Phenomenological Research and Analysis

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I. OBJECTIVE

The objective of this document is to provide an interim technical report on tasks 6.2, "Basic Research," 6.3, "Applied Research," and 6.4, "Research Methodology," as listed in the 1991 Statement of Work. This report covers the time period from 23 July to 30 November 1992, and includes all subtasks.*

* This report constitutes the fifth and sixth deliverable DI-MISC-80508 under contract number MDA908-91-C-0037.

II. INTRODUCTION

Under Statement of Work items 6.2, 6.3, and 6.4 in contract MDA908-91-C-0037, the Cognitive Sciences Laboratory of Science Applications International Corporation is tasked to conduct phenomenological research and analysis. This document details the activity accomplished under these items and constitutes the interim report covering the period from 23 July to 30 November 1992.

III. PROGRESS TO DATE

This section describes the progress to date for each of the subtasks listed under items 6.2, 6.3, and 6.4 (basic research, applied research, and research methodology, respectively). The section numbering corresponds to the numbering in the Statement of Work.

6.1 Basic Research

6.1.1 Biophysical Measurements

6.1.1.1 MEG and EEG Correlates

We have identified a considerable literature that describes the correlation between MEG and EEG measurements. Since each of these techniques measure different aspects of brain activity, we would expect correlations of some types of measurements and not for other types. Currently, a neuroscientist on our staff is examining the pertinent literature and formulating a comparison for our specific types of MEG/EEG measurements.

6.1.1.2 MEG Data Analysis

We are examining over 800 megabytes of brainwave data from two different analytical perspectives.

(1) Traditional Event-Related Desynchronization (ERD). A brain indicates that it is inattentive by the production of alpha waves. It is well-known that the brain can be aroused by motor action (e.g., moving a body part such as a finger), cognitive process (e.g., mentally reviewing a word list), and responding to an external stimulus (e.g., direct light flash). One of the brain's indicators of arousal from these activities is called ERD (i.e., alpha power either vanishes or is sharply reduced). Thus, if we can assure ourselves that the stimuli that we used in the MEG experiment constituted a AC stimulus, it would be likely that they also would show an ERD.

To search for ERDs in the previous data, we filtered each 2-minute run for alpha activity (i.e., 7-13Hz). As is published in the general ERD literature, we computed the power by squaring each sample point. We performed an ensemble average for 500 milliseconds of prestimulus time and for 1,500 milliseconds of poststimulus period.

We are currently examining a variety of normalization techniques so that we will be able to combine the data from run-to-run and across blocks. A combination across blocks of data will allow a very sensitive determination of whether ERDs are seen in the previous data.

(2) Wavelet Transform. In a recent article, Schiff demonstrated the use of wavelet mathematics to identify transients in non-stationary time series data.* This technique appears to be straight-forward, and we are currently adapting it to our MEG data.

* Steven. J. Schiff, "Resolving Time-Series Structure with a Controlled Wavelet Transform," *Optical Engineering*, Vol. 31, No. 11, pp. 2492-2495 (November 1992).

6.2 Data Patterns/Correlations

6.2.1 Sender/No Sender Analysis

We are very sad to report the recent death of Mr. Charles Honorton of the Psychophysical Research Laboratories (PRL). Through the PRL, Mr. Honorton had been subcontracted to conduct a detailed analysis of sender/no sender issues. This analysis was to include statistical evaluation methods and a discussion of the implications regarding target-individual matches. Mr. Honorton was an invaluable contributor to the field of anomalous mental phenomena research and will be greatly missed.

At the time of his death, we were working closely with Mr. Honorton in the analysis of the Ganzfeld data; however, he had not conducted any experimental activity on his subcontract. We are currently discussing the possibility that Dr. Robert Morris of the psychology department at University of Edinburgh will assume the tasks under a separate subcontract.

6.2.2 MEG and EEG Correlates with Anomalous Cognition

We have conduced a detailed literature search for MEG and/or EEG correlates with anomalous mental phenomena, and identified 53 relevant papers, which can be found in the bibliography in Section IV. We are currently examining these papers to provide a mini-meta-analysis on the topic area.

6.3 Applied Research

6.3.1 Long Distance Experiment

The objective of this experiment is to adapt a standard anomalous cognition (AC) experiment to a forced-choice situation. An additional objective is to incorporate fuzzy set technology into a "crisp," two-by-five, error correcting block code to improve AC detection.

6.3.1.1 Background

In the Spring of 1992, SAIC conducted a pilot experiment that was designed to explore the potential for maximizing the reliability of AC responses through objective and rapid analysis. In this study, we reverted to using a dichotomous binary procedure as opposed to a fuzzy set technique. By carefully selecting the dichotomous elements, we could use standard block coding techniques to incorporate complete single-error correction and a few two-fold error corrections as well. We used a message sending motif as a test-bed for this kind of analysis.

Unfortunately, only one receiver demonstrated an effect size larger than 0.20 (i.e., 0.22) for evidence of AC and no evidence of enhanced detection was seen.

One of the primary problems, which may have contributed to this result, was the nature of the target pool. In an attempt to make the targets dichotomous within packs and at the same time inherently interesting, targets within the pool ranged in scale from a panoramic scene of a cityscape to a photograph of three chairs and thus possessed a large variety of potential target elements. Since receivers were told in advance that the targets could contain absolutely any material, they were unable to censor their internal experiences, which may have resulted in enhanced intrinsic receiver noise. We define such a target pool as possessing a large target-pool *bandwidth.*

Another problem was that each encoding bit in the block code was linked to only one percept (e.g., the single target element of water). This exaggerated the importance of the chosen dichotomous elements. For example, if a receiver failed to sense water in the target but managed to sense most other aspects of the target regardless of whether they were part of the bit structure, then the block code was not particularly applicable.

In an AC application, a fundamental imbalance exists in this type of bit structure. The block coding assumes that binary zero is "assertive." For example, when *water* is not indicated in the response, it is equivalent to indicating that *water* is definitely not in the target. Unfortunately, it is possible or even likely that unless a receiver specifies explicitly that *water* is not present, then the presence or absence is indeterminate. The net effect is to render this type of discrete block coding invalid for AC applications.

To achieve our second objective (i.e., improved coding procedures), our new experimental protocol attempts to correct the problems discussed above, so that potential enhancement of the detection of AC may be optimized. The following modifications have been made.

- We used the *National Geographic* static target pool, which has been successful for many AC experiments in the past. This pool appears to include enough basic elements to keep a receiver from guessing, yet allow for some internal self editing to decrease the receiver intrinsic noise (i.e., intermediate target-pool bandwidth).
- The sensitivity to discrete block coding has been reduced by using a number of fuzzy-set elements to define each block coding bit. .Thus, each bit will not rely upon a single percept, but rather represent classes of different percepts.

We anticipate that these improvements will allow for a much improved detection of AC, and provide a more sensitive test of whether error-correction can be successfully applied to AC detection.

To achieve our primary objective (i.e., apply AC techniques to a forced-choice circumstance), we used an associative anomalous cognition (AAC) procedure. In this technique, AC targets are assigned one each to a limited set of alternatives. For example, in message sending each of four possible messages are assigned to a different *National Geographic* magazine photograph. In principle, a receiver provides his/her impressions as in a standard AC trial, and if an on-site analyst, who is blind to the target choice, is able to correctly match the response to the intended target, then the message, which was previously associated with that photograph is "received" correctly.

6.3.1.2 Target Construction

To accommodate the error correcting portion of the protocol, we assigned each of the block coding bits to five individual fuzzy set descriptors. These descriptors were developed under another program, but are included here in the Appendix. Each target in the *National Geographic* pool had been consensus encoded with regard to each descriptor's visual importance to the scene. For example, the element *waterfall* would most likely be coded as a numerical value of one in a close-up photograph of Yellowstone Falls, whereas it might only receive 0.2 for a distant view of Yosemite Falls. These assignments are called *membership* values in fuzzy set parlance. A collect of membership values for a photograph constitute the fuzzy set representation of the visual content of the scene.

Since the error-correction code that we are using requires us to construct the following four binary numbers: 00000, 01110, 10101, and 11011 (see Figure 2, on page 9), we identified five sets of descriptors for each bit position in the block code word. Each target pack of four photographs possessed their own unique set of 25 descriptors.

Consulting the historical fuzzy set target database, we summed the membership values for the descriptors for each bit position in each of the 20 target packs. Let the sum of the membership values for a given bit position be Σ. By inspection, we determined a threshold of 1.5 such that if $\Sigma \geq 1.5$, then the bit was defined as one. If $\Sigma < 1.5$ then the bit was defined as zero. We illustrate the technique for target pack one. Table 1 shows the fuzzy set descriptors and the result of the threshold analysis for the four targets in a pack. For example, target three corresponds to the binary number 10101 (i.e., the shaded cells in Table 1). That is, the sum of the membership values exceed the threshold for bit positions zero, two, and four.

Table 1.

Visual membership values for target pack 1.

Block Bit Position	Descriptor	Visual Membership Value			
		Target 1	Target 2	Target 3	Target 4
0	Wilderness	0.3		1.0	0.5
	Urban				0.5
	Hills		0.1	0.7	0.1
	Rocky			0.3	0.5
	Aligned		0.9		0.5
	TOTAL:	0.3	1.0	2.0	2.1
	BINARY:	0	0	1	1
1	Rise		0.1	0.7	0.8
	Boundaries		0.7		0.6
	Closed		0.3	0.2	0.3
	Settlement		0.8		
	Vegetation		0.9		0.4
	TOTAL:	0	2.8	0.9	2.1
	BINARY:	0	1	0	1
2	Parallel Lines	0.2	0.9		
	Repeat Motif	0.2	0.8	0.2	0.3
	Striated	0.1	0.6	0.4	0.4
	Weathered			0.7	
	Grainy	0.3		0.7	0.1
	TOTAL:	0.8	2.3	2.0	0.8
	BINARY:	0	1	1	0
3	Agriculture		0.9		0.2
	Rectangle	0.5	0.3		0.6
	Buildings	0.5	0.6		0.7
	Agricult. Fields		0.9		0.2
	Fuzzy		0.5		0.3
	TOTAL:	1.0	3.2	0	2.0
	BINARY:	0	1	0	1

Table 1. (continued)

Visual membership values for target pack 1.

Block Bit Position	Descriptor	Visual Membership Value			
		Target 1	Target 2	Target 3	Target 4
4	Valley			0.5	0.1
	Mountains			0.4	0.6
	Diagonal Lines		0.2	0.6	0.5
	Vertical Lines	0.2	0.1		0.4
	Horizontal Line	0.3	0.9	0.3	0.2
	TOTAL:	0.5	1.2	1.8	1.8
	BINARY:	0	0	1	1

In this way, four targets were were assigned to the four binary numbers of the block coding scheme for the remaining 19 packs.

6.3.1.3 Target Selection

For each trial in this experiment, a target pack was first selected randomly, and followed by a random selection of a target within the pack.

6.3.1.4 Receiver Selection

Four receivers participated in this experiment. Each was selected on the basis of their significant results from previous AC experiments. All receivers conducted their AC sessions at sites designated by the client and with the aid of a monitor.

6.3.1.5 Number of Trials

Three receivers will contribute a total of four trials each, and one will contribute eight. Thus, 20 trials will be collected for the experiment.

6.3.1.6 Trial Protocol

The following steps are performed for each trial:

(1) A receiver and a monitor traveled to an east coast location,which was designated by the client. The monitor had a sealed package containing all of the targets from one target pack.

(2) At a prearranged time, Menlo Park laboratory personnel on the west coast randomly selected a target binary number (i.e., photograph) from the pack and placed it in a designated location. This target remained in the designated location for the duration of a trial.

(3) For a period lasting no longer than 15 minutes, each receiver wrote and drew his/her impressions of the target.

(4) The response was collected and secured by the monitor.

(5) The monitor rank-ordered the four photographs from best to worst match to the response.

(6) After reporting the rank-order values to the Menlo Park laboratory, the monitor obtained the correct target and provided feedback to the receiver.

6.3.1.7 Analysis

To test the AAC portion of the experiment, the number of first place matches from the rank ordering will be computed for each receiver as well as across all receivers. An exact binomial distribution will be used to compute effect sizes and associated p-values.

To determine if the fuzzy set version of error correction is effective, we must define a response threshold, which is similar to the target threshold, that determines the value of the associated coding bit. Our first approach is to determine the threshold values from empirical data. We examined 160 responses from earlier experiments that used the same target set. Each response from this experiment had been coded using the fuzzy set elements shown in the Appendix. Different from the target coding, each membership value now represented the analysts' belief that each element was indicated in the response. For example, if the response assertively mentioned *water*, then the *water* membership value would be 1.0. If the response, however, only showed lines that might be interpreted as waves and *water* was not mentioned, then the membership value might be 0.6. This value indicates a 60% confidence factor that the response markings really means *water.*

Figure 1 shows the distribution for the sum of fuzzy set elements that represent coding bit three from target pack one (i.e., see Table 1). The distribution is computed from 160 responses across four different receivers. This curve represents the "natural" bias for the bit-3 elements in responses to the *National Geographic* target pool.

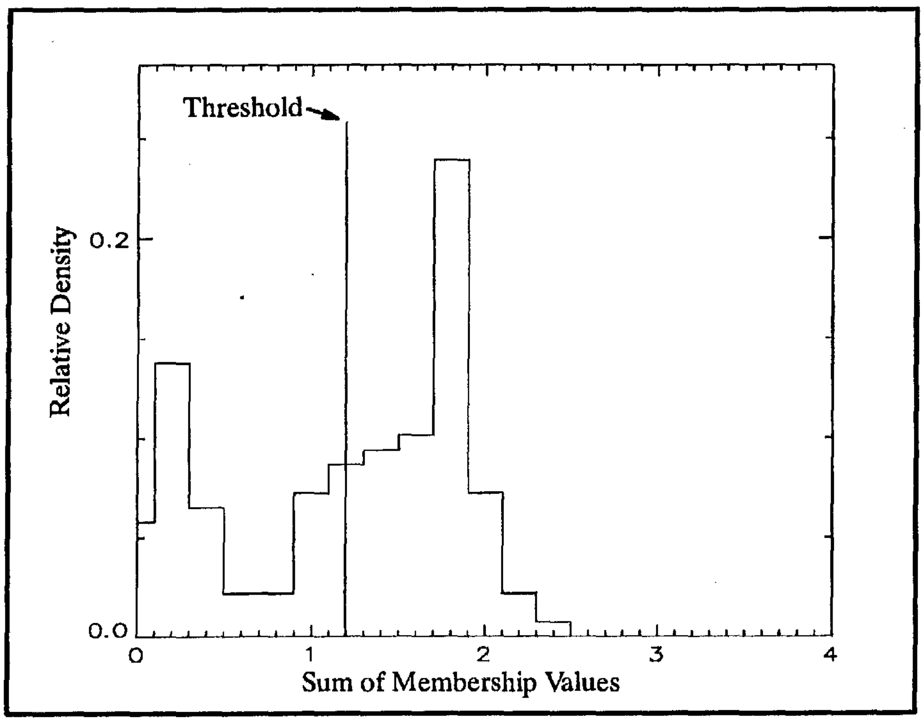

Figure 1. Response threshold (1.196) for target pack 1, coding bit 3.

The threshold of 1.196 is the mean value of this distribution. For bit three to be coded as a one, the sum of the response membership values must equal or exceed this value. Otherwise bit three will be assigned a value of zero. In a similar fashion, a unique threshold value is computed for each bit for each target pack.

In the fuzzy set analysis, each response is coded by an analyst who is blind to the target choice and unaware of which elements are used to form the coding bits. Membership sums are then computed for each bit and a single 5-bit binary number, which represents the response, is constructed.

Figure 2 shows the decoding matrix, which is specified by the block coding.

00000	01110	10101	11011	Targets
00001	01111	10100	11010	Single Error Correction
00010	01100	10111	11001	
00100	01010	10001	11111	
01000	00110	11101	10011	
10000	11110	00101	01011	
00011	01101	10110	11000	Double Error Correction
01001	00111	11100	10010	

Figure 2. A two-by-five bit, error correcting block code.

The analyst must then locate the 5-bit binary number from the fuzzy set analysis within the decoding matrix. The actual target binary number is the one represented by the 5-bit code that tops the column in which the encoded AC response is found. This matrix allows for correction for all single bit errors and a number of two bit errors within the AC response. As in the AAC case, the binomial distribution will be used to compute the effect sizes and related p-values for this approach.

6.3.1.8 Current Status

Data has been collected for the first eight of 20 trials. The remaining trials are scheduled for the third week in December. Analysis of the first eight trials is in progress.

6.4 Theoretical Issues

6.4.1 Anomalous Perturbation

This task has been deleted as per modification P00004.

6.4.2 Models

We have identified approximately 30 articles from the physics literature that bear directly or are associated with a number of potential models of AC. The most promising approach at this time involves aspects of general relativity and quantum gravity. The associated papers are being studied to provide assistance for model construction.

6.5 Research Methodology

6.5.1 Committees

We have received responses from three of the five members of the Scientific Oversight Committee on the previous year's work. Those comments are being addressed and will be included in the final report.

The Institutional Review Board did not meet during the reporting period; however, we obtained written permission for the use of humans in the experiment, which is described in Section 6.3.1.

SG1B

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SG1B

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V. GLOSSARY

Not all the terms defined below are germane to this report, but they are included here for completeness. In a typical anomalous mental phenomena (AMP) task, we define:

- Anomalous Cognition—A form of information transfer in which all known sensorial stimuli are absent. That is, some individuals are able to gain access, by as yet an unknown process, to information that is not available to the known sensorial channels.
- Receiver—An individual who attempts to perceive and report information about a target.
- Agent—An individual who attempts to influence a target system.
- Target—An item that is the focus of an AMP task (e.g., person, place, thing, event).
- Target Designation—A method by which a specific target, against the backdrop of all other possible targets, is identified to the receiver (e.g., geographical coordinates).
- Sender/Beacon—An individual who, while receiving direct sensorial stimuli from an intended target, acts as a putative transmitter to the receiver.
- Monitor—An individual who monitors an AC session to facilitate data collection.
- Session—A time period during which AC data are collected.
- Protocol—A template for conducting a structured data collection session.
- Response—Material that is produced during an AC session in response to the intended target.
- Feedback—After a response has been secured, information about the intended target is displayed to the receiver.
- Analyst—An individual who provides a quantitative measure of AC.
- Speciality—A given receiver's ability to be particularly successful with a given class of targets (e.g., people as opposed to buildings).

APPENDIX

Fuzzy Set Coding Forms

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CONCRETE DESCRIPTOR LEVELS I

Experiment: ________
Trial: ________
Response: ________
Coder: ________
Viewer: ________

LEVEL	SINGLE STRUCTURES	SUBSTRUCTURES
10	1 ☐ fort 2 ☐ castle 3 ☐ palace 4 ☐ church (other religious buildings, monastery) 5 ☐ mosque 6 ☐ pagoda 7 ☐ coliseum (stadium, amphitheater, arena)	
9	8 ☐ bridge 9 ☐ [dam (lock, spillway)]	10 ☐ boats (barges) 11 ☐ pier (jetty) 12 ☐ [motorized vehicles (cars, trucks, trains)] 13 ☐ column 14 ☐ spire (minaret, tower) 15 ☐ fountain 16 ☐ fence 17 ☐ arch 18 ☐ wall (e.g., the Great Wall) 19 ☐ monument
8		20 ☐ roads

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CONCRETE DESCRIPTOR LEVELS II

Experiment: ______
Trial: ______
Response: ______
Coder: ______
Viewer: ______

LEVEL	SETTLEMENT	ELEVATION	LAND/WATER INTERFACE	NO WATER OR VEGETATION	VEGETATION	AMBIENCE/ FUNCTION
7			21 port (harbor) 22 [oasis]		23 agricultural fields (orchards)	24 industrial 25 recreational 26 religious 27 mechanical 28 technical 29 agricultural 30 commercial
6	34 ruins (incomplete buildings)	35 mesa (plateau)	36 waterfall 37 glacier 38 canal (channel, manmade waterway)	39 desert	40 forest 41 jungle 42 swamp (marsh)	31 wilderness 32 urban 33 rural (pastoral) 131 historical (archaeological)
5	43 isolated settlement 44 town (village) 45 city	46 single peak 47 hills (slopes, bumps, humps, mounds) 48 mountains 49 cliff(s) 50 [plain, delta] 51 valley (cleft, gully, irreg. depression) 52 canyon 53 [crater, bowl–shape, regular depression]	54 unbounded large expanse of water (ocean, sea) 55 completely bounded expanse of water (lake, pool, pond) 56 partially bounded expanse of water (bay) 57 island 58 river (stream, creek) 59 coastline		60 vegetation (trees)	

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ABSTRACT DESCRIPTOR LEVELS I

Experiment: ______
Trial: ______
Response: ______
Coder: ______
Viewer: ______

QUALITIES

LEVEL 4

COLOR
- 61 ☐ yellow
- 62 ☐ orange
- 63 ☐ red
- 64 ☐ blue
- 65 ☐ green
- 66 ☐ purple (pink)
- 67 ☐ brown (beige)
- 68 ☐ black
- 69 ☐ white
- 70 ☐ grey

OTHER VISUAL
- 71 ☐ shiny (reflective)
- 72 ☐ [gold]
- 73 ☐ [silver]
- 74 ☐ [chrome]
- 75 ☐ [copper]
- 76 ☐ obscured (fuzzy, dim, smoky)
- 77 ☐ cloudy (foggy, misty)
- 78 ☐ old
- 79 ☐ weathered (eroded, incomplete)

IMPLIED TEXTURE
- 80 ☐ smooth
- 81 ☐ fuzzy
- 82 ☐ grainy (sandy, crumbly)
- 83 ☐ rocky (ragged, rugged, jagged, rubbled, rough)
- 84 ☐ striated

IMPLIED TEMPERATURE
- 85 ☐ hot
- 86 ☐ cold (snow, ice)
- 87 ☐ humid
- 88 ☐ dry (arid)

IMPLIED MOVEMENT
- 89 ☐ flowing
- 90 ☐ other implied movement

AMBIENCE
- 91 ☐ congested (cluttered, dense, busy)
- 92 ☐ serene (peaceful, unhurried, unfrenetic)
- 93 ☐ closed in (claustrophobic)
- 94 ☐ open (spacious, vast, expansive)
- 95 ☐ ordered (aligned)
- 96 ☐ disordered (jumbled, unaligned)

ARCHETYPES

LEVEL 3

STRUCTURE
- 97 ☐ building(s) (structure(s))

ELEVATION
- 98 ☐ rise (vertical rise as well as slope)
- 99 ☐ flat

INTERFACE
- 100 ☐ light/dark areas (big swaths)
- 101 ☐ boundaries
- 102 ☐ land/water interface
- 103 ☐ land/sky interface (horizon)

UNIQUENESS
- 104 ☐ single (or central) predominant feature
- 105 ☐ odd (or surprising) juxtaposition of elements

AMBIENCE
- 106 ☐ manmade (or altered)
- 107 ☐ natural

ABSTRACT DESCRIPTOR LEVELS II

Experiment: ______
Trial: ______
Response: ______
Coder: ______
Viewer: ______

2–D & 3–D GEOMETRIES

LEVEL	RECTILINEAR FORMS	CURVILINEAR FORMS	MIXED FORMS	IRREGULAR FORMS	REPEAT MOTIF
2	108 ☐ rectangle (square, box) 109 ☐ triangle (trapezoid, pyramid) 110 ☐ other polygonal (> 4 sides: hexagon, octagon, etc.) 111 ☐ cross–hatch (grid)	112 ☐ circle (oval, sphere) 113 ☐ [torus]	114 ☐ cylinder 115 ☐ cone 116 ☐ semicircle (hemisphere, dome)	117 ☐ irregular forms (irregular features)	118 ☐ repeat motif

1–D GEOMETRY

LEVEL				
1	119 ☐ stepped 120 ☐ parallel lines 121 ☐ vertical lines 122 ☐ horizontal lines 123 ☐ diagonal lines 124 ☐ V–shape 125 ☐ inverted V–shape 126 ☐ other angles	127 ☐ arc (curve) 128 ☐ wave form (ripples) 129 ☐ spiral		130 ☐ meandering curve