

ARMY RESEARCH LABORATORY



**A Methodological Study: A Semiotic
Approach to Analyzing the
Content of Information**

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A METHODOLOGICAL STUDY: A SEMIOTIC APPROACH TO
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U.S. ARMY RESEARCH LABORATORY

Aberdeen Proving Ground, Maryland

CONTENTS

INTRODUCTION	5
BACKGROUND	5
OBJECTIVE	6
A PRAGMATIC COHERENCE FRAMEWORK	6
Semiotic Content	7
Content Transformations	7
METHOD	9
Narrative Generation	9
Subjects	10
Materials	10
Procedures	11
SEMIOTIC ANALYSIS OF THE NARRATIVES	13
Semiotic Analysis Procedures	13
STUDY 1	
METHOD	14
Identify Transformations	15
RESULTS	15
Semiotic Content	15
DISCUSSION	16
Measures of Semiotic Content	20
Content Transformations	22
STUDY 2	
METHOD	24
Identify Semiotic Content	24
Identify Transformations	25

Apply Measures of Semiotic Content	25
RESULTS	26
Semiotic Content	26
DISCUSSION	27
Content Transformations	28
Measures of Semiotic Content	30
CONCLUSIONS	31

STUDY 3

METHOD	31
RESULTS	32
DISCUSSION	42
Benefits of Approach to Military Intelligence	43
Use in Naturalistic Settings	44
REFERENCES	47

APPENDICES

A. Definitions of Semiotic Information	49
B. Transformation Definitions	55
C. Scenarios	59
D. Study 1 Semiotic Measures	67
E. Levels of Resolution Definitions	73

DISTRIBUTION LIST	77
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FIGURES

1. M1 Information Hierarchy Nodes	11
2. Semiotic Content in NK Supply ($r = .00$)	17
3. Semiotic Content in NK Maneuver ($r = .47$)	17
4. Semiotic Content in NK Current Activity ($r = .48$)	18
5. Semiotic Content in NK Enemy Forces ($r = .87$)	18
6. Semiotic Content in NK Enemy Capability ($r = .89$)	19
7. Semiotic Content in NK ENCOA ($r = .57$)	19
8. Measures of Completeness and Specificity for NK ENCOA ($r = .19$)	21

9. North Korean Transformation - Team 1	23
10. North Korean Transformations - Team 2	23
11. Semiotic Content in Cuban Scenario	27
12. Cuban Transformations - Team 1	29
13. Cuban Transformations - Team 2	29
14. Illustration of Transformation Content for Cuba - Team 1	30
15a. Subject 1, North Korea, Semiotic Relationships and Transformations	33
15b. Subject 2, North Korea, Semiotic Relationships and Transformations	34
15c. Subject 3, North Korea, Semiotic Relationships and Transformations	35
16a. Subject 1, Cuba, Semiotic Relationships and Transformations	36
16b. Subject 2, Cuba, Semiotic Relationships and Transformations	37
16c. Subject 3, Cuba, Semiotic Relationships and Transformations	38

TABLES

1. Taxonomy of Semiotic Content	8
2. Types of Semiotic Transformations	9
3. Correlation Coefficients for Study 1 and Study 2.	26
4. Procedures for Analyzing the Semiotic Content of Information	32
5. Major Semiotic Similarities and Differences Between Subjects for the North Korean Scenario	39
6. Major Semiotic Similarities and Differences Between Subjects for the Cuban Scenario	40
7. Subject 1, Major Semiotic Similarities and Differences Between Subjects for the Scenarios	41
8. Subject 2, Major Semiotic Similarities and Differences Between Subjects for the Scenarios	41
9. Subject 3, Major Semiotic Similarities and Differences Between Subjects for the Scenarios	42

A METHODOLOGICAL STUDY: A SEMIOTIC APPROACH TO ANALYZING THE CONTENT OF INFORMATION

INTRODUCTION

As information technology becomes increasingly capable and available, more jobs will require information production. People will have access to greater volumes of information from more diverse sources. To perform successfully during these circumstances, people will need to learn what information is important and how it contributes to meeting their goals. Technology offers the capability to help this process. However, designing an enabling technology requires an understanding of how users interact with the content of information. We need to ascertain how people ascribe meaning to information, determine its importance, and use it to derive new information. The goal of this research is to understand the substance of information as the basis for designing enabling technology to increase the efficient and effective use of information. We are interested in the content of information and its use in an applied context rather than the processing of the information.

BACKGROUND

As a starting point for theory building, a broad base of diverse literature was examined to gather various perspectives of how people use and understand information. One focus was cognitive psychology, in general and problem solving, in particular (Warner & Burnstein, 1996). This literature proved limited, largely because of the emphasis on information processing (rather than information content) and on "toy" problems (rather than real-world objectives). However, two key concepts emerged that contributed to the development of a theoretical framework for examining the meaning and use of information.

The first concept was coherence (Greeno, 1977). Greeno described three conditions that are necessary to achieve a useful internal representation of a problem or situation. First, the representation must be coherent or connected in a way that all the parts make sense. Second, there must be a close correspondence between the constructed representation and what is being understood from the real world. Finally, the representation must be well connected or related to background knowledge. Thus, a coherent representation of a situation is one that has meaning based on domain knowledge, the context (i.e., the real world), and the idiosyncratic experience of the individual. This view underscores the importance of history and experience in building meaning around new information.

Pragmatics were the second critical concept. We have taken the term "pragmatic" from two early sources that clarify the importance of deriving meaning that is situated in a context. One source is James (1907), who developed a pragmatic theory of meaning. He stipulated that concepts are defined by their use in experience. The second source is Morris (1955) who defined pragmatic relationships in semiotics. In this view, the relationships between "signs" (i.e., real-world entities) and their users are paramount. Both views highlight the importance of experience, context, and current goals as key to deriving meaning.

Taken together, the concepts of coherence and pragmatic offered a paradox to the process of deriving meaning. On the one hand, the relationship to the real world and a goal within a context suggests meaning is well regulated within a domain. On the other hand, the rich connections between meaning and experience imply that meaning is highly idiosyncratic across individuals. One clear implication was that any theory of understanding or meaning ascription must address both prior knowledge and experience of the individual and the real-world situation and context in which the information is to be used.

OBJECTIVE

The intent of this effort was to develop a method for identifying the semiotic content and the content transformation of information using military intelligence (MI) as the information domain. Understanding the content and use of information is important to information production domains, such as MI. For example, it is a domain where information not only serves as the input but is also the output of the system. Users must make sense of incoming information, based on their prior knowledge and experience. It is then related to an operational context to generate useful intelligence. From a practical viewpoint, it would be of some consequence to learn if MI analysts use information differently in different levels of warfare and where the similarities and differences in information use occur between analysts. The semiotic analysis method should answer those questions.

A PRAGMATIC COHERENCE FRAMEWORK

The "pragmatic coherence" framework (PCF), developed to study human understanding and information use, is fully described in Warner and Burnstein. What follows draws heavily from this description and conveys the features of the framework pertinent to this effort. In developing the semiotic analysis approach to information, the two components of the PCF that were used were (a) a description of the semiotic content of information that describes the

information relationships, and (b) a description of the possible content transformations and the purposes of these transformations.

Semiotic Content

Semiotics, the study of signs, involves three elements: an object, a sign, and interpretation. A sign is simply anything that substitutes for something else. That “something else” is a real-world object, and interpretation is the meaning assigned to the sign. As such, semiotics offers a method for addressing meaning in information content.

Table 1 identifies a taxonomy of semiotic content that consists of three component relationships: syntactic, semantic, and pragmatic. Syntactic relationships are sign-to-sign relations from a semiotic perspective (Morris, 1955). We have defined them to consist of hierarchical or configural relations between observable entities. Semantic relationships are relations between signs and their meaning. They have been defined as conceptual or causal dependencies. Pragmatic relationships focus on relations between the meaning of signs and the consequences of that meaning. Pragmatic relationships consist of conditional, instrumental, or consequential dependencies. The first two categories are primarily domain defined. The third relationship depends heavily on individual goals, experience, and interpretation; thus, it is idiosyncratic. Appendix A provides further definition and examples of semiotic content.

Content Transformations

In addition to the components and their relationships, we are also interested in understanding how information is transformed to achieve an objective; therefore, a taxonomy of transformations was developed based on semiotic content (see Table 2). Two types of transformation are possible: coalescence changes the content by fusing information and forming a whole that is greater than its parts.

Analysis changes the content by separating it into pieces or decomposing information. Twelve specific types of transformation are identified. They are based on the purpose of the transformation and the nature of the information content transformed. Appendix B provides further definition of the transformations.

Table 1

Taxonomy of Semiotic Content

Semiotic content	Relationship type	Description
Syntactic	Objects	Physical entities that have measurable attributes and can be described and counted.
	Structures	Complex physical entities that have been aggregated from objects and other structures in a hierarchy.
	Events	Activities that are participated in or conducted by objects or structures and can be described in detail.
	States	A series of events whose aggregation leads to construction of a coherent whole.
	Time and space	Descriptive modifiers that place objects, structures, events, and states.
Semantic	Conceptual	Several alternate meanings can be derived from the sign; meaning is indicated but not definite.
	Causal	Explicit meaning is derived from the sign; an if-then relationship exists, marked by cause and effect.
Pragmatic	Conditional	Represents understanding of when and where consequences will occur. May include the conditions during which the consequences will occur.
	Instrumental	Represents understanding of how the consequences will be accomplished. May include who the agents of the consequence are.
	Consequential	Represents understanding of what the consequences are and why they occur.

Table 2

Types of Semiotic Transformations

Purpose of analysis ^a	Transformation ^b	Purpose of coalescence ^c
Parse	syntactic→syntactic	Aggregate
	syntactic←syntactic	
Decompose	syntactic→semantic	Interpret
	syntactic←semantic	
Interpolate	syntactic→pragmatic	Project
	syntactic←pragmatic	
Elaborate	semantic→semantic	Infer
	semantic←semantic	
Justify	semantic→pragmatic	Synthesize
	semantic←pragmatic	
Rationalize	pragmatic→pragmatic	Envisage
	pragmatic←pragmatic	

^aAnalysis refers to transforming information by taking it apart.

^bThe direction of the arrow indicates whether information is being put together (→) or taken apart (←).

^cCoalescence refers to transforming information by putting it together.

METHOD

We report on three studies. The first represents the initial developments of the semiotic analysis procedure. One intelligence analyst produced narratives concerning a convention war scenario. Teams comprised of an MI analyst and a behaviorist analyzed the narratives using a "strawman" procedure. The procedure was refined and used in Study 2 to analyze "operations other than war" narratives from the same subject. This study resulted in a further refinement of the semiotic analysis procedure. The third study applied those procedures to the narratives of two additional analysts. The results were analyzed to determine if the procedure could capture similarities and differences in the use of information by MI analysts.

Narrative Generation

Intelligence products in narrative form served as the stimulus materials for development

of the semiotic analysis procedures. This section details the generation of those products by intelligence analysts and the general approach used in the application of semiotic analysis.

Subjects

Three retired senior MI officers, considered MI experts, generated intelligence narratives. Two retired at the rank of Colonel and one at Brigadier General. All had spent their Army careers in MI and had served as both division and corps senior intelligence officers (G2s). Besides their standing as MI experts, these subjects had previously served as experimental subjects in other related research efforts.

One participant served as a pilot subject. His narratives were used to develop the measurement procedures in Study 1 and Study 2. Once the procedures were established, all narratives were used (in ensuing studies) to investigate individual differences in information use.

Materials

Stimulus Materials

Narratives were generated from two scenarios. The first scenario, North Korean, represented a conventional combat situation. The second scenario, Cuban, represented an operation other than war (OOTW). Scenarios are presented in Appendix C.

Each scenario provided the context of the mission and the sequence of events leading to a current situation. A map summarizing the known tactical situation for each scenario was also provided. For both scenarios, a map of southern Arizona was used to represent the terrain. This approach was adopted to ensure that all subjects were familiar with the terrain and to reduce the need for terrain analysis. (Terrain analysis is a potentially extensive and time-consuming activity that was not the focus of the experiment.) Staging scenarios on known terrain is common in military training exercises and thus was a familiar approach to the subjects.

In both scenarios, the subject was instructed to assume the role of the senior intelligence officer. For the North Korean scenario, the senior intelligence officer was the Corps G2. For the Cuban scenario, the senior intelligence officer was the Ranger Regiment S2.

Response Formats

Subjects were provided six one-page sheets and six copies of the terrain map.

Each one-page sheet corresponded to one of six information nodes in an MI information hierarchy. The nodes were part of an intelligence conceptual map representing different levels of knowledge about enemy behavior and were selected to provide variation in associated semiotic content. Figure 1 identifies the six nodes and their relative position within the hierarchy.

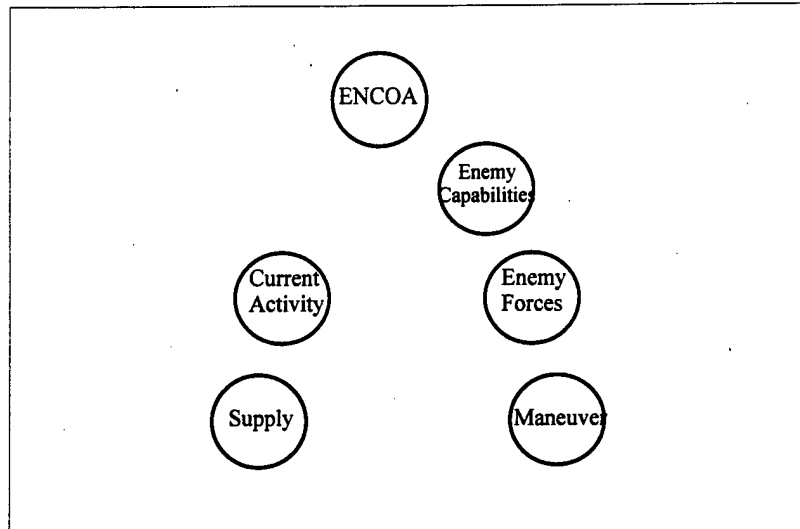


Figure 1. M1 information hierarchy nodes.

Response sheets were provided for subjects to use in preparing narratives about six topics: (a) enemy course of action (ENCOA), a summary of the probable action to be executed by the enemy; (b) enemy capabilities, a summary of the capabilities possessed by the enemy force; (c) current activity, a summary of significant enemy action; (d) enemy forces, a summary that describes the opposing enemy force; (e) maneuver, a description of enemy actions that relate to maneuver; and (f) supply, a description of enemy actions that relate to supply.

Procedures

Initial Instructions

Materials and written instruction were distributed to subjects via mail. The materials were organized into three parts: administrative, general, and specific. The administrative instructions directed subjects not to begin work until they had participated in a conference call to review the instructions and to answer any questions. They were asked to work independently and not to confer with one another. Materials not identified by name were to be

returned by mail upon completion. A contact was provided for subjects to call if questions arose during their work.

The general written instructions described the purpose of the experiment and the task. They indicated that the purpose of the experiment was to obtain textual and graphic data to help understand how individuals ascribe meaning to information and how they use that information to accomplish objectives within the intelligence domain. They also noted there was an interest in establishing a systematic method for analyzing that information.

The general instructions also explained that they were to produce a series of textual summaries or narratives. It was explained that the products concerned a variety of aspects of enemy information that would exist within two distinctly different situational scenarios. Scenarios were intentionally general to allow individuals to provide richness of detail from their own experience. General instructions concluded with an acknowledgment that the maps did not correspond with the scenarios and why they did not.

The specific instructions identified the two scenarios and the six narrative summaries that subjects were to prepare. Subjects were told that narratives could be as detailed as desired but should not exceed one page. It was explained that the information in the scenario might be insufficient to provide the detail necessary to construct the narratives. Thus, they should draw upon their own experience to develop the type of information they would expect to use. Subjects were asked to provide their narratives, working notes, and maps and to identify the order they were developed. Finally, subjects were provided with examples of narratives associated with a Soviet style force, as illustrations of the products they were expected to develop.

A teleconference was held to review the instructions and to answer any questions. The purpose of the experiment was reviewed and the outputs expected from subjects were identified. Questions raised by subjects and time lines were discussed.

Debriefing

After subjects had returned all materials, individual debriefings were held via teleconference. Each subject was told the purpose of the debriefing, namely, to obtain feedback about the instructions, experimental materials, and time to perform the task. Content issues were avoided during the debriefing process.

Debriefings concerned (a) ease of understanding the task, (b) clarity of instructions, (c) relationships to previous experiments, (d) ease of working with the map copies, and (e) ease of producing requested materials. Subjects were also asked if they referred to other materials, whether they would have liked to have had additional materials, and how long it took them to complete each of the six descriptions. (Note that subjects expressed no difficulty with the task and provided positive feedback about instructions. Completion times ranged from 12 to 16 hours and two of the subjects used graphic templates and reference manuals.)

SEMIOTIC ANALYSIS OF THE NARRATIVES

Both studies employed the same general approach to the analysis of the narrative products and the measurement of information. Differences occurred in the instantiation of procedures and the measurement dimensions. The following describes the general approach used in each study. The study-specific methodologies detail the procedures.

Semiotic Analysis Procedures

Initial semiotic analysis procedures were formulated around definitions of semiotic content and transformation taxonomy (see Tables 1 and 2). The notes and maps made by the subjects were reviewed and compared to the narratives and scenarios. The analysis showed that the notes and maps were used to organize the information in the scenarios. Because there was a one-to-one transfer from scenario to the maps and notes, neither was used in the analysis.

For any product, the first step in coding the semiotic content was to identify the semiotic relationships in the narratives and classify them using the taxonomy of semiotic relationships. The unit of analysis was defined by meaning and not by arbitrary physical characteristics (word, phrase, sentence, etc.). Therefore, a relationship could comprise a few words or an entire paragraph. For example, a semiotic relationship is indicated by each of the following: "A single tank division" (syntactic), "a good road network" (semantic), and "the enemy could continue defense in sector, to rest, refit, and wait for the force ratio to favor the attack" (pragmatic).

The next step was to characterize the semiotic relationships identified in the product using indicators of quality. These quality indicators were specific to the type of semiotic entity. Syntactic quality was based on sufficiency for understanding (by the subject matter experts [SMEs]) the structural, hierarchical, or contextual aspects of the sign. Semantic quality was based on sufficiency for understanding the meaning of the sign and pragmatic on deriving

consequences from meaning. Sets of semiotic entities of a given type (e.g., syntactic) were rated as a group rather than individually because of their inter-relatedness and contextual embeddedness in the larger product.

The final step in the rating process was to assess semiotic transformation. Semiotic transformations across nodes were identified by looking for source information that logically contributed to understanding or conclusions in subsequent nodes. Transformations were classified according to type, based on the nature of the transformed semiotic information using Table 2. For example, if a semantic relationship (e.g., the enemy can continue random acts of violence) is transformed into a pragmatic relationship (e.g., the enemy plans to continue to exploit the situation and call attention to their cause), Table 2 tells us that this is an infer-elaborate transformation. Because we do not know the direction of the transformation (i.e., if it was a result of coalescence or analysis), we conclude the transformation pair.

These general procedures were applied in two studies, using two teams of raters, each working with products generated by the subjects. Each team was comprised of a psychologist and intelligence analyst. The intelligence analysts were also considered MI experts, based on their military careers. Each had retired at the rank of Colonel. Their relevant military experience included division senior operations (G3), senior intelligence officer (G2), and tactical battalion commander. After training in the initial information measurement procedures, Study 1 commenced with each team rating the pilot subject's North Korea (NK) narratives. Then they met to compare their implementation of the procedures and their results. When discrepancies occurred, discussion ensued to determine the source of the discrepancy, and the definitions and procedures were adjusted. In Study 2, these teams applied the revised procedures and measures to the pilot subject's Cuban narratives. They met again to discuss and resolve discrepancies. Reliability of the ratings across teams was examined by computing correlations within each product to determine the extent of agreement about semiotic content.

STUDY 1

METHOD

Two intelligence analyst-psychologist teams independently analyzed one subject's North Korean narratives. The analysis was accomplished in three steps: (a) identify semiotic content, (b) apply measures of semiotic content, and (c) identify transformations. (Appendix D provides measurement definitions.)

Identify Transformations

Intelligence analysts identified information that was transformed across MI information hierarchy nodes (see Figure 1). Their approach was to start with the ENCOA node and work “downward” to find the information that contributed to the relationships in that narrative. For example, they selected a semiotic relationship in ENCOA and examined all other nodes for information that could have contributed to it. When contributing information was found, the semiotic type of each relationship and the source node(s) were noted; the search continued until all nodes had been reviewed for contributing information.

Each transformation was then labeled using Table 2 to determine the type of semiotic relationship. Transformation labeling yielded a transformation pair (e.g., decompose-interpret, rationalize-envisage) between a node pair. Because of the unrestricted manner in which narratives were generated, no attempt was made to determine whether the information was transformed using analysis or coalescence. That is, “direction” of the transformation could not be known.

RESULTS

Semiotic Content

Both teams determined that each information node narrative contained a single theme. Team 1 analyzed the narratives in the order in which they had been prepared: current activity, enemy forces, maneuver, supply, enemy capabilities, and ENCOA. Team 2 analyzed the data from the highest level node (ENCOA) down through the lower level nodes. The identification of semiotic content posed no difficulty. Both teams were comfortable with the procedures and their results. The data were analyzed by tallying the type of relationship by team by narrative. Tallies were compared through a correlation analysis across teams within node.

Syntactic Relationships

The preponderance of syntactic relationships identified in the narratives led us to conclude that in and of itself, syntactic relationships did not further our understanding of information use. The number of syntactic relationships ranged from 36 (maneuver and enemy forces) to 60 (current activity). Upon analysis, it became clear that one could not communicate without syntactic relationships. That is, within the MI domain, basic communication consists of objects and structures (who), events and states (what), time (when), and location (where) that provide domain specific meaning but do not reflect the use of information to further understanding. We concluded that communicative syntax was not of interest to our analysis.

Therefore, we would identify syntactic relationships in Study 2, only when they contributed to transformations.

Semantic and Pragmatic Relationships

A series of graphs presents the data for semantic and pragmatic relationships, by team, by narrative. Figures 2 through 7 present the data for the supply, maneuver, current activity, enemy forces, enemy capabilities, and ENCOA nodes, respectively.

DISCUSSION

The semantic and pragmatic content in these graphs illustrates the nature of semiotic content across nodes. Current activity and enemy forces have the least number of semantic and pragmatic relationships. From a domain perspective, these nodes reflected factual information, based largely on the scenarios from which the narratives were generated. In general, these nodes require less interpretation of signs than do other nodes, such as enemy capabilities, supply and maneuver, where the meaning of signs must be provided, and ENCOA, where the fundamental purpose is to derive the enemy's goal(s) from signs and their meaning. The conformance of the data to domain expectations could be viewed as an indication of the capability to measure information use via semiotic content.

The correlation coefficient (r) appears in each figure caption. These graphs and the correlations indicate some variability between teams in the identification of these relationships. However, several correlations were very high. The lack of agreement in the supply node (see Figure 2) results mainly from differences in tally procedures. For example, Team 2 tallied five pragmatic relationships, a semiotic unit that contained three consequences, as well as a conditional and instrumental aspect. Team 1 would have tallied this as a single consequential pragmatic relationship since the main thrust of the semiotic unit was outcome oriented. The relatively large, negative correlation in the current activity node was also related to how Team 2 tallied the relationships. What Team 1 would have tallied as a single instrumental pragmatic, Team 2 tallied as two Instrumental and one consequential pragmatic relationships (see Figure 4). In both cases, had each team tallied pragmatic relationships the same way, the difference would have been minor (zero versus one).

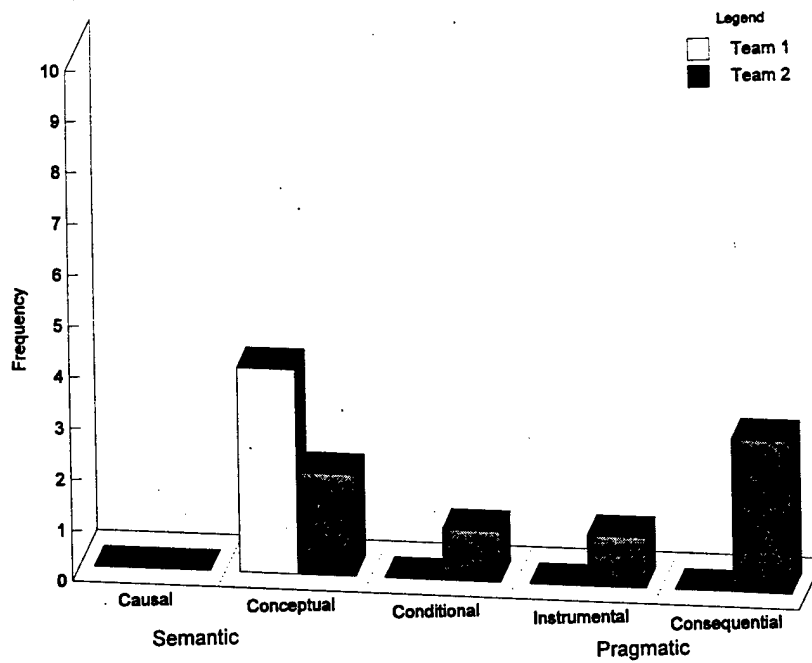


Figure 2. Semiotic content in NK supply ($r = .00$).

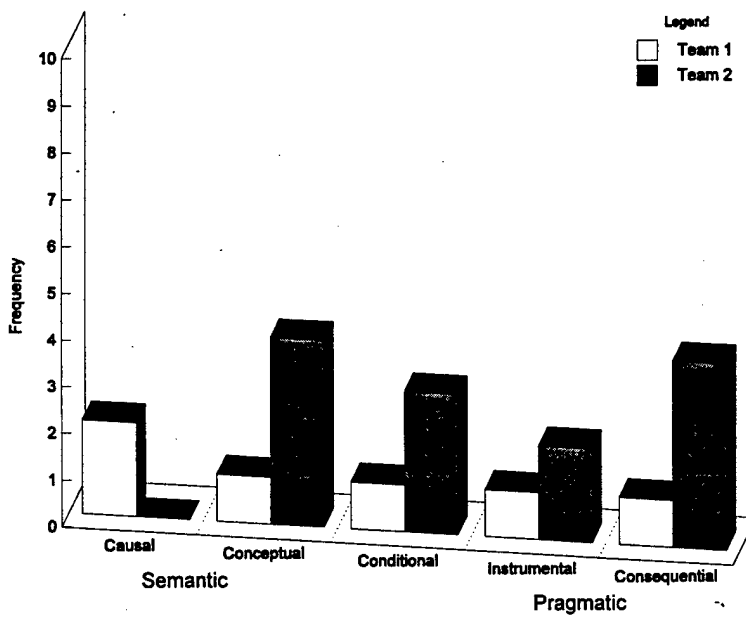


Figure 3. Semiotic content in NK maneuver ($r = .47$).

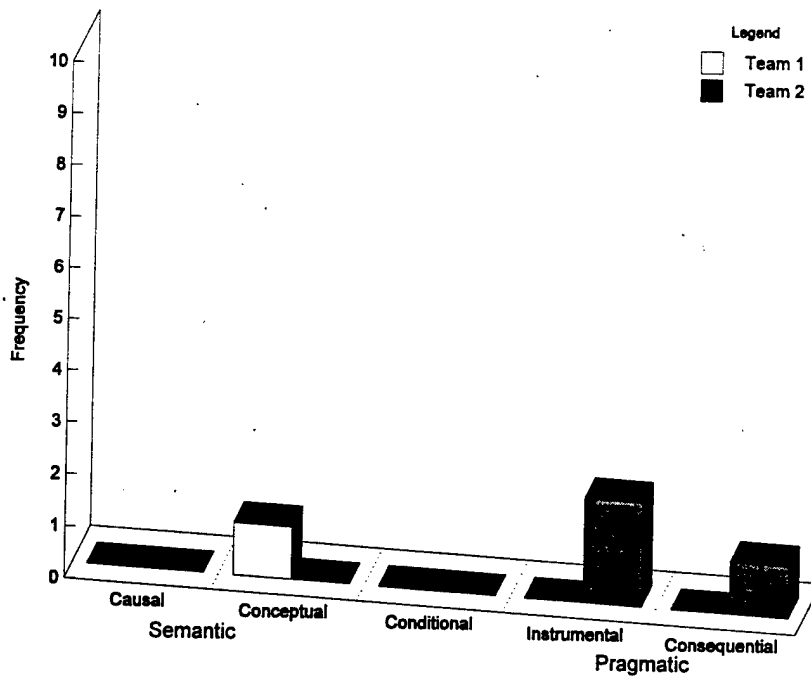


Figure 4. Semiotic content in NK current activity ($r = -.48$).

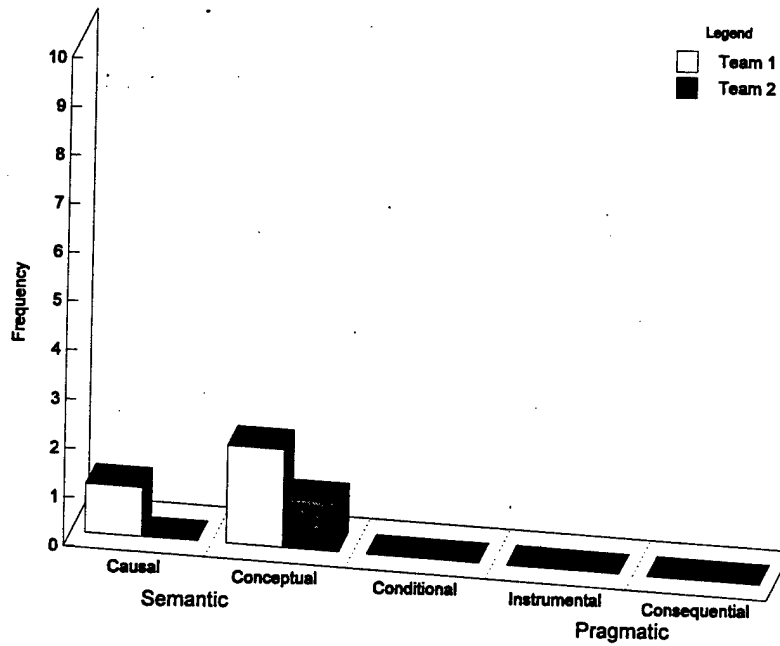


Figure 5. Semiotic content in NK enemy forces ($r = .87$).

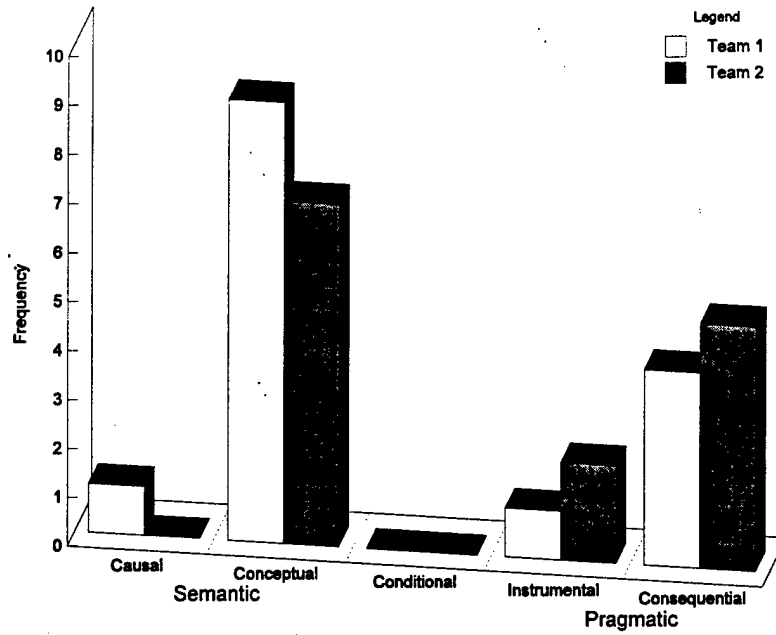


Figure 6. Semiotic content in NK enemy capability ($r = .89$).

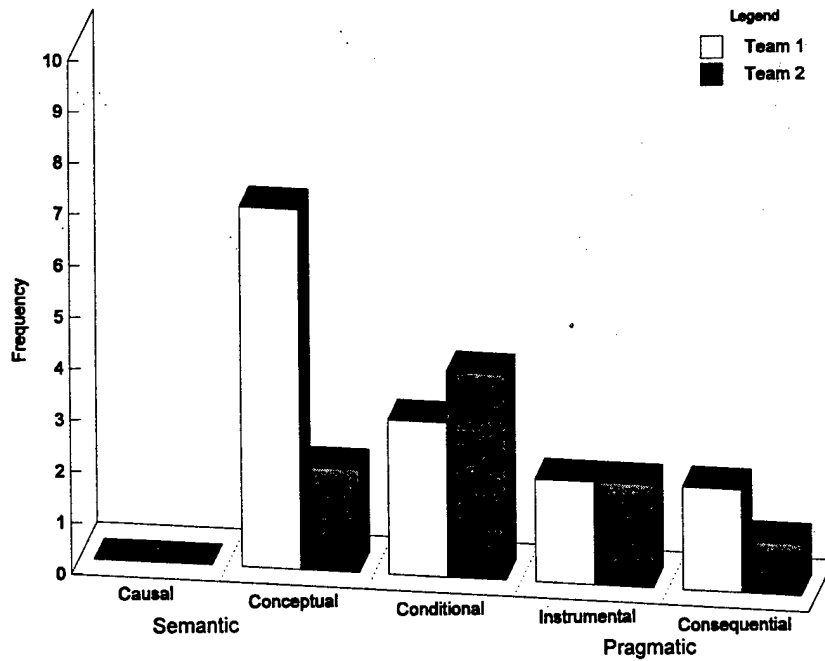


Figure 7. Semiotic content in NK ENCOA ($r = .57$).

As the constituent pragmatic relationships (instrumental, conditional, consequential) are more informative than the overall number of pragmatic relationships, procedures were modified. If a given pragmatic relationship has more than one constituent, each would be identified. As the total number of pragmatics is not of interest, this will not result in over-counting.

A second change in procedures involved the order in which the narratives were analyzed. The top-down approach (ENCOA through supply) used in the analysis of transformations produced a greater understanding of the narratives; thus, it would be used in Study 2. Additionally, our discussions led us to believe identifying semiotic relationships as explicit or implicit would facilitate identification of transformations. Explicit relationships were those semantic relationships that stated, within the narrative, both the sign and the sign's meaning or pragmatic relationships that stated both the sign and its consequence. Implicit relationships were those in which the antecedent sign(s) or meaning was not stated in the narrative. By labeling relationships as implicit, it would be evident that contributory signs and meaning must be sought in other narratives. While explicit relationships also might have antecedent information in other nodes, looking within the node first enabled the identification of, for example, a single, coherent relationship, as opposed to many individual relationships.

We did not attempt to reach consensus about the results of our analyses, since it was more appropriate to revise procedures. Overall, the high correlation on most narratives and the ability to identify differences led us to believe that with the revision of procedures, we could reach greater consensus.

Measures of Semiotic Content

Completeness and Specificity

Each team had difficulty in applying the completeness and specificity indicators. It was clear that the author of the narratives was able to understand the information and derive meaning and consequence. It was equally clear that the analysis teams were also able to do so. While the measurement criterion was clear, the referent was not. That is, was the information sufficient for the analyst to understand and transform, or was the information sufficient for the user to understand and transform? Team 2 solved their dilemma by providing ratings from two viewpoints: the user of the information (the battle commander) and the producer of the information (the MI analyst). Because of the difficulty with the measures, they only applied them to the ENCOA narrative. On the other hand, Team 1 rated all narratives from their own

viewpoint. They asked if the information was complete and specific enough for themselves to understand and transform.

Figure 8 provides the ratings of completeness and specificity of the semiotic relationships in the ENCOA node for both analysis teams (the Team 2 analyst's viewpoint values were used for comparison). The correlation coefficient of 0.19 confirms that the analysis teams were not applying the ratings consistently. Discussion of the measures revealed that their application to the MI domain was questionable. The intelligence analysts were resolute that regardless whether the information was complete and specific, the analyst must still produce a product and use the available information to do so. Therefore, these measures did not persist into Study 2. Rather, a measure of adequacy was developed that embodied the belief that all information was usable, some only less so.

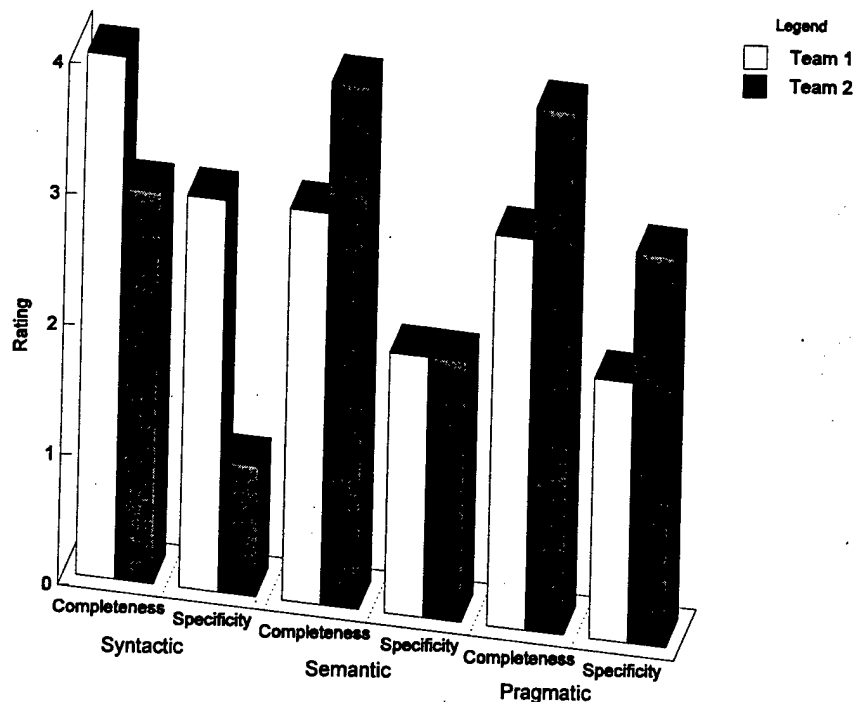


Figure 8. Measures of completeness and specificity for NK ENCOA ($r = .19$).

Relevance

Each team rated the semiotic content “relevant” for all nodes. That is, the relationships contained within the narratives were logically consistent given the scenario and node. How well the relevance measure discriminated was questioned. We believe relevance did

not discriminate because all subjects were experts in their field and used only what they regarded as relevant information. Relevance was not carried forward to Study 2. This measure may provide the means to discriminate among levels of expertise. Investigations involving an experience continuum will provide a better vehicle for testing how well this measure discriminates.

Semiotic Density

Semiotic density yielded a percentage of each type of relationship, by node. The density of syntactic relationships played a large part in the identification of communicative syntax and the decision to disregard it in future analyses. Syntactic density ranged from 73% to 98%. However, since the lower percentages are more accurately a reflection of an increase in semantic and pragmatic relationships, we felt that the direct measure of those relationships was more appropriate. Semiotic density ranged from 0% to 15% and pragmatic from 0% to 13%. Since the semiotic density data are based on the content data displayed in Figures 2 through 7, resulting patterns are equivalent.

All inter-team correlations for semiotic density were .99, indicating almost no differences between teams in the density of overall semiotic relationships. These correlations were computed on total semantic and total pragmatic relationships (as opposed to their constituents). The lower correlations for semiotic content are likely a result of the constituent relationships.

As semiotic density required all semiotic relationships to be tallied, and the same information was available directly from the identification of semantic and pragmatic relationships, this measure did not persist in subsequent analyses.

Content Transformations

Each team was able to identify information that had been transformed, although the pattern of transformations differed across the two teams. Figures 9 and 10 show the transformation pairs between the applicable nodes for Teams 1 and 2, respectively. In these figures, transformation type is indicated as a link between the two involved nodes. The number in parentheses after each transformation pair represents the tally of transformations between the two nodes.

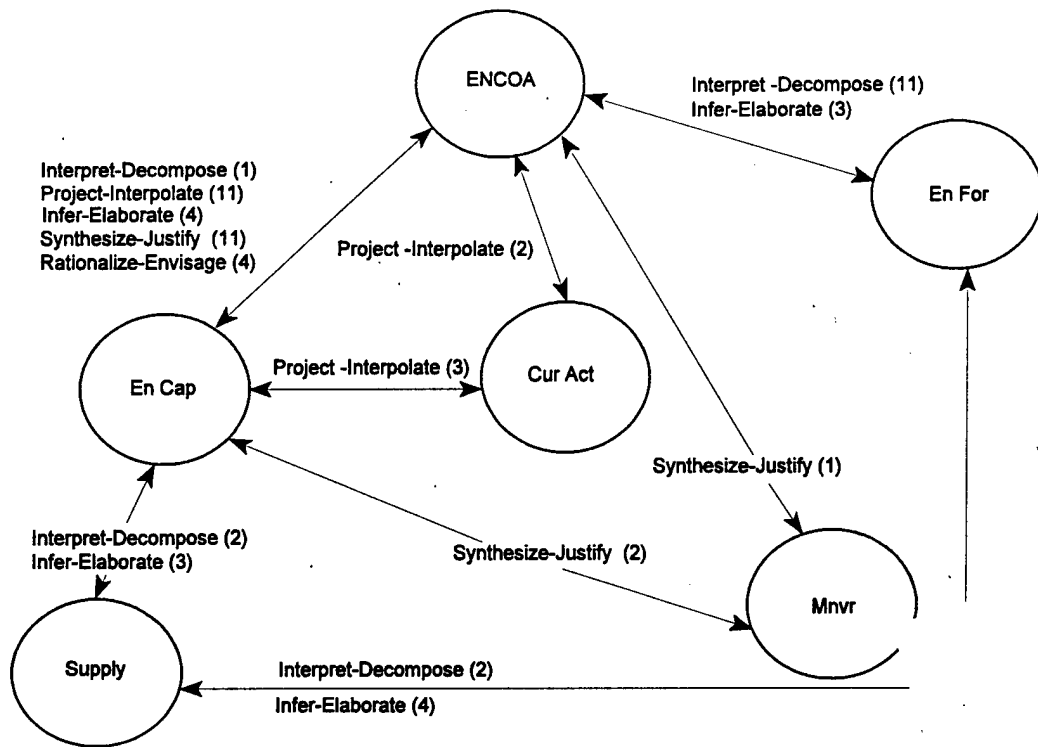


Figure 9. North Korean transformation - Team 1.

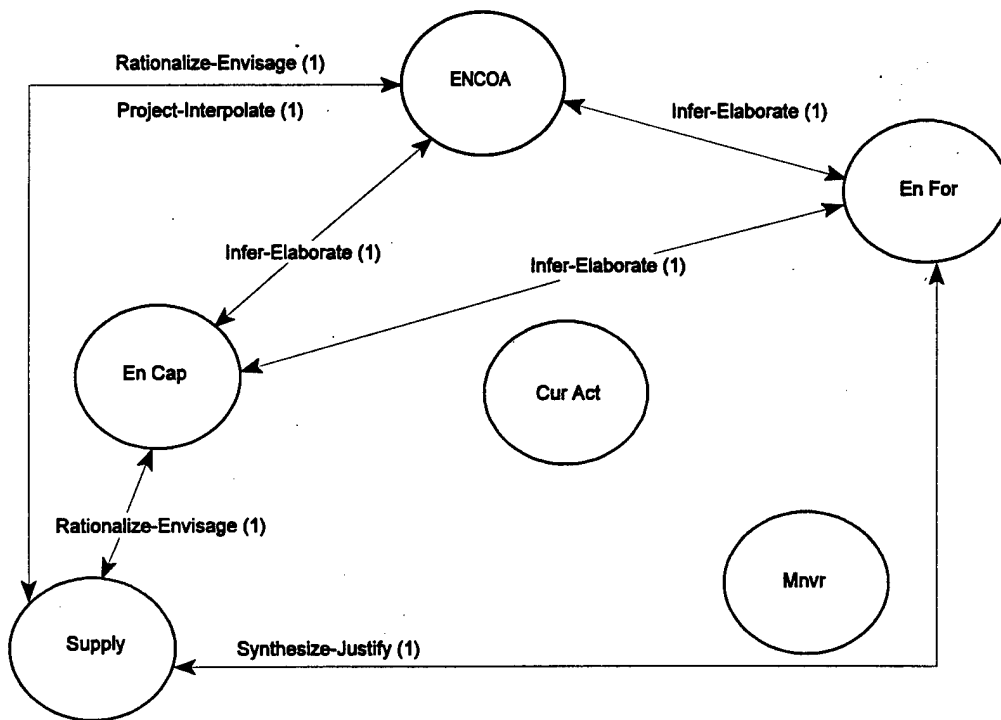


Figure 10. North Korean transformations - Team 2.

The discussion of the differences in transformations was limited, because neither team had recorded the content of the transformations. Since there were many different patterns of transformation, it was difficult to characterize the pilot subject's use of information. Common findings were that information from supply was used to understand enemy capabilities and enemy forces and that information from enemy capabilities and enemy forces was used to understand ENCOA.

There was some overlap in the types of transformations among these nodes, but generally, transformation-type differences resulted from differences in identified types of semiotic content. For example, Team 1 might have identified a rationalize-envisage transformation (pragmatic-pragmatic) between enemy capabilities and ENCOA. If Team 2 identified the same information being transformed between these two nodes, yet labeled the "antecedent" information as semantic, a justify-synthesize transformation would result.

While there were considerable differences in the transformation results, the teams believed the results demonstrated an ability to find information that had contributed to transformations. Changes in semiotic content procedures should help to resolve some differences and result in greater consistency for transformations.

STUDY 2

METHOD

Procedures for the second study derived from the analysis and discussion of those employed in Study 1. In this study, narratives from the Cuba scenario were used. While general procedures remained the same, there were changes in the identification and measurement of semiotic content and content transformations.

Identify Semiotic Content

The approach to semiotic content in Study 2 was more holistic. That is, the narratives were first read to understand their content. This was in contrast with Study 1, where the focus was on finding (and counting) relationships. A second difference was in the approach to syntactic information. In Study 1, we found that much of the syntactic information was communicative in nature. That is, syntax was the "stuff" of communication and one could not write a narrative without it. However, one could write a narrative without invoking semantic or

pragmatic relationships. Therefore, we did not identify communicative syntactic relationships. Syntactic relationships were of interest only when they contributed to transformations.

Additionally, relationships were labeled as either implicit (the antecedent sign or meaning was not present in the narrative) or explicit (the antecedent sign or meaning was present in the narrative). This facilitated identification by introducing the notion that relationships might be distributed throughout the narrative. For example, an introductory paragraph might present the meaning of separate signs that were dispersed throughout the narrative. Thus, the appropriate identification is a single (explicit) semantic relationship, as opposed to one semantic and many syntactic relationships. Additionally, implicit relationships alerted us to the need to examine other narratives for a transformation leading to the meaning.

The identification and labeling of semantic and pragmatic relationships were the same as for Study 1, but narrative analysis was fixed at a top-down order. This approach, used to identify content transformations in Study 1, provided a greater understanding of the narratives, consistent with the holistic approach.

Identify Transformations

Transformations were identified before the application of the measure of semiotic content, as the familiarity with narrative content, developed during the identification of semiotic relationships, facilitated identification of transformations. Transformations were identified using the same procedure as in Study 1. Starting with ENCOA, lower nodes were searched for information that explicitly fed higher nodes. While we realized that all the information probably contributed to understanding, we focused on the explicit information that could reliably be identified as contributory.

Apply Measures of Semiotic Content

A measure of adequacy of the semiotic content was developed for Study 2. Adequacy was a binary measure that could take the value of "yes," or "yes, but." These values capture the notion that within MI, all information is used. That is, the analyst must produce intelligence, regardless of the characteristics of the information received. Adequate information could be used to further understanding (i.e., develop transformations) or to lead the analyst to information that would further understanding. Information that is not adequate ("yes, but") might still be used by the analyst but would require explanation, support, definition, or "control." Control means that

the information can only be understood in the context of understanding at another node. For example, information is understood in one way if you know that the enemy has nuclear-biological-chemical capability (another information node), but in quite another way if they do not. Hence, "yes, but" described a class of information deficiency.

The application of this measure was also tailored to the semiotic relationship. The measure was applied across all pragmatic relationships, producing one measure, per subject, per scenario. The analysts asked themselves if, given the operational context, they understood the pragmatic relationships or if they required explanation, support, definition, or control? If they understood, then the value of the measure was "yes." If they needed further information, then the value was "yes, but." Semantic relationships were judged adequate within node, as meaning was considered relative to the node. Analysts asked the same adequacy question and applied the same values for semantic relationships.

RESULTS

Semiotic Content

The identification of semiotic content was facilitated by the discussion of differences in Study 1 and the revised procedures--a holistic approach and a focus on semantic and pragmatic relationships. As in Study 1, these data were analyzed by tallying the type of relationship, by team, by narrative. These tallies were then compared by correlation analysis, across teams, within node. Table 3 provides a comparison of the correlation coefficients for Study 1 and Study 2.

Table 3
Correlation Coefficients for Study 1 and Study 2

Node	Study 1 Correlation coefficient (r)	Study 2 Correlation coefficient (r)
Supply	0	.90
Maneuver	.47	.81
Current activity	-.48	1.00
Enemy forces	.87	.87
Enemy capabilities	.89	.43
ENCOA	.57	.46

While the correlations for enemy capabilities and ENCOA decreased from Study 1, all demonstrated a fair amount of agreement (as opposed to Study 1, where there was a lack of agreement in all but two nodes). This consistency is probably attributable to several factors, including the increased familiarity with semiotic content, the improved analysis procedures, and the focus on understanding the content before identifying relationships, facilitated by the order of analysis. The more consistent correlations can be taken as an indication that the analysis became more stable.

DISCUSSION

In contrast with Study 1, we felt that with improved procedures and increased consistency, it was appropriate to reach consensus about semiotic content. There was no difficulty in reaching consensus. Figure 11 provides a graph of the results for semantic and pragmatic content in the Cuba narrative, across nodes. The data represented in this figure were reached via consensus between the two teams. Discrepancies between the two teams resulted primarily from the tendency for Team 1 to identify some conceptual semantic relationships as consequential pragmatic and for Team 2 to break semiotic units into more finely grained units. Procedures were modified to account for these discrepancies. The modifications focused on identifying coherent semiotic units and possible “clues” to distinguish semantic relationships from pragmatic (e.g., pragmatic are more likely to be in the future tense).

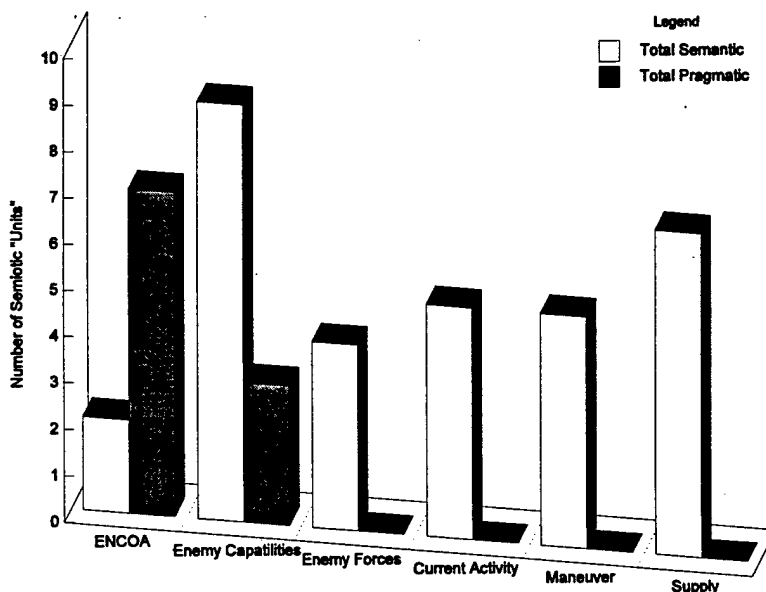


Figure 11. Semiotic content in Cuban scenario.

It is tempting to compare the results of Study 1 and Study 2, to identify scenario differences and the sensitivity of semiotic content to those differences. This comparison is inhibited by the lack of consensus data for Study 1, as the better approach (at that point in time) was to modify procedures. However, each team noted differences between the scenarios that they believed would be revealed by consistent application of the procedures to the remaining narratives. For example, each team identified two instrumental pragmatic relationships (concerning “how”) in ENCOA, North Korea (Study 1). On the other hand, the consensus data revealed no instrumental pragmatic relationships in the same node for Cuba (Study 2). This could be interpreted to mean that the uncertainties of OOTW (based on the lack of historic and contemporary information) result in lesser understanding of how the enemy will enact their plans.

Content Transformations

Again, there were considerable differences in the identification of transformations, as evidenced by Figures 12 and 13, which depict transformations identified by Teams 1 and 2, respectively. However, productive discussion was possible, as Team 1 had identified the content of the transformation, providing the basis for discussion. A primary difference was that Team 1 identified information that was either transferred (moved directly between nodes, without transformation) or transformed from the scenario. This may have contributed to some of the differences between the two teams. Ignoring the transformations from the scenario (which Team 2 did not include in their analysis), all but two of the transformations identified by Team 1 were also identified by Team 2.

Discussion revealed that Team 2’s approach to identifying transformations had been considerable broader than Team 1’s. Team 2 had identified information that could generally have contributed to transformations. Team 1 identified information that explicitly could be seen to have contributed. While we acknowledge that most information likely contributes to understanding, the more focused, explicit approach is defensible and less open to alternate interpretation. Transformation procedures were thus modified to incorporate the more explicit approach and the identification of transformation content.

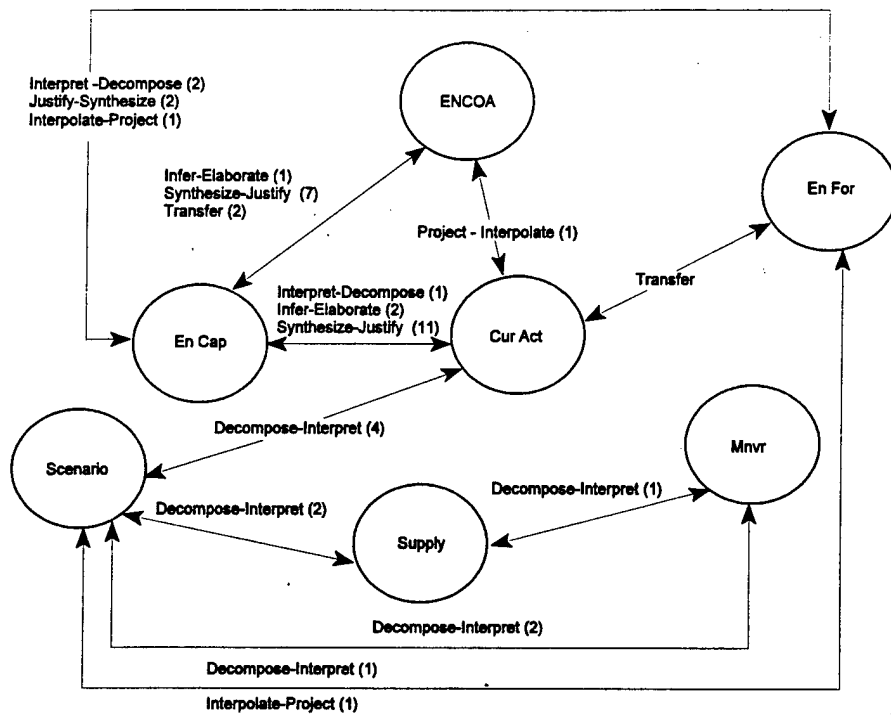


Figure 12. Cuban transformations - Team 1.

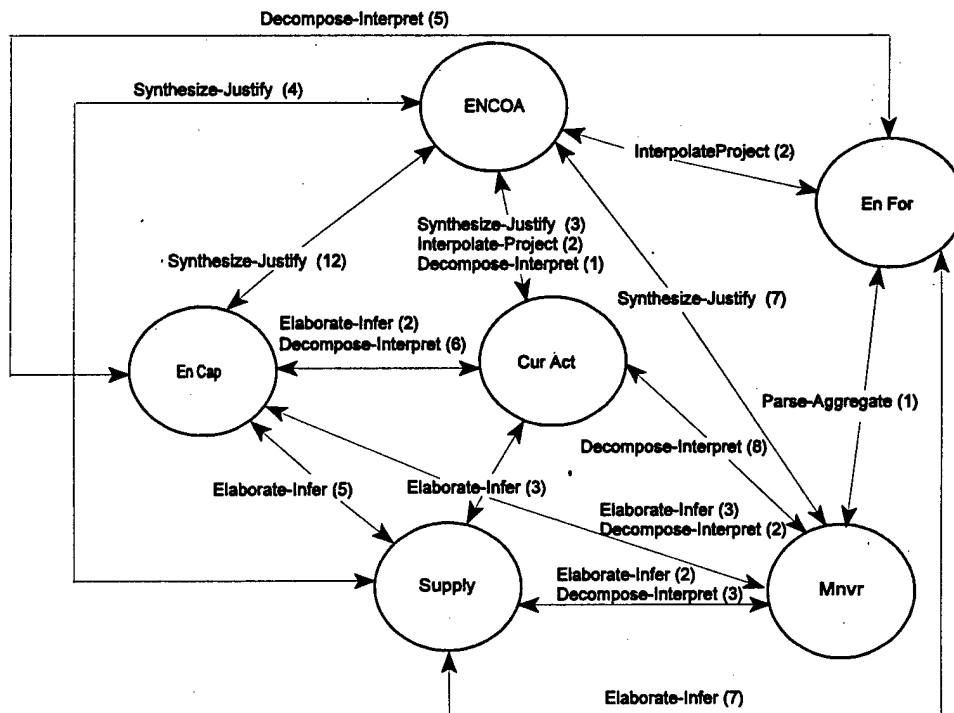


Figure 13. Cuban transformations - Team 2.

Figure 14 provides a sample of the transformation content identified by Team 1. The figure illustrates information transformed from the scenario to enemy forces, enemy capabilities, and ENCOA. In this transformation chain, individual enemy locations (syntactic) in the scenario where transformed into the consequence (pragmatic) in enemy forces in which they are dispersed for safety and security reasons. This was then transformed into the meaning (semantic) in enemy capabilities in which they may divide the hostages into smaller groups and disperse them, which was further transformed into the course of action (pragmatic) wherein we can expect the hostages to be moved within 24 to 36 hours and split into smaller groups.

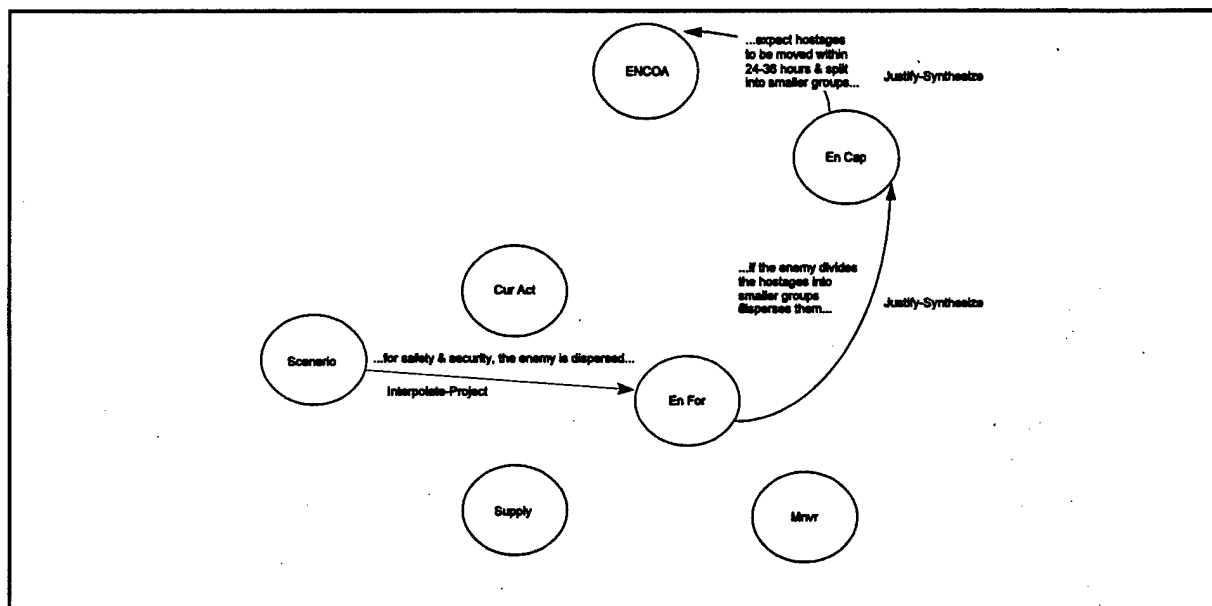


Figure 14. Illustration of transformation content for Cuba - Team 1.

Measures of Semiotic Content

Each team applied the measure of adequacy to semantic content, and Team 1 rated all relationships to be adequate. They had some difficulty in its application, as the criterion for adequate information was that it could lead the analyst to understanding or to information that would contribute to some later understanding. Since Team 1 had been able to identify relationships and transformations, they felt that the analyst had furthered understanding. Even when they applied the measure from their own viewpoint (i.e., had their understanding been furthered), they rated all relationships “adequate.”

When faced with the same dilemma, Team 2 further developed the measure of adequacy into three dimensions adequate with respect to (a) spatial information, (b) behavioral information, and (c) temporal information. They continued if the value was "yes, but," to indicate which type of elucidation was required (support, definition, explanation, or control from another node). This lower level of resolution resulted in a greater degree of variability than did the singular measure. For example, they rated six (of nine) relationships in ENCOA as requiring further support for temporal aspects and one requiring spatial support. These measures are still being discussed and will require further definition for their continued application.

CONCLUSIONS

As with any case study procedure, the data analysis was labor intensive, time consuming, and the substance of the data was more important than its enumeration. We do not view this as a drawback to the methodology since its purpose was to determine how to identify substance. However, the issue of content of information in a domain creates a dilemma. Previous research with these subjects (Burnstein et al., 1995) indicated idiosyncrasies in their evaluations of the importance of information for use in accomplishing different goals.

Domain idiosyncrasies were also apparent in our intelligence analysts, themselves domain experts. However, we discovered that it was very easy for our intelligence analysts to resolve their differences and produce a stable domain-relevant analysis. This means that while the procedures are appropriate to identifying the semiotic content and content transformations in information, an additional step may be necessary. Because we used two teams, we relied on a consensus building process to finalize the analytical results. Therefore, if two teams are used, a final, consensus building step will be necessary.

STUDY 3

METHOD

The result of the previous studies produced a procedure for identifying the semiotic content of information that illustrates how information is used to derive meaning (see Table 4). These procedures were applied to the narratives of two additional subjects. A re-analysis of the initial subjects narratives was also done. Except for syntactic relationships, the definitions used remained the same (Appendices A and B). A hierarchy of levels of resolution (Appendix E) was used to identify syntactic relationships.

Table 4

Procedures for Analyzing the Semiotic Content of Information

Read the narratives

- Begin at the highest level in the information hierarchy
- Read each narrative for understanding and a feel for the major themes

Identify semiotic content

- Classify the semantic and pragmatic relationships (using the future tense clue as necessary)
- Identify whether the relationships are implicit or explicit
- Tally each type of relationship
- Identify the patterns of semiotic content

Identify transformations

- Begin at the highest level in the hierarchy. For each semiotic relationship
 - Search all lower narratives for information that explicitly contributes to the relationship
 - Mark all contributing information in a way that facilitates analysis
 - Construct an information flow diagram
 - Identify the patterns of transformation

Assess the adequacy of the semiotic relationships

- Look for conspicuous information that
 - Leads you to question the soundness of the transformation
 - Is inconsistent across nodes
 - Has no substantiation in other nodes
 - Needs further explanation, support, definition, or control
-

RESULTS

Figures 15 and 16 summarize the results of the semiotic analysis for each subject for the North Korea scenario (Figures 15a, b, and c) and the Cuba scenario (Figures 16a, b, and c) overlaid on the knowledge nodes and scenario. The figures show the types of semiotic content occurring within the knowledge nodes and the types transformation that were made between nodes. The type of transformations that occurred are identified on each line. The solid lines between nodes represent syntactic and semantic transformations. The dashed line represents pragmatic transformations. The shaded areas within each node indicate the presence of semantic and pragmatic semiotic relationships (no shading indicates the absence of that relationship). The frequency for the different relationships and transformations are not represented. That is not to say that frequency of occurrence is not important. Given the conditions of this study, its lack of ecological validity and performance data, we believe the frequency data are an artifact. Tables 5 and 6 summarize the similarities and difference between subjects. Tables 7 through 9 show the major semiotic differences within each subject for the two scenarios.

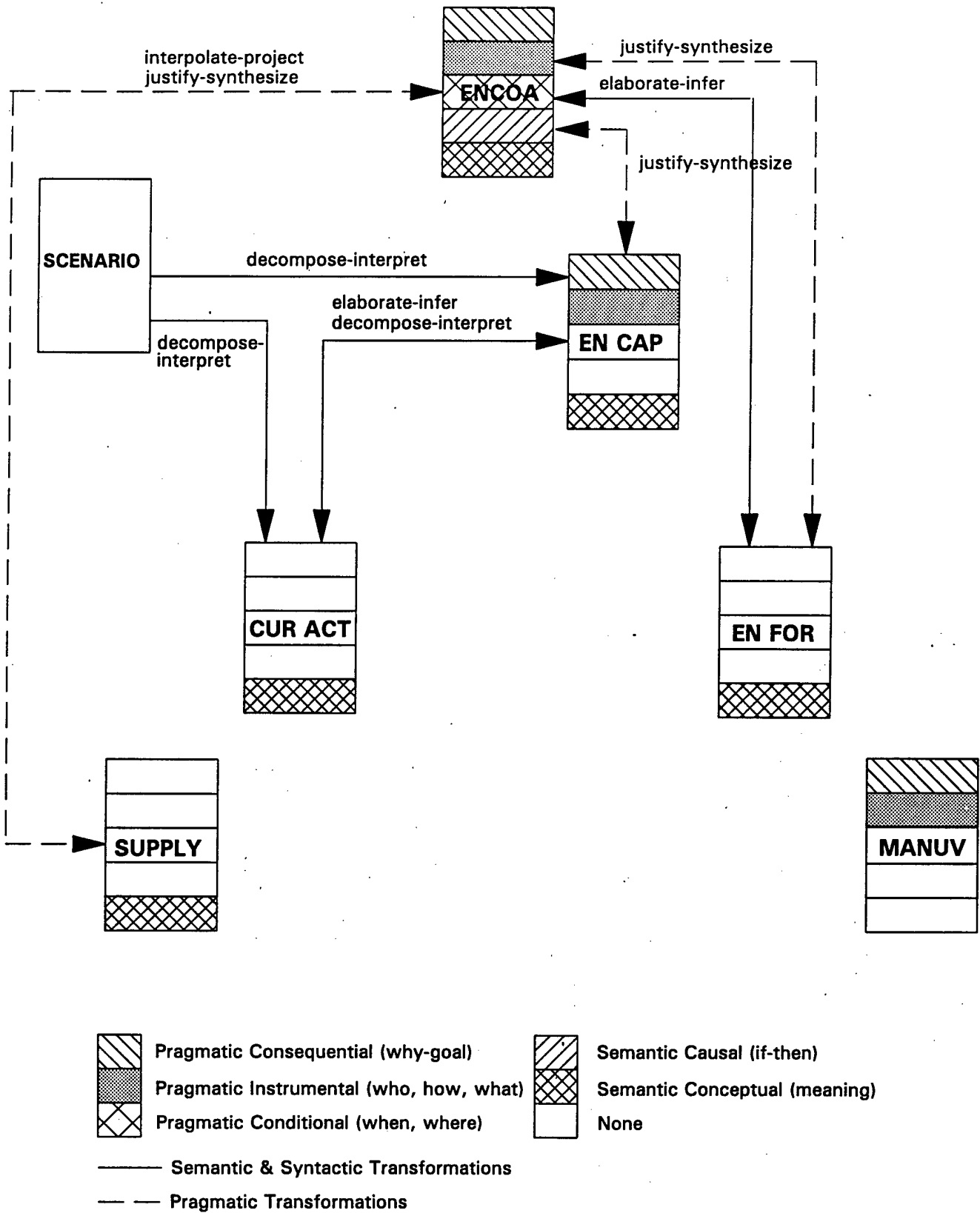


Figure 15a. Subject 1, North Korea, semiotic relationships and transformations.

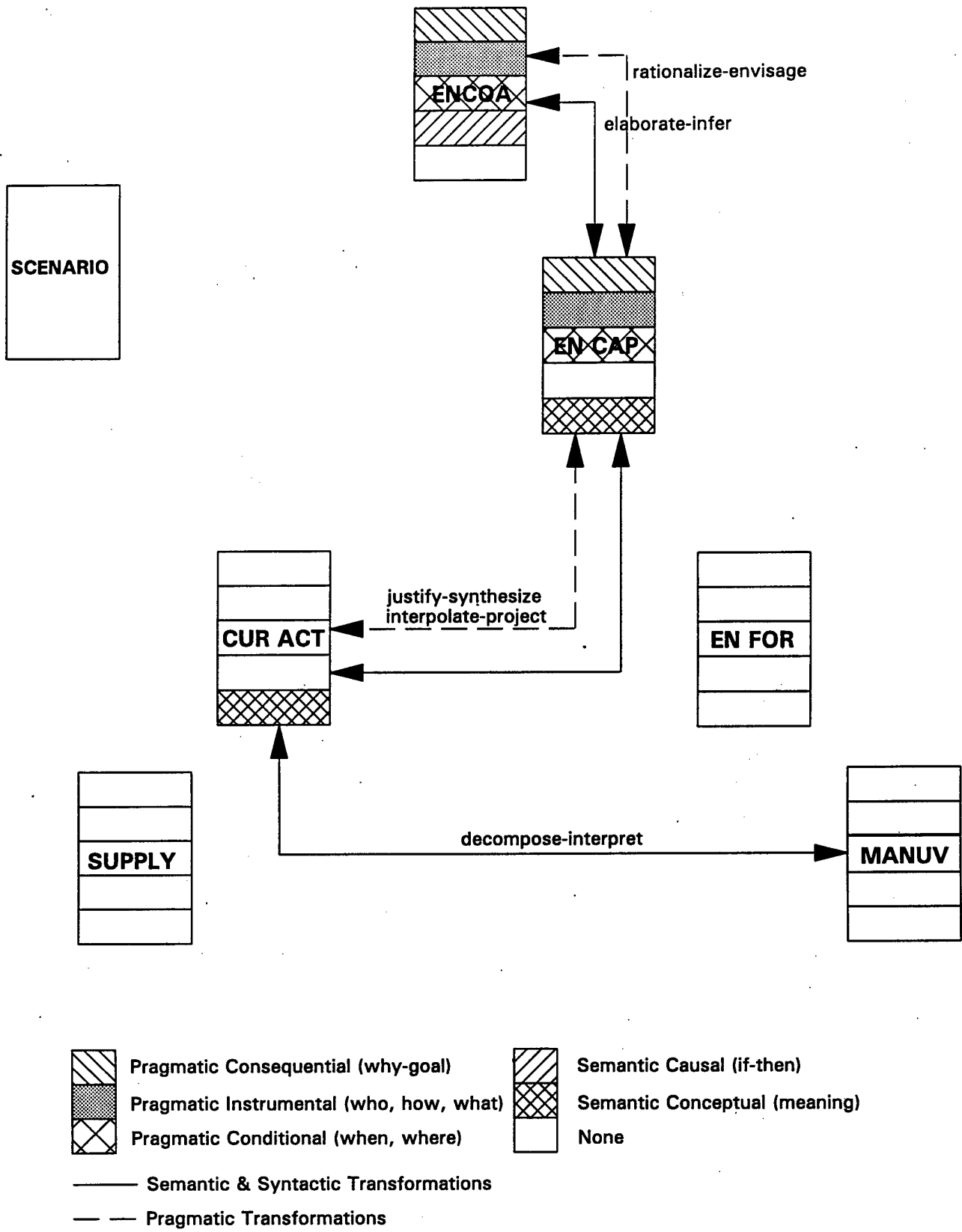
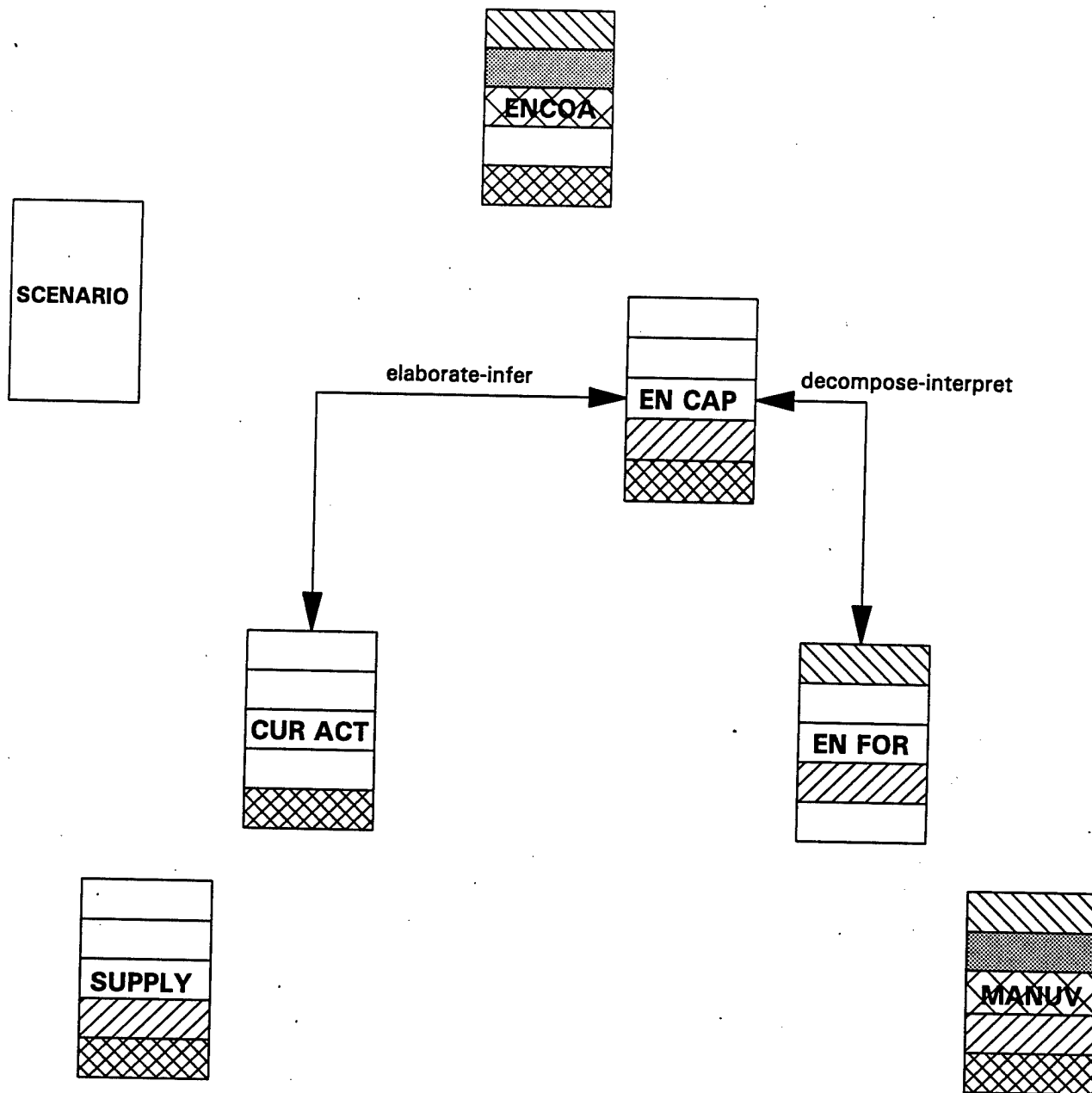


Figure 15c. Subject 3, North Korea, semiotic relationships and transformations.









- | | | | |
|---|---|---|-------------------------------|
|  | Pragmatic Consequential (why-goal) |  | Semantic Causal (if-then) |
|  | Pragmatic Instrumental (who, how, what) |  | Semantic Conceptual (meaning) |
|  | Pragmatic Conditional (when, where) |  | None |
- Semantic & Syntactic Transformations
 - - - Pragmatic Transformations

Figure 16a. Subject 1, Cuba, semiotic relationships and transformations.

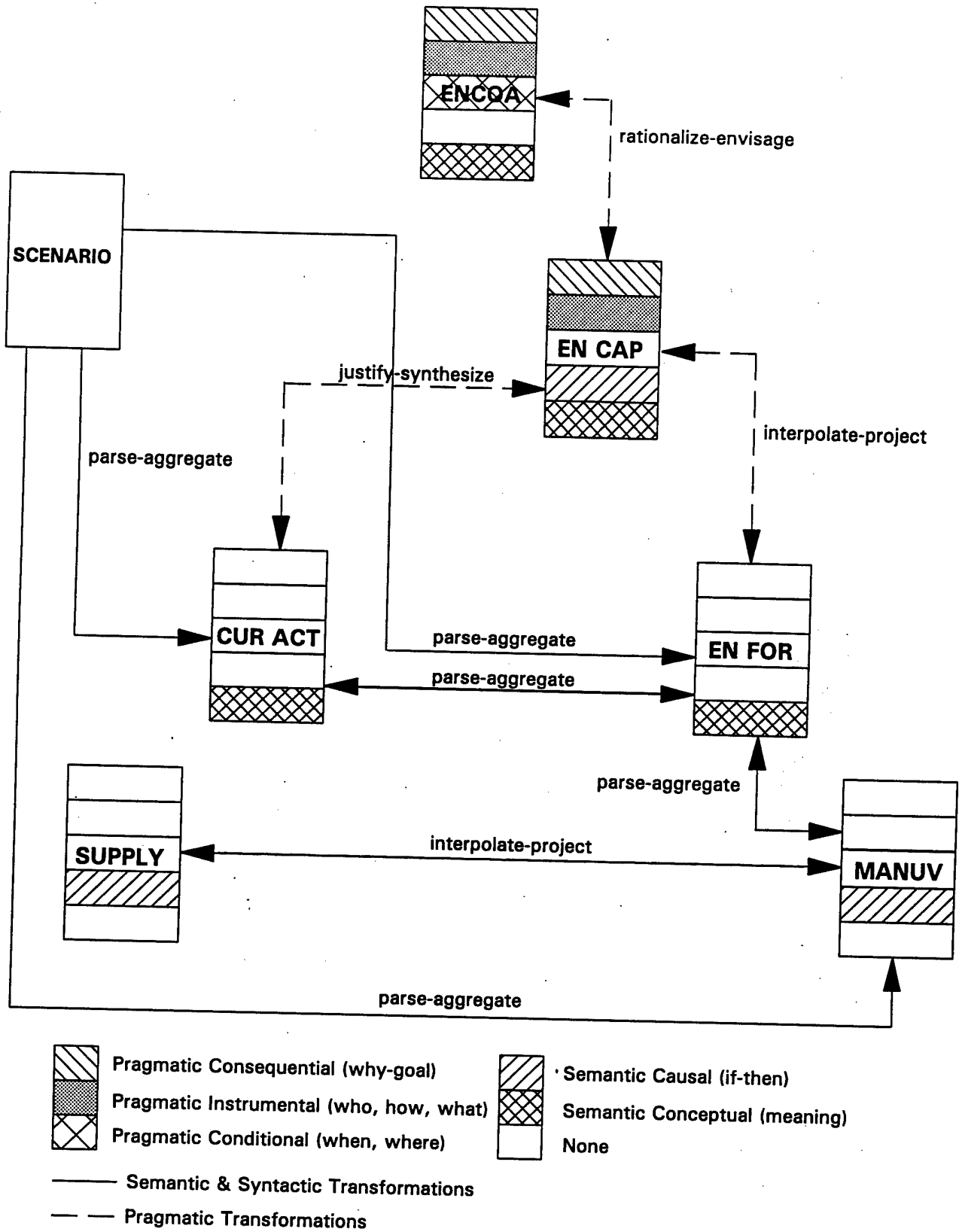


Figure 16c. Subject 3, Cuba, semiotic relationships and transformations.

Table 5

Major Semiotic Similarities and Differences Between Subjects for the North Korea Scenario

Pattern	Analyst 1	Analyst 2	Analyst 3
Semantic			
Similarities	Few causal relationships	Few causal relationships	Few causal relationships
	Conceptual relationships occur in all but one node	Conceptual relationships occur in all nodes	
Differences			Conceptual relationships occur only in higher nodes
			No relationships in lower nodes
Pragmatic			
Similarities	All types occur in ENCOA		All types occur in ENCOA
	Relationships occur in higher and lower nodes	Relationships occur in higher and lower nodes	
Differences		Consequential relationships dominate	Relationships occur only in higher nodes
Transformations			
Similarities	Sparse to moderate transformations		Sparse to moderate transformations
	Enemy capabilities a focal point	Enemy capabilities a focal point	
Differences	Pragmatic relationships developed in maneuver and transferred to ENCOA	Abundant transformations All nodes involved	Enemy capabilities and current activity are focal points

Table 6

Major Semiotic Similarities and Differences Between Subjects for the Cuba Scenario

Pattern	Analyst 1	Analyst 2	Analyst 3
Semantic			
Similarities	Few causal relationships Majority conceptual relationships occur in higher levels	Few causal relationships	Few causal relationships Conceptual relationships occur only in higher levels
Differences		Abundant conceptual relationships occur in all levels	
Pragmatic			
Similarities	All types occur in ENCOA	All types occur in ENCOA Relationships occur only in ENCOA and enemy capabilities	All types occur in ENCOA Relationships occur only in ENCOA and enemy capabilities
Differences	Strong presence of pragmatic relationships in maneuver		
Transformations			
Similarities	Enemy capabilities a focal point	Enemy capabilities a focal point	Enemy capabilities a focal point
Differences	Sparse amount of transformations involving few nodes Pragmatic relationships developed in maneuver and transferred to ENCOA None involve pragmatic relationships	Abundant transformations involving all levels	Sparse to moderate transformations involving all levels

Table 7

Subject 1, Major Semiotic Differences and Similarities for the Scenarios

Pattern	Korea	Scenario	Cuba
Semantic			
Similarities		Conceptual relationships tended throughout	
Differences			Causal relationships abundant
Pragmatic			
Similarities		Primarily restricted to ENCOA and maneuver	
Differences			
Transformation			
Similarities			
Differences		More frequent and build to ENCOA and enemy capability	

Table 8

Subject 2, Major Semiotic Differences and Similarities for the Scenarios

Pattern	Korea	Scenario	Cuba
Semantic			
Similarities		Semantic conceptual found throughout	
Differences			
Pragmatic			
Similarities		Occurs in ENCOA	
Differences		Found in lower level nodes supply and maneuver. Pragmatic instrumental used.	
Transformation			
Similarities		Builds into enemy capability and ENCOA. Different transformations occur throughout with justify-synthesize and decompose-interpret predominant	
Differences			

Table 9

Subject 3, Major Semiotic Differences and Similarities for the Scenarios

Pattern	Scenario	
	Korea	Cuba
Semantic		
Similarities	Conceptual relationships tended throughout	
Differences	No causal relationships. Several nodes void of semantic relationships.	Causal found in lower level node supply and maneuver.
Pragmatic		
Similarities	Used in ENCOA and enemy capability	
Differences		
Transformation		
Similarities	Current activity and enemy capabilities seem central.	
Differences	Enemy forces and supply are not involved in transformation.	Enemy forces involved centrally. All nodes involved in transformation.

The identification of individual differences through the use of levels of resolution was limited. Many of the levels of resolution did not discriminate. While the "capability" levels of resolution demonstrated differences, relating category differences to either scenario or node characteristics is difficult. At this point, this construct requires further application and analysis to determine its utility. In addition, the measures of adequacy of the information failed to be useful. How one measures the adequacy or quality of information remains an unanswered question.

DISCUSSION

These results indicate that the methodology can demonstrate how individuals use information differently. The methodology has demonstrated both similarities and differences between the ways analysts approached each problem. Similarities may result from the fact that all analysts have attained similar levels of expertise and received training from the same system that represents common processes and understanding of enemy activities (particularly in

conventional warfare). Differences in analysts' information use can result from MI-related experiences. For example, while trained by the same system, the analysts received their training at different times when different zeitgeists were likely in effect. Different experiences also result from different commands (e.g., Pacific versus Europe) at different times. Finally, idiosyncratic approaches to MI analysis may result in different information use. For example, some senior analysts may focus on managing the analysis process, while others focus on the analysis process itself. Additionally, some analysts may have a more intuitive approach to analysis while others are more data driven.

It is important to again stress that these data were collected in an experimental setting using artificial tasks. We have demonstrated differences and similarities that reflect information use in that context alone. The data provide no basis for inferring goodness or qualitative aspects of performance. Only application in a naturalistic setting, using real tasks can provide the basis for such inference. It is within that setting that the quantitative aspects of the semiotic analysis become important. For example, an abundance of transformations may be overkill when the existence of one pragmatic relationship may be all that is needed to provide the necessary intelligence.

Benefits of Approach to Military Intelligence

The military intelligence system faces difficult challenges as the 21st century approaches. On the one hand, new collection technologies are continuing to emerge that allow huge volumes of data to be captured. While these data offer great potential, they must be assessed for quality, carefully analyzed to develop appropriate interpretations, and synthesized into a meaningful whole. However, as the analysis requirements for producing valid intelligence are multiplying rapidly, the resource base for accomplishing these tasks is shrinking. Improvements in information processing are required to leverage these trends and to offer MI an increased data analysis and intelligence production capability.

The approach investigated here offers potential benefits to the MI community in two primary areas: training and systems support. Turning first to training, this research provides a theoretical basis and a methodology for beginning to understand individual differences among MI personnel in information processing. This understanding highlights the need to develop training aimed at the capability to use information in a flexible manner to satisfy a goal, rather than to adhere to doctrinal templates in the analysis process. Training aimed at more flexible use of

information is likely to produce intelligence analysts who are able to respond effectively to varying situations because information use is always specifically linked to their analysis goal.

More specifically, training in goal-oriented information processing might include structured experiences to allow MI personnel to (a) understand their individual pattern of information use, (b) experiment with using information in different ways within the context of alternate scenarios, (c) understand effective patterns of information use in a normative sense, (d) adjust their information processing to conform to established normative standards, (e) recognize priorities in information use, (f) consider how disparate information elements relate to each other and are influenced by situational and contextual factors, and (g) assess their capability in information processing and focus on specific needs for improvement. This training should focus on both the semiotic content of information used as well as the nature of the transformation made during the analysis process.

This approach also offers potential to the MI community for development and design of new systems. This approach could be applied in the development of an adaptive user interface by (a) diagnosing the patterns of semiotic content and semiotic transformations used by an individual analyst, (b) adjusting the types of information provided to support the individual's preferred information-processing patterns, (c) adapting the form of the information provided to more closely suit individual preferences, (d) structuring the semiotic content of data to the known requirements of an individual analyst's goal or scenario context, and (e) alerting the analyst when his or her information-processing pattern is inappropriate for a given goal or context and provide cues for alternate actions.

Such an adaptive user interface would offer two primary benefits. First, it would augment the intelligence analyst's information-processing preferences supporting the use of specific types of semiotic content and semiotic transformations. Second, it would assist the user in determining appropriate semiotic content and semiotic transformations for specific goals and contexts through the use of goal-oriented databases constructed to support the user faced with various circumstances.

Use in Naturalistic Settings

This approach and methodology has potential for understanding information processing in a variety of naturally occurring settings, in addition to the MI community. One particularly striking example resides in the many and varied training and testing environments using simulation networking technology currently in use or being developed in the military community.

These environments span service branches, are greatly dispersed geographically, and exert an influence on large numbers of military personnel.

Simulated networking environments offer a noteworthy opportunity to further understand information use in a variety of circumstances because of their simulation capabilities and their capabilities for digital or voice data capture. Realistic scenarios can be played within these environments and all data and information captured for subsequent analysis. Such an approach would allow greater understanding of the information requirements (both from a content and transformation point of view) of individuals and units across a broad range of mission contexts, scenarios, and conditions. These results could be used to inform development of a set of goal-oriented databases that support both training and system (i.e., adaptive user interface) development. Results also could be used to further understand individual analysts' differences to enhance information usage strengths and compensate for information use limits.

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APPENDIX A
DEFINITIONS OF SEMIOTIC INFORMATION

DEFINITIONS OF SEMIOTIC INFORMATION

Syntactic

The syntactic is defined as the structural relationship of sign to sign; it may be either hierarchical or configural but is always physical and concrete. It may include an isolated sign in which the relationship to other signs is implied within a domain.

Relationships:

Objects: Animate and inanimate physical entities that have measurable attributes and can be described and counted.

Examples: Soldiers, pieces of equipment, terrain features, observation posts, assembly areas, routes of march, and platoon leaders.

Structures: Complex animate and inanimate physical entities that have been aggregated from objects and other structures in a hierarchy.

Examples: Platoons, a surface-to-air missile site, a company defensive position, the enemy rear area, an avenue of approach, and battalion officer complement; platoons and observation posts might aggregate to a company defensive position. The presence of structures may imply the presence of other objects or structures that have not been observed.

Events: Activities that are participated in or performed by objects or structures and can be described in detail. For our purposes, these are subdivided into military and non-military; each of these is further divided into threatening and non-threatening.

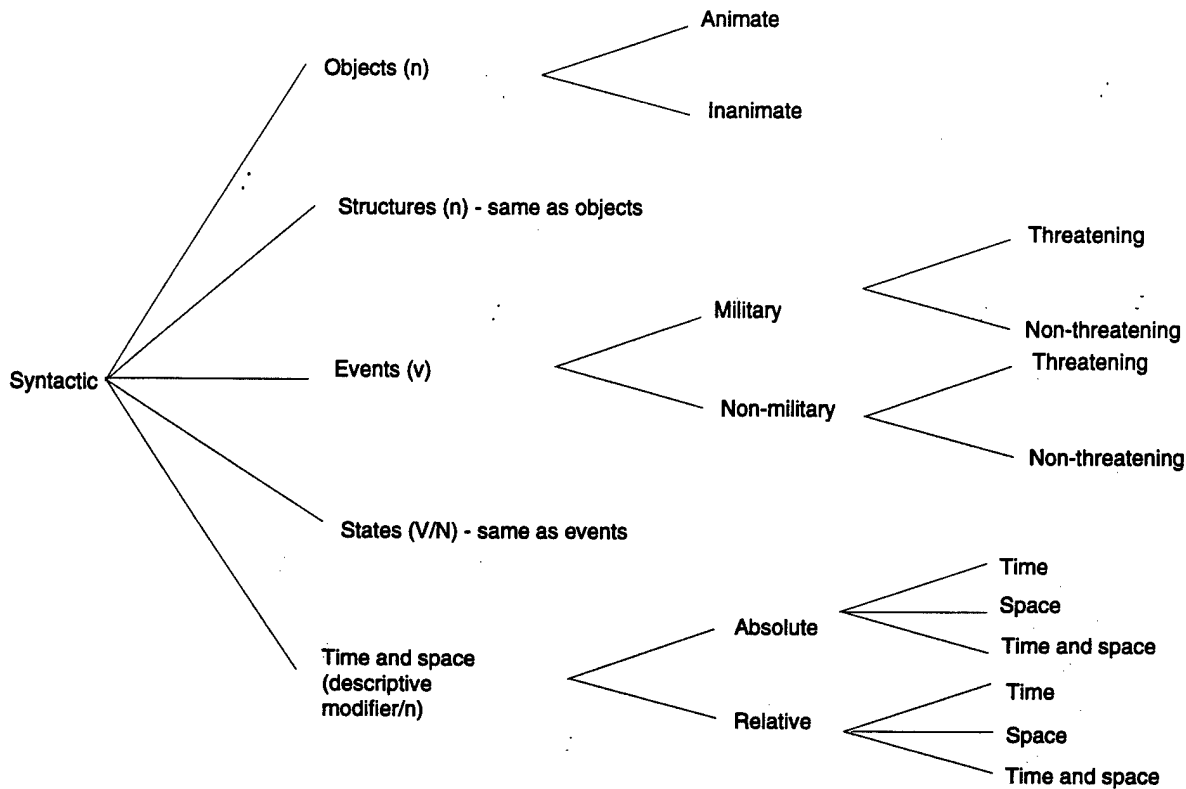
Examples: Attack or defense, a river crossing, an ambush, the laying of a mine field, and traffic on a command net. Events are typically fixed in either time or space or both. An attack, a defense, a river crossing, and an ambush are all executed by a unit of some echelon (structure) at some location in a particular time frame. A mine field is laid by soldiers (objects) of some unit (structure) at a given location. Radio traffic occurs on a command net (structure) at a particular time.

States: A series of events whose aggregation leads to construction of a coherent whole. In the intelligence domain, the taxonomy in events applies.

Examples: An offensive, a defensive, an advance, a retrograde, a defense, and normal operation of the net (these associations with the events are not exclusive but are representative). Relative to events, states are typically extended in space and time.

Time and Space: Either absolute or relative, descriptive modifiers that place objects, structures, events, and states.

Examples: Absolute examples are geographic coordinates, UTM coordinates, a date, a time, a date-time group, dimensions, altitudes, directions, and distances. Relative examples include those modified by words such as about, approximately, and until and projections in place, that is, the enemy artillery can range a particular friendly position.



Semantic

The semantic is defined as the relationship of a sign to meaning derived in a domain.

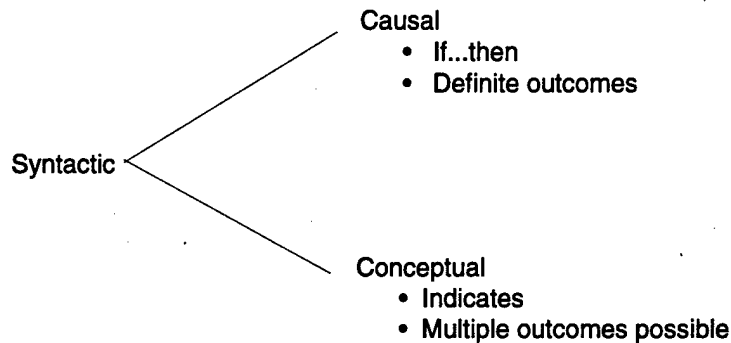
Relationships:

Causal: Explicit meaning derives from a sign; an if-then relationship, marked by cause and effect exists. These are relatively rare in the intelligence domain.

Examples: Rain and snow cause slippery roads; marshlands cause degraded trafficability; artillery fire causes damage (even if it is only a hole in the ground). A given resupply rate causes restoration of combat effectiveness. A given rate of march will bring the enemy to a given point at a calculated time.

Conceptual: Several alternate meanings derive from a sign; meaning is indicated but not definite, and multiple outcomes may exist.

Examples: Three platoons usually indicate the presence of a company, three companies indicate a battalion, and so on through the standard echelons; the reverse down through the various standard echelons is true as well. In either direction, however, these indications are not absolute; the three platoons could be from separate companies and you are faced by a battalion and not a company. Tanks indicate armor formations; bridging equipment indicates engineer activity and the likelihood of river-crossing operations; stockpiling of supplies can indicate either attack or defense. Movement of combat formations forward can mean (indicate) either offense or defense as well.



Pragmatic

The pragmatic is defined as the relationship of the sign's meaning to the consequences of that meaning interpreted in a domain.

Relationships:

Conditional: Represent the interpreted understanding of when and where the consequences will occur.

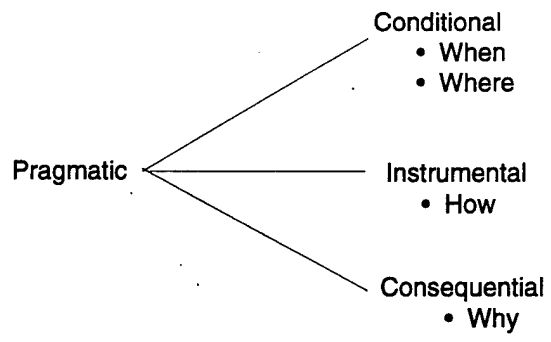
Examples: Location of a forthcoming enemy attack, projection of a time frame for an enemy change from defense to offense, and estimation of the enemy's needed period for refitting.

Instrumental: Represent the interpreted understanding of how the consequences will occur.

Examples: Identification of missions by unit function and equipment, identification of the main effort, selection of approach routes to an objective, and prediction of the use of specific types of chemicals.

Consequential: Represent interpreted understanding of what consequences occur and why.

Examples: Predictions of enemy action to take specific objectives and their reaction to actions by friendly forces.



APPENDIX B
TRANSFORMATION DEFINITIONS

TRANSFORMATION DEFINITIONS

Syntactic \Leftrightarrow Syntactic

Aggregate refers to coalescing lower level syntactic elements into higher level elements, such as structure. Parse refers to analyzing higher level structures into their component parts.

Syntactic \Leftrightarrow Semantic

Interpret refers to coalescing syntactic elements into meaning or possible meaning. Meaning is generally domain defined. Decompose refers to breaking down the elements underlying a domain-defined meaning.

Syntactic \Leftrightarrow Pragmatic

Projecting refers to coalescing syntactic elements to compute estimations relevant to a specific objective. Interpolation refers to analyzing an estimation to determine the elements that lead to the estimation.

Semantic \Leftrightarrow Semantic

Infer refers to coalescing semantic information into information having different or richer meaning, possibly moving from one conceptualization to another. Elaboration refers to analyzing the relationships that may have led to a particular conclusion or conceptualization.

Semantic \Leftrightarrow Pragmatic

Synthesize refers to coalescing semantic information to impose the context of the operational environment. That is, one is forming a story that can be used to generate hypotheses about the current operational situation. Justify refers to analyzing contextually situated information or hypotheses to provide empirical support.

Pragmatic \Leftrightarrow Pragmatic

Envisage refers to coalescing contextually situated information and hypotheses to develop predictive scenarios regarding the operational situation. Rationalize refers to analyzing predicted scenarios for potential consequences.

APPENDIX C

SCENARIOS

SCENARIOS

Note. These scenarios are presented just as they were given to the subjects.

North Korean Scenario

In the 15 months after the death of Kim IL Sung, the economic conditions in North Korea (NK) continued to deteriorate; the regime maintained its commitment to the development of military capability rather than the satisfaction of the needs of its citizens. The NK government displayed an increasingly bellicose attitude in public pronouncements which caused nuclear nonproliferation talks with the UN and the US to sputter and eventually fail. During this period, it was conclusively shown that NK's extended range IRBM was being actively marketed and had been sold to Iran, Iraq, and Syria. Despite protestations to the contrary, NK scientists and military developers continued to work on the development of nuclear weapons; in the estimation of the US intelligence community, several weapons had been built but none had been weaponized for use on a missile.

As a result of this behavior, NK was censured by the UN and further excluded from international trade by most nations. As had frequently been the case during that last several years, NK complained long and loud about the joint US/Republic of Korea (ROK) exercises which were held earlier this year. The difference this year was that NK declared a general mobilization and instituted policies designed to place the country on a "war footing." Though NK has always maintained considerable military strength forward deployed, in June a buildup of offensive forces at or near the DMZ began. Attendant to this buildup, other forces from the northern provinces were moved into positions vacated by units which deployed to the forward area. Defensive buildups around the capital, Pyong Yang, and the main industrial cities were also noted. During the ensuing two months, the following significant activities occurred: the NK Navy increased coastal patrols; ground and air forces were noted in training for what appeared to be combined arms offensive operations; infiltration into South Korea, both along the DMZ and in susceptible coastal areas, were at record highs; and terrorist bombing, assassination, and sabotage incidents in the South increased proportionately.

South Korea responded in turn with its own general mobilization, bolstered its forces on the DMZ, and requested the US provide additional material assistance and immediate ground and air combat forces. After considerable public and legislative debate, the US agreed to the ROK request and initiated the actions necessary to dispatch ground, air and naval forces to the Korean Peninsula. Within hours, air combat squadrons were dispatched, a carrier task force was steaming for Korea, and a US Army heavy corps had begun preparation for movement to ports of embarkation.

By the second day, sufficient air power had arrived in country to double the possible sortie rate and within 72 hours the Army Corps had loaded its equipment aboard ships and was awaiting aerial transport of soldiers to Korea.

Before US ground forces arrived in country, NK launched a full scale attack along the entire breadth of the DMZ with all of its forward deployed forces. Although ROK and US Air Forces immediately established air superiority, NK ground forces enjoyed significant initial success despite suffering heavy casualties. Even without the use of NBC, NK forces achieved several penetrations of forward ROK positions, particularly from the west coast to the central spine of the peninsula. These penetrations were exploited by the North, forcing the ROK forces to fight a delaying action while withdrawing to defensive positions along a line from Pusan to just north of Seoul, and extending southeast to the east coast.

In the course of this fighting, Seoul suffered severe damage from both artillery and direct fire fights. The city did not fall, a considerable morale boost for the soldiers of the South, but NK forces achieved penetrations both east and west of the city. The ROK Army was hampered in its defensive efforts by the necessity to protect the civilian populace and to evacuate them to safe havens.

After only five days of fighting, losses to both sides were so heavy that a pause in the fighting was mandatory. Each force withdrew from contact and established hasty defensive positions across the entire width of the peninsula. Since that action, the ROK forces have continued to develop their defensive positions but the northern forces have not. Currently, operations are limited to the intensive patrolling by both forces in the 25 kilometer gap which separates them; NK special paramilitary forces have been reported in the gap.

The extended period of this pause allowed the arrival of the ships carrying the equipment belonging to VIII US Corps. Corps soldiers, who had previously arrived by air, were married up with their equipment, and the Corps was moved into assembly areas, preparatory to movement to the front. The Corps HQ, Corps troops, two Divisions, 14th ARM and 23d Mech, and an attached Infantry Brigade from the 17th Mountain Division, have closed. CINCUNC made the decision to insert VIII Corps in the approximate center of the defensive line because of the weight of its combat power and the necessity to replace I Corps ROK/US Group, which has borne the brunt of the NK attack and is near combat ineffective.

During this pause, the NK forces have also resupplied and refitted and significant numbers of individual replacements have been brought forward despite friendly aerial efforts to prevent transport from moving in the NK rear. The arrival of a second NK mechanized corps in the sector immediately opposite I Corps has been reported.

VIII Corps is currently in AA Maine (vicinity WV7883), awaiting orders to conduct a relief in place of I Corps within the next 24 hours. The known tactical situation is summarized on the attached map.

You are the Corps G2.

Cuban Scenario

In early 1997, Fidel Castro died of natural causes. Without the force of his personality, the Communist regime quickly lost the support of the Cuban people. Within four months, a spontaneous but peaceful revolution occurred; the people, led by populists, demanded that the Communists step down and that a democratic government be constituted. A caretaker government was installed and general elections under a UN mandate were scheduled. The Cuban constitution was modified along US constitutional lines and, within months, a functioning democracy was in operation. Much of the expatriate Cuban population in the US returned to their native land and some were elected to the legislature. The Executive Branch of the government, however, was exclusively native.

The Communist Party, although maintaining a low profile, remained politically active, involved in the trade unions, and even retained governmental control in a few isolated, rural areas. Several radically hard-line, splinter groups have broken off from the mainstream party due to ideological differences and their willingness to engage in violence to achieve their goals. These groups share a common theme—the restoration of a Marxist dictatorship by any means available. Although clearly a minority view, this desire continues to enjoy some support in the general populace; these sympathizers are isolated in geographically separated pockets.

The Cuban Armed Forces have undergone significant reductions as all services have been cut back to minimal budgets and most units reduced to cadre status. The new government's rationale for this action has been that the country needs to concentrate all available resources in the civilian economy. These actions have caused considerable consternation among both current and former military officials and left relatively large numbers of the former military without employment. Many hard-line military types, particularly senior officers, took serious exception to both democratization and downsizing and resigned as a public protest.

Despite these significant political gains, the Cuban economy continued to decline and appeared on the verge of catastrophic failure. Although UN pronouncements strongly supported the fledgling democracy, concrete support in the form of financial assistance was not forthcoming. The newly constituted government, although somewhat reluctant to involve the US intimately in Cuban affairs, made a formal request for massive US economic aid and the advice and assistance which attends such a program.

Over the last six months, there have been an increasing number of incidents in which public meetings were disrupted, interest groups attempted to undermine new governmental policies, and anti-democratic literature was distributed. Additionally, there were several incidents of sabotage of public utilities or manufacturing and indiscriminate bomb explosions scattered across the island. Although unproven, these incidents are all thought to be an orchestrated Communist attempt to destabilize the democratic government; the mainstream Party vehemently denies this allegation.

Last month, after long debate, the US Congress passed, and the President signed, the Assistance for Cuba Act which authorized and funded the largest aid program aimed at a single country in US history. Preparatory to implementing specific fiscal provisions, the Act required

joint Administration/Congressional assessment of the actual situation on the ground in Cuba. To fulfill this requirement, a large (43) US delegation including two Cabinet members, a Senator, four Representatives, and various staffers from these and other Federal agencies departed the US for a month long visit to Cuba. The principal result of this trip was to be a report upon which the detailed plan for expenditure of some \$75 billion in aid monies would be constructed. Midway in the trip, assistance of US business was requested and two Fortune 500 CEOs (with several aides) subsequently joined the delegation. Hosting the U.S. delegation and traveling with it were two Ministerial level, Cuban officials and 15 of their staff. Both US and Cuban groups include several security officers. The tour of the island included retail, agricultural, and manufacturing interests. In the last week of the trip, a number of staffers split off from the delegation to collect specific information at several locations or to begin work on the report.

At the beginning of this week, the entire delegation, U.S. and Cuban alike, were kidnapped by a group, thought to be terrorists, numbering about 15. This event occurred in a small city about 70 miles from Havana. The attacking force accomplished their crime between 0200 and 0400 by taking over the entire hotel in which the delegation was quartered. The Cuban government, immediately upon learning of the incident, subordinated a lightly armed infantry battalion of 300 soldiers from a nearby military garrison to the local police and instructed this force to secure the area and await a communication from the hostage takers. No apparent attempt to leave the hotel was made and the terrorists made no demands in the ensuing 24 hours; in fact, they refused all attempted communication. As might be expected, word of this event leaked to the press and was immediately sent out all over the world; the international media descended on Cuba but most were kept away from the city. By the second day of the standoff, large crowds had gathered in the general vicinity of the hotel and the police were having trouble controlling both the crowds and associated vehicular traffic. In the early morning hours of the third day, the police and soldiers surrounding the hotel were overwhelmed by what is reported to be a well-armed paramilitary force of indeterminate, but considerable, size. It was subsequently learned that the City Hall, main Police Station, and key power and telecommunication facilities were taken over at approximately the same time. The situation in the city is extremely confused but it is clear that heavy casualties were suffered by government forces and that the civilian population did not escape unharmed.

Before noon of the third day, an ex-Army General announced by radio that these events had been engineered by a Communist splinter group which was known to be anti-democratic. He also announced that the hostages would not be released until the current government had been dissolved and Communist control of Cuba restored. He went on to list a number of less important demands and ended by saying that if his timetable was not met, the hostages would be executed, one at a time. To date, that timetable has not been announced. The Cuban authorities do not know the whereabouts of the General, but do know the radio signal originated at a radio station in the city. All attempts to initiate direct contact with the General have failed. The General is known to be a hard-line Communist; while his grip on reality may be at question, the personal loyalty of his troops is not. Although reports are contradictory, Cuban officials believe he has about two battalions at his disposal. The Cuban Army is currently attempting to seal off the entire city so that he cannot be reinforced.

Consultations between the US and Cuban governments concluded that the situation must be resolved as soon as possible. The remaining Cuban Army, while loyal to the government, is neither trained nor equipped to handle this mission so the Cuban President requested that the US execute a hostage rescue mission.

The US President, after consulting Congressional leaders, agreed to undertake a rescue. The mission was assigned to USSOCOM. The 6th Ranger Regiment with Delta Force attached was given the mission and transported to Havana with all equipment within 12 hours.

You are the Ranger Regiment S2.

APPENDIX D
STUDY 1 SEMIOTIC MEASURES

STUDY 1 SEMIOTIC MEASURES

Phenomena: Information
Unit of analysis: InfoWad
Construct: Semiotics
Dimensions: Syntactic, Semantic, Pragmatic
Measure: Quality
Indicator 1: **COMPLETENESS** - A measure of the detail provided in the relationship, so that it is sufficient to transform, understand, or apply the information. Detail is always a modifier describing attributes of the sign.

Scale: Ordinal

Units: Syntactic:
4 = There is sufficient detail to transform the information
3 = There is sufficient detail to “ask the right questions” (to get more of the right detail) but not to transform the information
2 = There is so much detail that it interferes with the ability to transform the information
1 = There is insufficient detail to transform the information.
Criterion: Sufficient¹ to transform the information.

Units: Semantic:
4 = There is sufficient detail to understand the meaning of the sign
3 = There is sufficient detail to “ask the right questions” (to get more of the right detail) but not to understand the meaning of the sign
2 = There is so much detail that it interferes with the ability to understand the meaning of the sign
1 = There is insufficient detail to understand the meaning of the sign
Criterion: Sufficiency¹ for understanding the meaning of the sign

Units: Pragmatic:
4 = There is sufficient detail to derive consequence from meaning
3 = There is sufficient detail to “ask the right questions” (to get more of the right detail) but not to derive consequence from meaning
2 = There is so much detail that it interferes with the ability to derive consequence from meaning

¹ Sufficient to allow the identification of appropriate alternate “meanings,” given the scenario and node. That is, a sign may have many meanings; the completeness and specificity of the sign enable you to understand what the possible, relevant meanings are for you; the degree of completeness and specificity will determine if you can then “select” the “correct” meaning of the sign.

Criterion: 1 = There is insufficient detail to derive consequence from meaning
Sufficiency for applying consequence to meaning

Indicator 2: **SPECIFICITY** - The degree to which the sign is sufficient to transform, understand, or apply the information. Specificity refers to the level of resolution of the sign. That is, it is contained within the sign; it is not a modifier. For example, T72 is more specific than tank, which is more specific than armored vehicle.

Scale: Ordinal

Units: Syntactic:
3 = Level of resolution is sufficient to transform the information
2 = Level of resolution is sufficient to ask the right questions but not transform the information
1 = Level of resolution is insufficient to transform the information
Criterion: Sufficiency for transformation

Units: Semantic:
3 = Level of resolution is sufficient to understand the meaning of the sign
2 = Level of resolution is sufficient to ask the right questions but not understand the meaning of the sign
1 = Level of resolution is insufficient to understand the meaning of the sign
Criterion: Sufficiency for understanding

Units: Pragmatic:
3 = Level of resolution is sufficient to derive consequence from meaning
2 = Level of resolution is sufficient to ask the right questions but not derive consequence from meaning
1 = Level of resolution is insufficient to derive consequence from meaning
Criterion: Sufficiency for application

Indicator 3: **RELEVANCE** - Is the relationship supported by the domain, given the context (scenario) and purpose (node)? That is, is the meaning provided correct for that node in that scenario?

Scale: Binary
Units: Yes and No

Phenomena: Information
Unit of analysis: InfoWad
Construct: Semiotics

Dimensions: Syntactic, Semantic, Pragmatic
Measure: Quantity
Indicator: **DENSITY** - The percentage of each type of semiotic relationship over the relevant semiotic relationships, for a given scenario and node.

Scale: Continuous

Units: Syntactic:
a: The number of syntactic relationships divided by the number of semiotic relationships

Units: Semantic:
a: The number of semantic relationships divided by the number of semiotic relationships

Units: Pragmatic:
a: The number of pragmatic relationships divided by the number of semiotic relationships

APPENDIX E
LEVELS OF RESOLUTION DEFINITIONS

LEVELS OF RESOLUTION DEFINITIONS

1. Location: Where

- a. Area - a generalized extent of space or surface
- b. Referenced Area - an extent of space or surface that is connected to either a geographic feature or a military unit.
- c. Position - an extent of space or surface that is specified in terms of geographic or mapping coordinates

2. Intentions: What

- a. Geopolitical - political military actions that might have world impact
- b. Strategic - military actions that might have theater to national impact.
- c. Operational - military actions that might have campaign-wide impact
- d. Tactical - military actions that might have operation or battle impact
- e. Cited Force - the above related to a unit or force
- f. Cited Geographic - the above related to location

3. Rationale: Why

- a. General - reasoned connection between cause and effect; indirect relationship
- b. Casual - if-then connection between cause and effect; direct relationship

4. Capability: How

- a. General - execution of a generic action
- b. Strategic - execution of an action at or above theater
- c. Operational - execution of an action at campaign level
- d. Tactical - execution of an action at operations or battle level
- e. Unit - action attributed to type units
- f. System - action attributed to type hardware
- g. Specified Unit - action attributed to a specific unit.
- h. Specified System - action attributed to specific hardware

5. Entity: Who

- a. Intrinsic Major Component - the overall entity
- b. Force Component - a major segment of an entity
- c. Specific Force Unit - an identified lesser segment of an entity
- d. Specific Unit - a numbered unit

6. Time: When

- a. Future-History - more than 48 hours in either direction
- b. Current - more than 12 but fewer than 48 hours in either direction
- c. Immediate - fewer than 12 hours in either direction

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