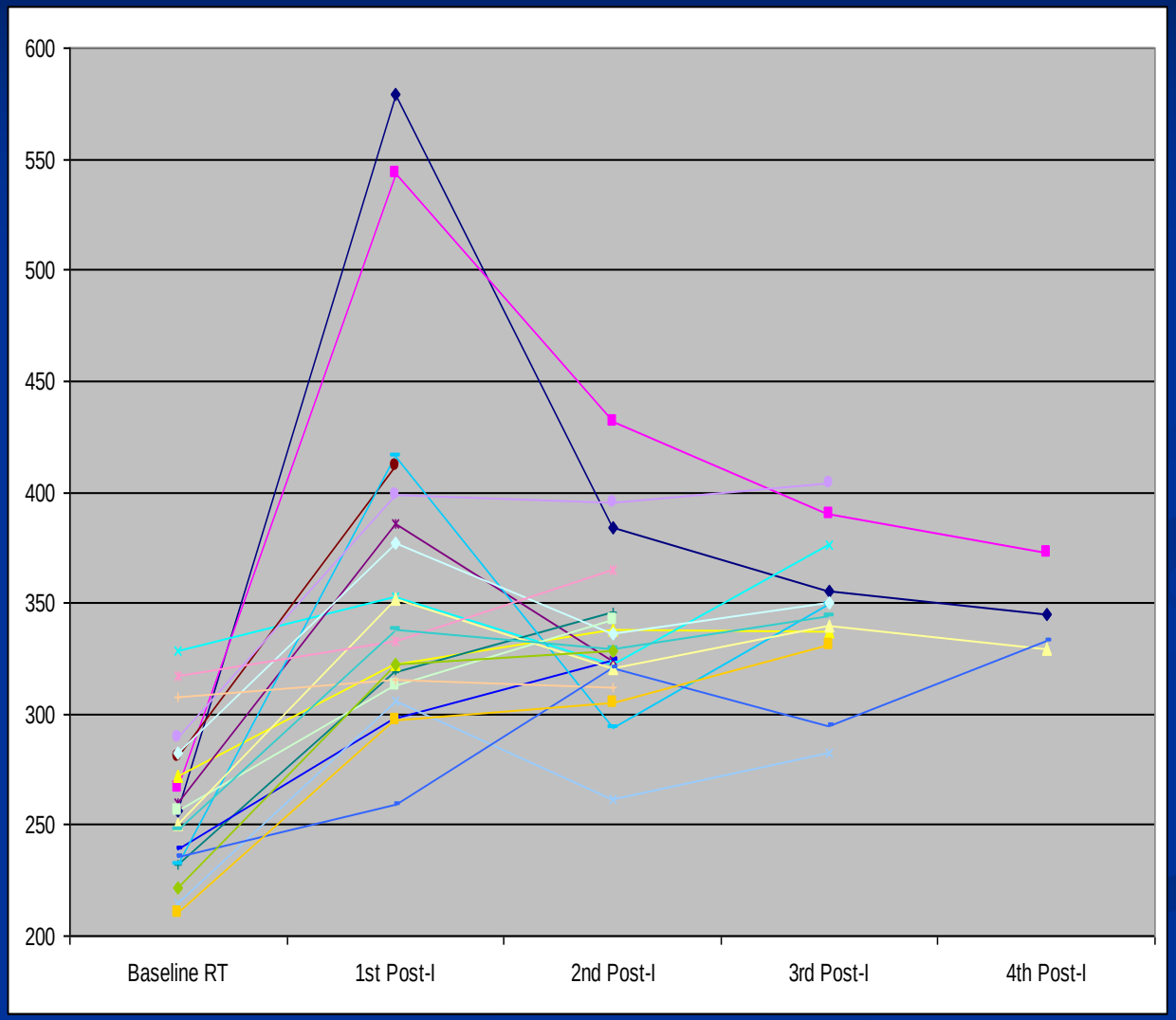
ANAM: Recovery from Sports Concussion

Warden, D.L., Bleiberg, J., Cameron, K.L., Ecklund, J., Walter, J., Sparling, M.B., Reeves, D., Reynolds, K.Y., and Arciero, R. Persistent prolongation of simple reaction time following sports concussion. Neurology, 2001, 57(3), 524-526.

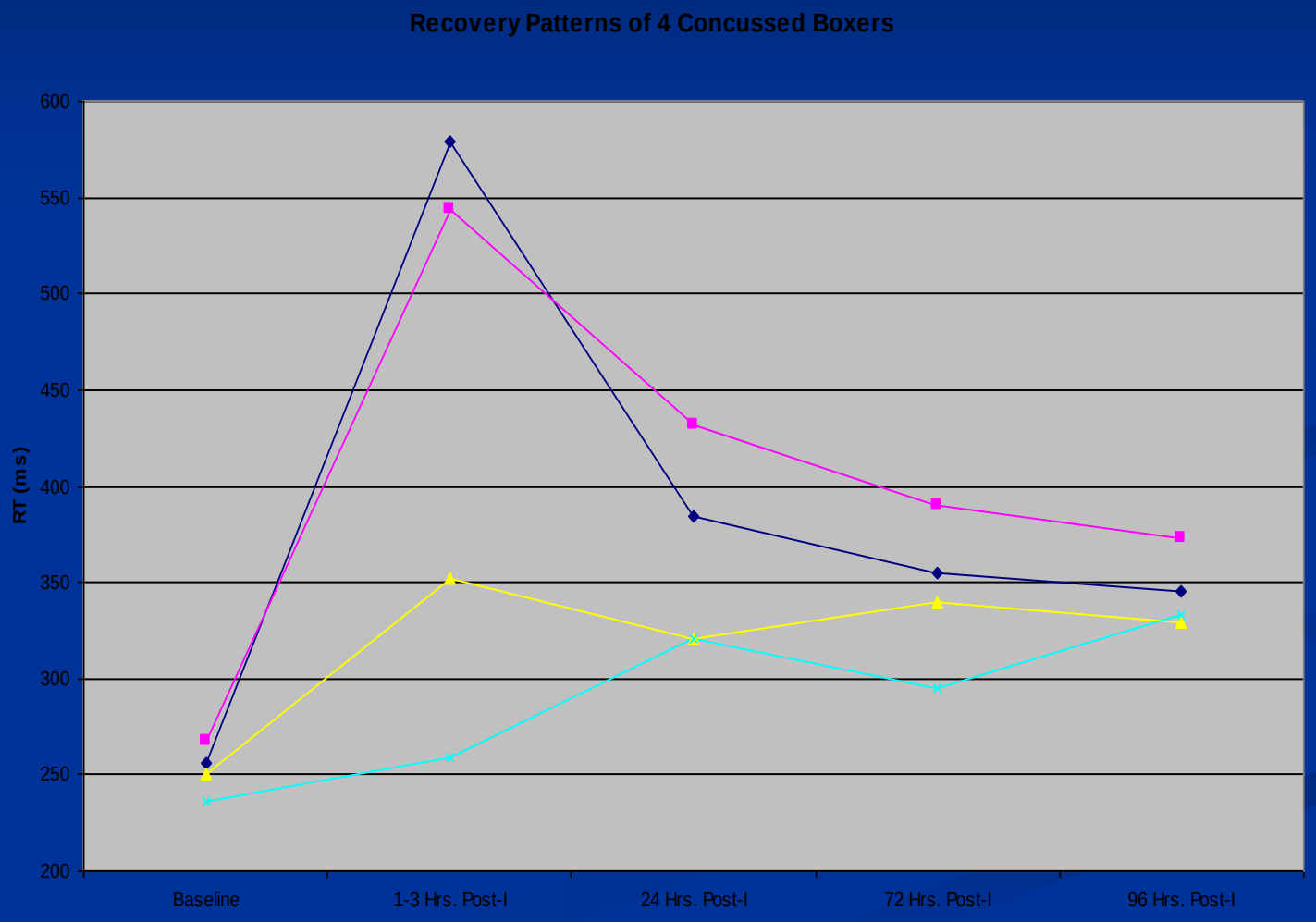
Reaction Time: Group Means



Reaction Time: *Per Subject*



4 subjects start and end in same place, but in two different ways

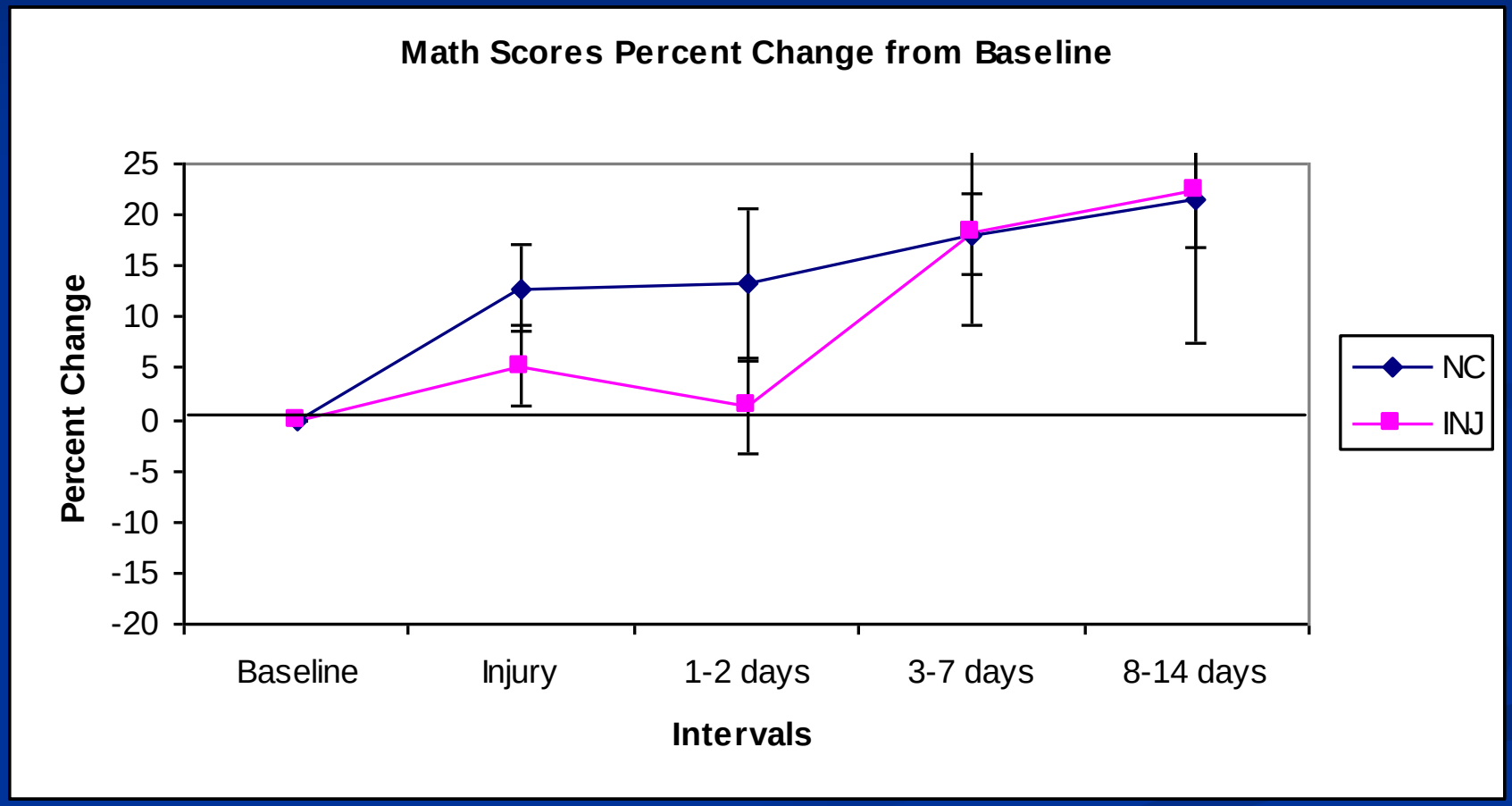


Group Data and Clinical Practice

- Group data may be statistically significant and provide important scientific knowledge
- Transition from group data to clinical practice is complex
- **CAUTION: ANAM interpretation will be limited for at least several more years until additional data are available**
- **IMPLICATION: To use ANAM responsibly, you must be able to provide competent concussion clinical care *without* ANAM**

Concussion Recovery Curves

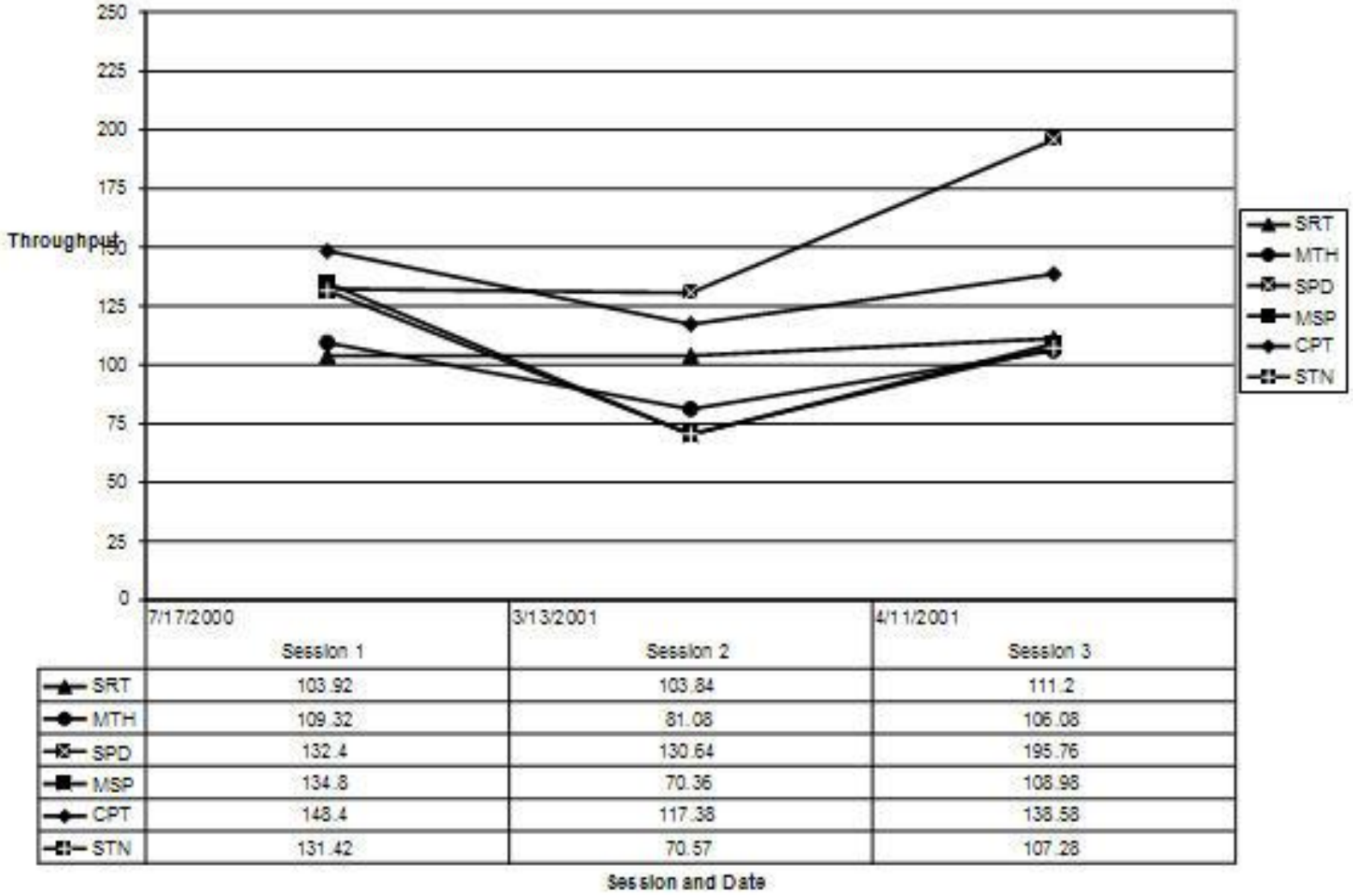
Bleiberg J., Cernich A.N., Cameron K., Sun W., Peck K., Ecklund L.P., Reeves C.D., Uhorchak C.J., Sparling M.B., Warden D.L. Duration of Cognitive Impairment after Sports Concussion. *Neurosurgery*, 2004. (54)5, 10 73-1080.



Fort Bragg

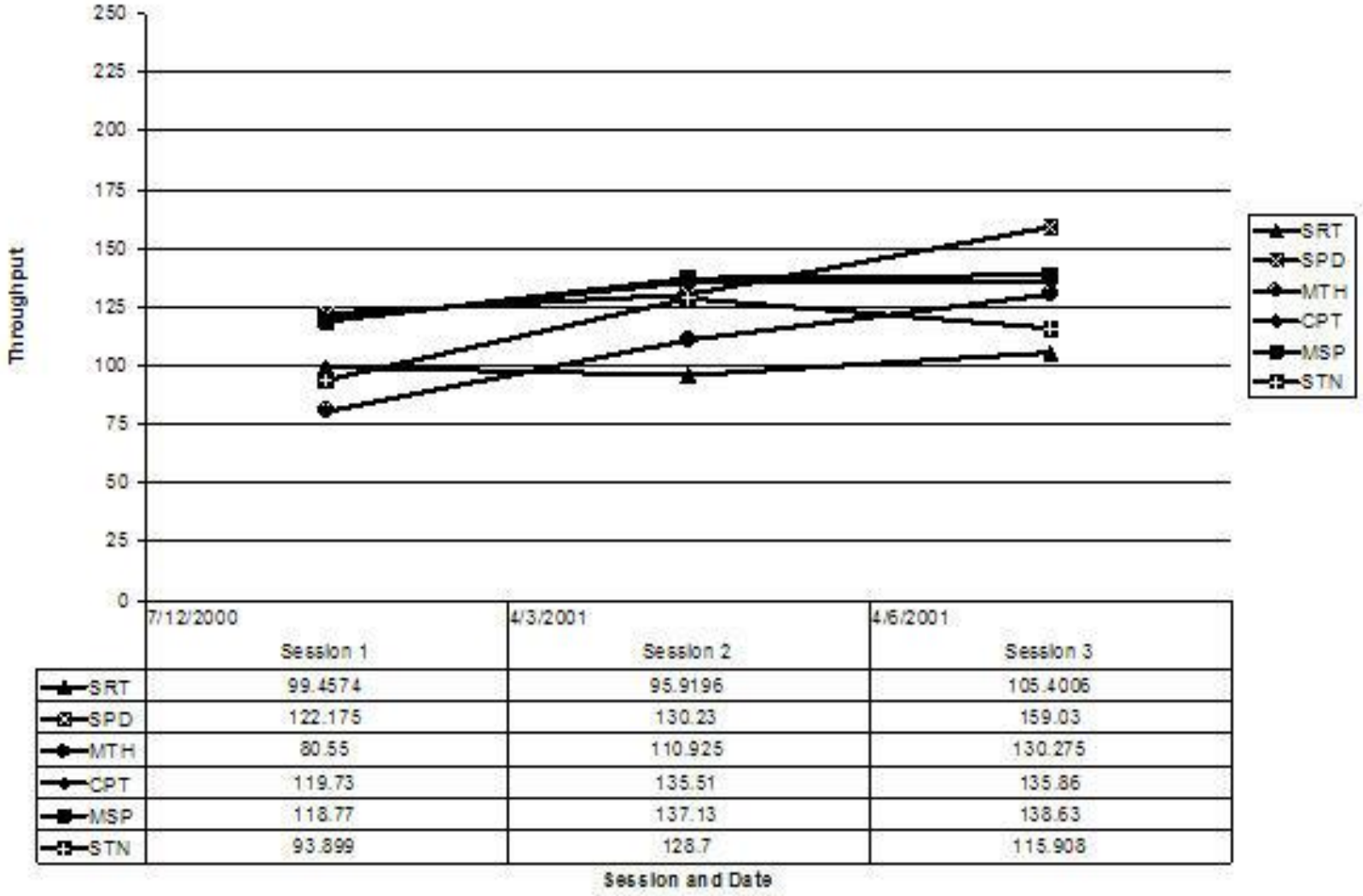
- Over 8,000 paratroopers have received baseline assessment at Fort Bragg. Controls were recruited that were demographically similar to injured for purpose of follow-up comparison.
- ANAM was used to track recovery from concussion following any mild head injury.
- Differences between groups on various ANAM tests were found for three different contrasts: presence or absence of LOC, duration of LOC, and presence or absence of amnesia.

Figure 1. Three ASMB Sessions in a Concussed Subject



	7/17/2000 Session 1	3/13/2001 Session 2	4/11/2001 Session 3
SRT	103.92	103.84	111.2
MTH	109.32	81.08	106.08
SPD	132.4	130.64	195.76
MSP	134.8	70.36	108.96
CPT	148.4	117.38	138.58
STN	131.42	70.57	107.28

Figure 2. Three ASMB Sessions in a Control Subject



	7/12/2000 Session 1	4/3/2001 Session 2	4/6/2001 Session 3
SRT	99.4574	95.9196	105.4006
SPD	122.175	130.23	159.03
MTH	80.55	110.925	130.275
CPT	119.73	135.51	135.86
MSP	118.77	137.13	138.63
STN	93.899	128.7	115.908

Getting a "Good" Baseline

- "Normal" moment-to-moment variability of performance
- Confounding Factors
  - Sleep the night before
  - Motivation (bored at baseline, but highly motivated at post-injury testing)
  - Stress, anxiety, depression
- **Group versus individual, one-on-one testing**
  - **"Spoiled" baselines**

Bottom Line

- The testing software is fine
  - Testing procedures need ongoing quality assuranc
  - But primary need is for more knowledge of how to interpret the data in clinical applications
    - Obvious: stable baselines, practice-effects, confounds
    - Non-Obvious: low frequency but serious mistakes (not knowable till first patient with great scores has nasty outcome)

When to use ANAM

- We use ASMB to assist clinical decision-making only after athletes have become *asymptomatic*
- We tell caregivers: If the clinician can see it, and/or the athlete can feel it, the clinical question has been asked and answered and computerized testing is moot.

Post-Injury Testing Issues

- Same confounds as baseline
- Practice-Effects
- Test-retest reliability

- Reliable Change Index

Sdiff: Standard error of difference score

SEm: Standard error of measurement

r: Test-retest reliability

M2 - M1: Practice-effect

S1: Standard deviation of control group

RC: 90% confidence interval

Future

- Most research on ASMB and similar has been performed by the instruments' developers.
- Inventors have a level of competence with their own tools that that may or MAY NOT be teachable
- Tools behave differently in the hands of their creator
- I know how to use it, **but can you?**
  - What type manuals, training sessions, etc. are needed
  - Data display formats, reference group data,

Neuropsychological Functioning in SLE as Assessed by Traditional Pencil and Paper and by Reaction-Time Based Computerized Measures

Tresa M. Roebuck-Spencer, Ph.D.,[1] Cheryl Yarboro, RN,[2] Miroslawa Nowak, M.D.,[2] Larissa Lapteva, M.D.,[2] Thomas Weickert, Ph.D.,[3] Bruce Volpe, M.D.,[4] Betty Diamond, M.D.,[5] Gabor Illei, M.D.,[2] Joseph Bleiberg, Ph.D.,[1]

[1] Neuroscience Research Center, National Rehabilitation Hospital, Washington, DC; [2] NIAMS, NIH, DHHS, Bethesda, MD; [3] NIMH, NIH, DHHS, Bethesda, MD; [4] Weill Medical College of Cornell University, White Plains, NY; [5] Albert Einstein College of Medicine, Bronx, NY

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Background:

Cognitive dysfunction is common in patients with Systemic Lupus Erythematosus (SLE) and can have a significant impact on the everyday functioning of these patients. Assessment of cognitive function in SLE has traditionally been conducted with batteries of standard neuropsychological tests. Administration of these tests requires skilled personnel and can be time consuming, preventing its widespread use in the outpatient clinical setting. Moreover, these traditional tests are often limited in their ability to detect very subtle impairment and lack adequate alternate forms for multiple testing sessions. A cost- and time-efficient screening tool would allow for routine evaluations of cognitive impairment over extended periods of time and would indicate when a more thorough neuropsychological evaluation is needed.

The Automated Neuropsychological Assessment Metrics (ANAM) is a 30-minute computerized cognitive testing battery that can be self-administered and has been used successfully to assess subtle cognitive dysfunction in other medical conditions with neurobehavioral sequelae. The ANAM battery is constructed of subtests that have been shown to measure similar underlying cognitive domains as traditional neuropsychological measures (e.g., processing speed, working memory, resistance to interference). ANAM has the potential to be used as a screening tool to help physicians detect and track subtle cognitive dysfunction in patients with SLE. Thus, the purpose of the current study was to characterize the nature of cognitive dysfunction in SLE using traditional neuropsychological measures and the ANAM battery, and to asses the correlation between ANAM and traditional neuropsychological testing in a cross-sectional cohort of lupus patients.

Methods

Participants: Forty-eight individuals with SLE participated in the current study. This sample was primarily female, right-handed, college educated, and Caucasian. A sample of historic controls was utilized for group comparisons on a subset of ANAM subtests. The historic controls were similar to the SLE sample with respect to age, sex, and education (p's > .05), although there were a greater percentage of Caucasian individuals in the control sample (χ^2=17, p < .01). See Table below for a breakdown of sample demographics.

	Study Sample (n=48)	Reference Sample (n=25)
Age (Mn, range)	41.6 (20 – 67)	39.0 (20 – 66)
Sex (Female: Male)	38:8	22: 3
Ethnicity (n,%)		
Caucasian	25; 52%	25; 100%
African American	11; 23%	
Asian/Asian American	3; 6%	
Hispanic/Latino	8; 17%	
Education (Mn, range)	14.9 (10 – 20)	14.4 (12 – 20)

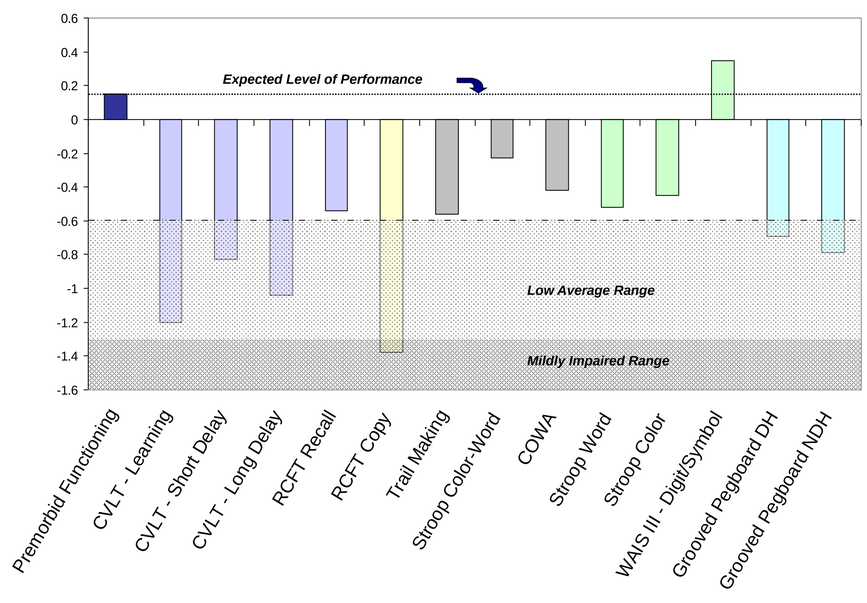
Measures: All participants were administered ANAM and a 2-hour battery of traditional neuropsychological tests. The Reading subtest of the Wide Range Achievement Test – Third Edition (WRAT-III) was used in the present study as an estimate of premorbid intellectual functioning. Traditional neuropsychological tests and ANAM subtests are listed and described in the following two tables.

Test	*Description*	*Domain Assessed*
WRAT-3	Reading words off a list	Premorbid Intellectual Functioning
California Verbal Learning Test (CVLT) – Learning	Learning of word list over five trials	Memory
CVLT – Short Delay	Recall of word list after a short (3-minute) delay	Memory
CVLT – Long Delay	Recall of word list after a long (20-minute) delay	Memory
Rey Complex Figure Test (RCFT) - Recall	Recall of complex figure after a long (30-minute) delay	Memory
RCFT - Copy	Copy of a complex figure	Visuo-spatial
Trail Making Test -Part B	Sequencing of alternating numbers and letters (1-A-2-B-3-C, etc)	Executive Functioning
Stroop Color-Word	Naming ink color while ignoring the printed word (e.g., for BLUE subject says "red," not "blue")	Executive Functioning
Controlled Oral Word Association (COWA)	Generating words that start with a given letter	Executive Functioning
Stroop Word	Speeded word reading	Information Processing Speed
Stroop Color	Speeded color naming	Information Processing Speed
Digit/Symbol Subtest	Quickly writing numbers to matching symbols according to a code	Information Processing Speed
Grooved Pegboard Test	Fitting grooved pegs into holes in a pegboard separately with the dominant hand (DH) and the non-dominant hand (NDH)	Fine-motor speed & coordination

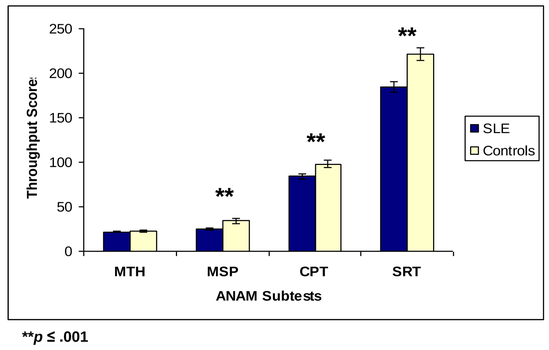
ANAM Subtests	*Description*	*Domain Assessed*
Continuous Performance Test (CPT)	Examinee must continuously monitor numbers and identify if each number is the same or different from the immediately preceding letter	Information Processing Speed; Attention; Working Memory
Code Substitution (CDS)	Examinee must decide if a symbol/digit pairing is consistent with pairings presented in a "code" above	Information Processing Speed; Attention; Visual Scanning; Learning
Code Substitution Delayed (CDD)	Presented 20 minutes after CDS. Examinee must decide if a presented symbol/digit pairing is consistent with the earlier presented "code"	Information Processing Speed; Attention; Memory
Matching to Sample (MSP)	Examinee must select which of two designs match a target design presented 5-seconds earlier	Information Processing Speed; Attention; Short-Term Memory
Matching Grids (MTG)	Examinee must determine if two designs are the same or different from each other	Information Processing Speed; Visual Attention; Visuospatial Processing
Mathematical Processing (MTH)	Examinee must decide whether the solution to a three-step arithmetic problem (e.g., 5 + 2 – 3 = ?) is greater than or less than 5	Information Processing Speed; Attention; Working Memory; Mathematical Abilities
Simple Reaction Time (SRT)	Measures simple reaction time in response to a stimulus (*)	Simple Visuomotor Reaction Time
Sternberg Memory Test (STN)	Examinee must memorize a string of 6 letters and later determine whether individually presented letters were included in the original string	Information Processing Speed; Attention; Working Memory; Short-Term Memory

Results

Description of Cognitive Functioning in SLE sample: All traditional neuropsychological test scores were converted to z-scores based on published norms. For all tests, z-scores were corrected for age, and for the COWA test z-scores were also corrected for educational level. The majority of individuals demonstrated at least average premorbid intellectual abilities, as assessed by the WRAT-III. SLE patients performed within the average range across most tests, although performance in all areas was below that of expected levels. Patients performed in the low average or mildly impaired range on tests of verbal learning and memory, visuoconstruction, and fine-motor speed and coordination. See figure below.



Comparison of SLE and Historic Controls on ANAM Subtests: Data from historic controls, matched to the SLE patients on the basis of age, educational level, and sex, were available for a subset of ANAM subtests (MTH, MSP, SRT, and CPT). Using between group t-tests, groups were compared on ANAM throughput scores, a ratio between speed and accuracy. Patients with SLE performed more poorly on three of four ANAM subtests (MSP p < .01; CPT p = .01; & SRT p < .001). See figure below.



**$p \leq .001$

Correlations between ANAM and Traditional Neuropsychological Tests: *ANAM* subtests were significantly correlated with most of the traditional neuropsychological tests, particularly those assessing executive functioning, information processing speed, and fine-motor speed and coordination. ANAM subtests requiring learning and short-term memory (CDS, CDD, MSP, and STN) were correlated with traditional tests known to measure those domains (Individual r-values are included in the table below).

ANAM subtests	*CPT*	*CDS*	*CDD*	*MSP*	*MTG*	*MTH*	*SRT*	*STN*
WRAT-3	0.168	**.310***	0.248	0.219	0.209	**.534****	0.272	**.371***
CVLT – Learning	0.13	**.420****	**.334****	0.11	0.162	0.282	0.141	**.329***
CVLT – Short Delay	0.175	**.343***	**.406***	0.094	0.189	0.183	0.211	**.388****
CVLT – Long Delay	0.159	**.449****	**.418***	0.179	0.195	0.15	0.185	**.369***
RCFT - Recall	0.157	**.515****	**.583****	**.567****	**.487****	**.337***	**.350***	**.454****
RCFT - Copy	0.051	0.234	**.307***	0.261	0.246	**.354***	0.203	0.28
Trail Making	**-.333***	**-.604****	**-.573****	**-.582****	**-.501****	**-.451****	**-.321***	**-.620****
Stroop Color-Word	0.233	**.463****	**.480****	**.471****	**.558****	**.501****	**.342***	**.673****
COWA	0.139	0.248	0.217	0.018	0.091	**.354***	0.111	**.399****
Stroop Word	**.328***	**.313***	0.22	0.066	0.245	0.183	**.469****	**.422****
Stroop Color	0.262	**.443****	**.294***	0.149	**.426****	0.261	0.17	**.521****
WAIS III – Digit/Symbol	**.410****	**.623****	**.623****	**.454****	**.487****	**.486****	0.244	**.616****
Grooved Pegboard-DH	-0.237	**-.358***	**-.341***	**-.365***	**-.481****	**-.472****	**-.301***	**-.367***
Grooved Pegboard-NDH	-0.27	**-.332***	**-.326***	**-.364***	**-.490****	**-.584****	**-.304***	**-.307***

***p < .05; **p <.001**

Conclusions:

Although patients with SLE performed within the average range on most traditional neuropsychological tests administered in this study, their performance was lower than expected levels on almost all tests administered. Performance was in the average range in the areas of information processing speed and executive functioning. Patients with SLE demonstrated low average performance in the areas of verbal learning and memory and fine-motor speed and coordination. Their greatest area of difficulty, with performance in the mildly impaired range, was observed on a test of visuoconstruction, which also required visuospatial planning and organizational skills. In addition, patients with SLE performed more poorly than matched controls on ANAM subtests measuring information processing speed, simple motor speed, and working memory.

The ANAM computerized battery of cognitive tests has been administered in many settings as a screening for cognitive impairment and to track changes in cognition related to disease progression. ANAM is both cost- and time-efficient and requires less training to administer than traditional neuropsychological tests. This study confirmed the relationship between ANAM subtests and traditional neuropsychological tests in an SLE sample and also demonstrated that ANAM is a sensitive tool to detect cognitive dysfunction in this group of patients.

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Post-Polio Clinics Directors
Network March 20, 2007

Disclaimer: The following are unofficial notes that have not been read by or approved by the speaker.

- Most of Dr. Bleiberg's work is in sports concussions, lupus, fibromyalgia and now post-polio.
- Advantage of using computerized testing is that it is much shorter, briefer and less taxing to the patient. It requires less wear and tear on the research coordinator. It is pretty much self-administered.
- Origin of the software is early 1980's chemical warfare program for Detrick. It still exists.
- NASA uses this software in the space shuttle.
- Dr. Bleiberg has grant money for studies to improve the quality of science and healthcare, mostly in sports concussions and now blast concussions.
- Trait vs. State – Fitness for duty – trait; readiness to perform – state. Traits are easier to measure; states are unstable and harder to measure in a reliable way.
- One of the things learned from the study, it is sensitive enough that if there is an incomplete recovery, an underlying condition should be ruled out. They now have data on what a recovery should look like.
- ANAM worked with Lupus and will probably work with Post-Polio to determine if there is a cognitive impediment.
- USUHS has 20 patients currently in the post-polio cognitive study. Two hundred patients are to be enrolled.