

REPORT DOCUMENTATION PAGE

DTIC FILE COPY
Approved
DATE 11-16-1990 0704-0188

1. REPORT SECURITY CLASSIFICATION UNCLASSIFIED			1b. RESTRICTIVE MARKINGS		
2. SECURITY CLASSIFICATION AUTHORITY			3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution unlimited		
4. DECLASSIFICATION/DOWNGRADING SCHEDULE			5. MONITORING ORGANIZATION REPORT NUMBER(S) AFOSR-TR- 90 1081		
6a. NAME OF PERFORMING ORGANIZATION Department of Psychology		6b. OFFICE SYMBOL (if applicable)	7a. NAME OF MONITORING ORGANIZATION Air Force Office of Scientific Research/NL		
8a. NAME OF FUNDING/SPONSORING ORGANIZATION Air Force Office of Scientific Research/NL			7b. ADDRESS (City, State, and ZIP Code) Bolling Air Base, DC 20332-6448		
8b. OFFICE SYMBOL (if applicable)			9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER AFOSR-90-0007		
8c. ADDRESS (City, State, and ZIP Code) Bolling Air Base, DC 20332-6448			10. SOURCE OF FUNDING NUMBERS		
			PROGRAM ELEMENT NO. 61102F	PROJECT NO. 2313	TASK NO. A4
11. TITLE (Include Security Classification) Towards an Integration of the Non-Invasive Methodologies of Cognitive Neuroscience: The Eleventh Carmel Workshop					
12. PERSONAL AUTHOR(S) Donchin, Emanuel					
13a. TYPE OF REPORT FINAL TECHNICAL		13b. TIME COVERED FROM 1/3/90 TO 1/8/90		14. DATE OF REPORT (Year, Month, Day) 1990, September 18	
15. PAGE COUNT 11 pages					
16. SUPPLEMENTARY NOTATION					
17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)		
FIELD	GROUP	SUB-GROUP			
05	09		Carmel Conference, brain, cognitive neuroscience		
19. ABSTRACT (Continue on reverse if necessary and identify by block number)					
This report summarizes a conference held in Carmel, CA in January, 1990. The conference brought together investigators who use a variety of techniques designed to visualize the activity on the structure of the brain in awake behaving subjects. At issue was the manner in which the effects using these design techniques can be integrated so as to yield a more comprehensive view of the neurological basis of cognition. (TTZ) DTIC ELECTE S NOV 16 1990 B D					
20. DISTRIBUTION/AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS			21. ABSTRACT SECURITY CLASSIFICATION Unclassified		
22a. NAME OF RESPONSIBLE INDIVIDUAL Alfred R. Fregly, Ph.D.			22b. TELEPHONE (Include Area Code) (202) 767-5021		22c. OFFICE SYMBOL NL

TOWARDS AN INTEGRATION OF THE NON-INVASIVE METHODOLOGIES OF
COGNITIVE NEUROSCIENCE: THE ELEVENTH CARMEL WORKSHOP

FINAL REPORT

Submitted by

Cognitive Psychophysiology Laboratory
Department of Psychology
University of Illinois
Champaign, Illinois 61820

Principal Investigator: Emanuel Donchin

26 OCT 1990

TOWARDS AN INTEGRATION OF THE NON-INVASIVE METHODOLOGIES OF COGNITIVE NEUROSCIENCE: THE ELEVENTH CARMEL WORKSHOP

We present here a report on a conference held, on January 3-8, 1990 in Carmel, Ca. with the sponsorship of the Air Force Office of Scientific Research, Biomagnetic Technologies, Inc., John D. & Catherine T. MacArthur Foundation, James S. McDonnell Foundation, National Aeronautics & Space Administration, and the National Science Foundation. The goals of the meeting as described in the proposals submitted to the various sponsors were as follows:

The past decade has seen a burgeoning of techniques serving Cognitive Neuroscience. There are novel radiological means for visualizing intracranial process and structure and there are novel means for recording extracranially the manifestation of information processing activities. Much of this work has been reviewed in a report published in 1989 by the National Research Council entitled: Brain and Cognition: Some New Technologies, edited by D. Druckman and John Lacey. It is evident that these two classes of techniques are complementary in the sense that the radiological approaches have impressive spatial resolution but rather poor temporal resolution while the recording approaches achieve temporal resolution in the millisecond range while their spatial resolution, with the exception of the MEG, tends to be rather poor. The issue before the conference we propose is the extent to which these approaches have been or can be integrated.

Such an integration is unlikely to be limited to concurrent recording of data from a subject by multiple means. Technological and theoretical reasons dictate to each technique its own brand of experimental paradigms. Therefore, the conditions of recording which are optimal for one approach often conflict with the demands which others impose on the experiment. A necessary condition for the integration is thorough mutual understanding of the paradigmatic constraints that shape the work in each of the domains. From that understanding there may emerge a synthesis that will take the form of yet another research paradigm which will capitalize on the strength of the component techniques. This note outlines a workshop designed to help initiate such an integration. I write to inquire if your agency would consider a proposal for the support of such a conference to be conducted as the eleventh of the Carmel Conferences, a series that has been organized by the Cognitive Psychophysiology Laboratory at the University of Illinois.

The conference will bring together both senior and junior investigators who represent each of the four main techniques we shall review. The two radiological approaches will be PET and MRI and the two recording approaches will be ERP and MEG. We plan to include a number of investigators who have actual experience with the use of more than one of the techniques. In addition we shall invite a group of cognitive psychologists with an interest in Cognitive Neuroscience. The number of attendees

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will range from 25 to 45. The general format of the conference will follow the pattern established in the previous 10 Carmel Conferences.

It is with considerable pleasure that we report that these goals were achieved. As will be describe below, the conference was held as scheduled. With very few exceptions the participants we invited were available for the entire conference. The feedback we received from all participants was very positive.

The conference program, as well as the list of participants, are appended. Ten of the participants were invited Tutorialists who were responsible for the plenary lectures delivered during the first two days of the meeting. The various sponsoring organizations were represented by 12 individuals. The large majority of these representatives participated actively in the conference and in the panel discussions. The rest of those attending were university-based scientists. It is important to note that the conference budget provided only partial coverage for this last category of participants. The fact that most of those to whom we offered participation in the meeting accepted these terms and came to Carmel attests to the attractiveness and timeliness of the program. (Of course, that we met in Carmel may also have contributed to the meeting's attractions).

The focus of the conference can perhaps be best judged from the enclosed "Charge to the Panels." During the third and fourth day of the meeting the participants were assigned to four panels. Each panel was so "charged" such that between them the Panels were asked to address the main issues that lead us to convene the workshop. As the conference focused on the integration of the non-invasive techniques for functional, and structural, brain imaging we asked the first two panels to consider the technical issues which arise in the definition and specification of active brain loci and to conduct a comparative evaluation of the radiological, magnetic and electric procedures. The other two panels examined the interface between Cognitive Science and Neuroscience. It is to the elucidation of the interactions at that interface that the various methods we are considering are dedicated. One panel looked at the interface from the perspective of the Neurosciences and the other panel started with the view points of the Cognitive Sciences.

While we did not conduct a formal debriefing of the participants the general atmosphere, the active discussions, the numerous cross disciplinary interactions at the workshop and the remarks of many participants indicate that the workshop was a success. It was quite clear as the meeting progresses that the diversity of techniques used, each deriving from a very different scientific background, masks a general uniformity in the paradigms we all use. We were able to identify the relative blind spots of various techniques and to develop ideas as to how these can be circumvented.

It is, of course, terribly frustrating that there are inevitable tradeoffs in choosing each of the novel procedures now available for non-invasive observation of the brain. The power of a technique in some dimensions is traded off for weaknesses in other dimensions. For

example, the very fine spatial resolution of the radiologic techniques is traded off for their very poor temporal resolution. Similarly, ERPs and MEGs who offer millisecond resolutions are very deficient in their ability to spatially resolve the origins of the potentials.

One of the most important aspects of the meeting is that it forced us to examine these trade offs in detail and to get a better perception of the particular strengths and weaknesses of the various techniques and as a consequence on the research domains to which each technique can make an important contribution. It became equally clear that the approaches are complimentary and that joint collaboration is possible and desirable.

However, the collaboration must take into account the specific attributes of the approaches. Thus, for example, it would make a lot of sense to use one of the radiologic approaches to identify the structures that are active during the activation of some information processing sub-system. However, once the structural information is identified it would make considerable sense to examine its activity by traditional psychophysiological means which allow processing to take place in real time, on a millisecond time scale, rather than integrated over many seconds.

One issue to which considerable attention was devoted in the conference was the degree to which recently proposed approaches to dipole localization, using the scalp recorded EEG are valid. The Scherg algorithm received the most critical analysis. Though, some attention was also given to the approach developed by Bio-logic Systems Corporation. Opinions were quite strongly divided on the issue. Proponents of the approach felt that it is in fact possible, in the appropriate circumstances, to identify active structures using the Scherg approach. Indeed, some of the published claims imply that dipole localization may rival radiologic, and neuromagnetic, approaches. Others found these claims a bit strong. The opposition ranged from claims that as implemented at present the dipole localization programs are more an art than a science to analyses of the approach that sought to invalidate it on mathematical and logical grounds. It is probably fair to say that, not surprisingly, no one who came in with strongly held views about the matter was lead to a change in view. The more neutral observers seem to believe that the proof of the approach would be in its successes. It would, of course, be of considerable value to compare the structural information provided by PET scans with the information provided by dipole localization algorithms.

One of the striking conclusions from the body of material we were presented is that there appears to be now confluence of data concerning the P300 components which promise to converge to a useful synthesis. The emergence of a body of data regarding the P300 was not anticipated in planning the meeting. Yet, it was clear that the following bodies of data converge. There is a rich source of converging information from intracranial recordings, from lesion studies, from neuromagnetic and from animal studies that involve at least to a degree the P300 with hippocampal activity. At the same time, there is much evidence from several laboratories that the amplitude of P300 is strongly related to the subsequent recall

of the eliciting stimuli. Finally, there is much interesting work in the study of memory, especially in amnesic patients, that relates hippocampal damage to memory deficits in a manner consistent with interpretations of the relation between P300 and memory. This has lead several of the participants to suggest that a useful topic for the next Carmel meeting could be an attempt to bring together a wide array of neuroscientists, and cognitive neuroscientist, who focus on either the hippocampal formation, memory, or P300. A proposal, calling for a meeting in January of 1992, is in preparation.

Eleventh Annual Carmel Conference

Towards An Integration of the Non-Invasive Methodologies of Cognitive Neuroscience

January 3-8, 1990

Agenda

Note: Unless otherwise indicated, all sessions will be held in the Carmel Conference Room.

Wednesday, January 3

Afternoon

- 4:00 - 6:00 **Registrational Reception - The Garden Room**
- 8:00 - 9:30 **Opening Session - Emanuel Donchin, University of Illinois, Urbana-Champaign**
"Cognitive Neuroscience - The Vessels are New, But How About the Wine? The Implications of Novel Technologies for Cognitive Neuroscience."
- 10:00 **Conviviality - The Executive Suite**

Thursday, January 4

- 8:00am **Continental Breakfast**

Morning Session:

- 9:00 - 10:00 **David LaBerge, University of California, Irvine**
"Why Should Cognitive Science Bother with the Brain?" This lecture will focus on those aspects of theory and observation in cognitive science that may best benefit from the progress in cognitive neuroscience.
- 10:00 - 11:00 **Mike Gazzaniga, Dartmouth University**
"Observations on the Damaged Brain: The Oldest Profession in Cognitive Neuroscience." The utilities and dangers of inferences from brain lesions, and how this enterprise has been affected by contemporary neuroscience.
- 11:00 - 12:00 **Michael Coles, University of Illinois, Urbana-Champaign**
"Psychophysiological Measures and the Study of Cognition." An overview of the paradigms used in psychophysiology. Both a historical introduction to the enterprise and some illustrations of the state of the art.
- 12:30 **Lunch served in the Poseidon Room**

Afternoon Session

- 2:00 - 3:00 Steve Hillyard, University of California, San Diego
"The First 300 Milliseconds: Can the ERP Help Us Visualize Human Information Processing Immediately Following the Stimulus?" A review of how ERPs illuminate the pre-attentive and pre-verbal phases of human information processing.
- 3:00 - 4:00 Herbert Vaughan, Albert Einstein College of Medicine
"Beyond the Superficial I: Inferring the Sources of ERP Components From the Distribution of Electrical Activity on the Scalp." An introduction, and a survey, to the state of the art in source localizations inferred from EEG recordings.
- 4:00 - 5:00 Lloyd Kaufman, New York University
"Beyond the Superficial II: The Use of Magnetoencephalography for Localizing the Sources of Event-Related Activity." An introduction and a survey of the state of the art in source localization using MEG.

Evening Session

- 9:00 - 11:00 **Poster Session.** Traditionally this evening has served, in the Carmel meeting, as an opportunity for participants to present their latest data in a rather informal setting. The Garden Room.

Friday, January 5

- 8:00am Continental Breakfast

Morning Session:

- 9:00 - 10:00 Gregory McCarthy, Veterans Administration Hospital, New Haven
"Beyond the Superficial III: Intracranial Observations of Event-Related Brain Activity."
- 10:00 - 11:00 Marcus Raichle, Washington University, St. Louis
"Observing the Active Brain I: An Introduction to the Methods and Uses of Positron Emission Tomography."
- 11:00 - 12:00 James W. Prichard, Yale University
"Observing the Active Brain II: Cerebral Metabolic Studies by Magnetic Resonance Spectroscopy."
- 12:00 - 1:00 Michael Posner, University of Oregon
"The Proof of the Pudding? Integrating Methods in the Study of Lexical Access and Attention."
- 1:30 Picnic Lunch at Point Lobos (weather permitting)

Afternoon Session

At this point the meeting breaks into four panels, each of which is given a specific charge. The panels meet for the remainder of Friday as well as for the entire day Saturday, January 6, 1990. The panels are arranged so that the different orientations represented in the meeting participate in each of the panels.

Saturday, January 6

The entire day is devoted to the meetings of the panels. Meeting times will be scheduled by the panel chairmen.

8:30pm Conference Banquet - Fresh Cream Restaurant, Monterey

Sunday, January 7

8:00am Continental Breakfast

Morning Session

9:00 - 12:00 Report of Panel I: The Identification of Intracranial Sources

12:30 Lunch served in the Spy Glass Restaurant

Afternoon Session

2:00 - 5:00 Report of Panel II: The Strengths and Weaknesses of the Different Technique

Monday, January 8

Note the shift in the day's program to help those leaving after the last session.

7:00am Continental Breakfast

Morning Session

8:00 - 11:00 Report of Panel III: The Contribution of Cognitive Science to Neuroscience

11:30 Lunch, The Poseidon Room

Agenda

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Afternoon Session

1:00 - 4:00 **Report of Panel IV: The Contribution of Neuroscience to Cognitive Science**

4:15 **Adjournment**

Eleventh Annual Carmel Conference

Towards An Integration of the Non-Invasive Methodologies of Cognitive Neuroscience

January 3-8, 1990

List of Participants

Watson Alberts
National Institutes of Health
NINDS, Bldg. 31, Rm. 8A52
7550 Wisconsin Avenue
Bethesda, MD 20892

Shlomo Bentin
University of California, San Diego
Department of Neurosciences
7857 Camino Noguera
San Diego, CA 92122

William Black
Biomagnetic Technologies, Inc.
4174 Sorrento Valley Blvd.
San Diego, CA 92121

Ivan G. Bodis-Wollner
Mt. Sinai Medical Center
Box 1052
One Gustave L. Levy Place
New York, N Y 10029

John Bruer
James S. McDonnell Fdn
1034 S. Brentwood Blvd., #1610
St. Louis, MO 63117

John T. Cacioppo
Ohio State University
Department of Psychology
1885 Neil Avenue
Columbus, OH 43210

Gastone G. Celesia
Loyola University Medical Center
Department of Neurology
2160 S. First Ave.
Maywood, IL 60153

Susan Chipman
Office of Naval Research
Code 1142CS
800 North Quincy Street
Arlington, VA 22217-5000

Michael G. H. Coles
University of Illinois
Department of Psychology
603 East Daniel St.
Champaign, IL 61820

M. Joan Dawson
University of Illinois
Dept of Physiology & Biophysics
524 Burrill Hall
407 S. Goodwin Ave.
Urbana, IL 61801

Emanuel Donchin
University of Illinois
Department of Psychology
603 East Daniel St.
Champaign, IL 61820

Terrence S. Early
Washington U. School of Medicine
Department of Psychiatry
4940 Audubon
St. Louis, MO 63110

Richard J. Faleschini
Biomagnetic Technologies, Inc.
4174 Sorrento Valley Blvd.
San Diego, CA 92121

Alfred R. Fregly
Air Force Office of Scientific Res
Life Sciences Directorate, Bldg 410
Bolling AFB, D C 20332-6448

Michael S. Gazzaniga
Dartmouth Medical School
Department of Psychiatry
Pike House
Hanover, NH 03756

Gabriele Gratton
University of Illinois
Department of Psychology
603 East Daniel St.
Champaign, IL 61820

Ruben C. Gur
University of Pennsylvania
Dept. of Psychiatry, Brain Beh. Lab
3815 Walnut St., 205 Piersol Bldg.
Philadelphia, PA 19104

Earle Heffley
University of Illinois
Department of Psychology
603 East Daniel St.
Champaign, IL 61820

Steven A. Hillyard
U. of California, San Diego
Department of Neurosciences, M-008
La Jolla, CA 92093

~~Edward Johnson~~ *James R. ...*
U.S. Army Research Institute
5001 Eisenhower Ave.
Alexandria, VA 22333-5600

Lewis L. Judd
National Inst. of Mental Health
Alcohol, Drug Abuse & Mntl Hlth Adm.
5600 Fishers Lane, Rm. 17-99
Rockville, MD 20857

Lloyd Kaufman
New York University
Psychology Department
4 Washington Place
New York, N Y 10003

Robert T. Knight
U. of California, Davis
Department of Neurology, VAMC
150 Muir Rd.
Martinez, CA 94553

Stephen Koslow
National Institutes of Mental Health
Division of Basic Sciences
5600 Fishers Lane, Rm 11-103
Rockville, MD 20857

Steve Kosslyn
Harvard University
Department of Psychology
33 Kirkland Street
Cambridge, MA 02138

Diane Kurtzberg
Albert Einstein College of Medicine
Department of Neuroscience
1410 Pelham Parkway South
Bronx, N Y 10461

David LaBerge
University of California
Department of Cognitive Science
Irvine, CA 92717

Paul C. Lauterbur
University of Illinois
Biomedical Magnetic Resonance Lab
1307 W. Park St.
Urbana, IL 61801

Laurence T. Maloney
New York University
Psychology Department
4 Washington Place
New York, N Y 10003

Gregory McCarthy
Veterans Administration Hospital
Neuropsychology Research Lab, 116 B1
West Haven, CT 06516

David E. Meyer
University of Michigan
Department of Psychology
330 Packard Road
Ann Arbor, MI 48104-1346

Richard Nakamura
National Institutes of Mental Health
Neuroscience Research Branch
5600 Fishers Lane, Rm 11-105
Rockville, MD 20857

Ivan Pal
Bio-logic Systems Corp.
One Bio-logic Plaza
Mundelein, IL 60060

Andrew C. Papanicolaou
U. of Texas Medical Branch
Div. of Neurosurgery, E, 17
Old John Sealy Hospital
Galveston, TX 77550

Alan Pope
NASA, Langley Research Center
MS 152E
Hampton, VA 23665-5225

Michael Posner
University of Oregon
Department of Psychology
College of Arts & Sciences
Eugene, OR 97403

James W. Prichard
Yale University
The School of Medicine
Department of Neurology, LCI-702
333 Cedar Street
New Haven, CT 06510

Marcus Raichle
Washington U. School of Medicine
Department of Neurology
510 S. Kings Highway
Campus Box 8131
St. Louis, MO 63110

Gregory Simpson
Albert Einstein College of Medicine
Department of Neurology
Kennedy Center Room 817
1410 Pelham Parkway South
Bronx, N Y 10461

Abraham Snyder
Washington University
Div. of Radiation Sciences
510 S. Kingshighway, C. Box 8131
St. Louis, MO 63110

Kenneth Squires
Biomagnetic Technologies, Inc.
4174 Sorrento Valley Blvd.
San Diego, CA 92121

Eugene Streicher
NINDS, National Institutes of Health
Div. of Fundamental Neurosciences
Federal Building, Room 916
Bethesda, MD 20817

Don M. Tucker
University of Oregon
Department of Psychology
Eugene, OR 97403

Herbert Vaughan
Albert Einstein College of Medicine
Department of Neuroscience
1410 Pelham Parkway South
Bronx, N Y 10461

Harold Weinberg
Simon Fraser University
Department of Psychology
Burnaby 2, British Columbia
Canada

Charles C. Wood
Los Alamos National Laboratory
Biophysics Group (P-6), MS M715
Los Alamos, NM 87545

Joseph Young
National Science Foundation
Human Cognition and Perception
Washington, D C 20550

Staff

Wally Meyers
University of Illinois
Department of Psychology
603 East Daniel St.
Champaign, IL 61820

Barbara Mullins
University of Illinois
Department of Psychology
603 East Daniel St.
Champaign, IL 61820