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USING AN ANALYTIC PSYCHOLOGICAL METHOD TO AID DIALOGUE UNDERSTANDING

by

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Abstract

This thesis describes a way in which psychological knowledge of a dialogue can be used to aid in the understanding of a conversation. Based on some of the parsing ideas of Colby's PARRY system and employing a case system for verbs, the program also uses the psychological analysis method called Transactional Analysis. Transactional Analysts argue that the structure of language forms used in conversations is strongly related to underlying psychological motivations and character traits. In fact, sometimes the exact words used can indicate a particular psychological trait which can, in turn, be used to characterize further utterances in a dialogue.

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CHAPTER 1

Introduction

A current problem in computational linguistics research is the necessity to use different strategies to analyse different types of discourse. Narration is different than informative text and in turn, written discourse differs from spoken dialogue. These differences lie not in syntax or sentence semantics alone but in the harder problems of general discourse semantics or intra-sentential semantics, pragmatics, and conversational strategies.

The motivation for this work is the desire to develop conversational computer systems that can communicate successfully with a user in a natural language. Early, largely unsuccessful, natural language systems were based mostly on syntax but later systems had more success when sentential semantics were added. Current research acknowledges the need for additional information to aid in understanding a single sentence or sequence of sentences and this has resulted in in the addition of knowledge based on research in such areas as linguistics, cognitive science, psychology, and philosophy of language. Levels of understanding ranging from the primitive morphemes to the complex knowledge associated with the human need for interaction as well as real-world knowledge must be included in the list of what is needed to understand dialogue.

Although machine-person conversation is the ultimate goal of natural language research, a prior requirement is to understand the nature of person to person dialogue.

One of the things that makes dialogue such a difficult field of study is that the roles of the speaker/hearer and the rules they use to speak are not very well understood. Grice's (Grice 1967) rules for conversation reveal only a small part of what goes on in a conversation. The problem of understanding dialogue has been approached from many areas and for different reasons. As one example, psychologists try to analyze dialogue in a therapeutic setting where the literal meaning is not as important as the underlying psychological meaning of what is said. The method called Transactional Analysis (T.A.) is one such approach used in therapy.

In Transactional Analysis, the actual words, or types of words, used can be psychologically important. This information can help predict further utterances and thus may be important as an aid to "parsing" subsequent dialogue. Understanding a sentence at a psychological level helps in determining its extended meaning and so adds to the known facts of the dialogue as a whole. Certain psychological interactions develop in predictable ways, which suggests that the psychological meaning of the next sentence to be parsed can be predicted. Since the literal meaning and psychological meanings are related, some aspects of the linguistic content of the sentence can also be anticipated.

Most current computer dialogue understanding systems only

analyze the words of one speaker. The typical second speaker is the computer and its "psychology" and responses are known since they are part of its programs. The psychological interplay between two people in a conversation has not been extensively studied from a computational point of view. This thesis explores the idea of adding psychological dialogue analysis to linguistic analysis to determine the psychological intent of the speakers and hence to predict the direction of a conversation.

The particular psychological analysis method used in this thesis is Transactional Analysis because of the number of dialogue forms which have been identified and the depth of the associated analysis. The ideal system would be designed so that any type of psychological analysis could be easily integrated without changing much of the linguistic analysis but in reality, much can depend on the psychological approach used.

The first part of this thesis contains a more detailed introduction to, and background information of, the fields of discourse understanding and the psychological study of conversation. Chapter Three gives more detail of three important areas of the research, namely Transactional Analysis, verb case, and the PARRY system; the implementation details are described in Chapter Four. The fifth chapter gives the results and examples and is followed by a summary in Chapter Six.

CHAPTER 2

Linguistic and Psychological Background

It is important when studying a specific dialogue model, to explore the underlying theories on which it is based. This model is based on research from two different fields, those of computational linguistics and therapeutic psychology.

2.1 The Computational Linguistic Approach

2.1.1 Syntax and Semantics

The early efforts in natural language understanding began with what has been called by some, a linear approach. Within this approach the sentence was first parsed and then the resulting structure was interpreted to produce a semantic form. One such early scheme based on research in transformational grammar, used a system of what were called "semantic markers". These semantic markers, stored as dictionary entries, defined and limited the way in which a word could be combined with other words. For example, the word "yellow" can be combined with a PHYSICALOBJECT, a HUMAN, or a FRUIT. In the phrase, "yellow X", the X would be checked to see in which category it belonged and would thus define the sense of "yellow". A problem arises with this method when more than one category is acceptable; for

example, a noun may fall into two or more acceptable categories for an adjective. This problem may be solved by saving all of the possible interpretations but the number of possibilities can become large and unwieldy.

A later semantic approach, called procedural semantics, was developed by Woods (Woods 1968) and Winograd (Winograd 1971). Woods' airline-guide question-answering system works on an input sentence, assumed to have been parsed; its structural description is a syntactic tree. This syntactic tree is then mapped to a semantic form by breaking the tree down into subtrees, such as head noun and verb, and matching against the template part of rules associated with the subtree elements. The semantic programs then build a query using procedures that represent the conceptual primitives in the airline guide database. These primitives are any of the predicates, commands, or functions that would be used in the database query. An example of a primitive predicate is "CONNECT(FLIGHTNUMBER,CITY1,CITY2)". The verb CONNECT is represented by a procedure that scans the database to determine if flight FLIGHTNUMBER flies from CITY1 to CITY2, in which case CONNECT returns true; otherwise it returns false. Woods' approach to the semantics of question answering was also used later in the LUNAR system.

One of the most widely known natural language processors is Winograd's SHRDLU based on the blocks world domain. SHRDLU begins analyzing the user's sentence syntactically until a meaningful unit has been parsed. Semantic routines are then

called to analyze the unit and if there are no objections to the unit on semantic grounds (inferencing may also be necessary), the syntactic parse will continue; otherwise the syntactic parser is informed that there is a problem and that a different parse should be tried. The semantic procedures that are called are specific to the type of phrase parsed; for example, there are two semantic procedures called during the parse of a noun phrase. The definitions of the words in the dictionary are also in the form of procedures and contain a type of semantic marker list. During the processing, the units are translated into MICROPLANNER, a language that stores knowledge in the form of assertions and theorems in a database. An advantage of procedurally encoded knowledge is that it is very flexible. However, this flexibility can cause problems because the procedures are difficult to modify while attempting to maintain overall consistency. Another valid criticism of the system is that SHRDLU is too dependent on the blocks world domain. Nevertheless, SHRDLU was one of the first systems to simultaneously handle the problems of parsing, semantics, references to previous discourse, knowledge representation, and problem solving.

Other examples of semantic theories in linguistics are semantic networks (Simmons 1973), Fillmore's case system (Fillmore 1968, 1969), and Schank's conceptual dependancy networks (Schank 1973). In simple terms, a semantic network is a labelled directed graph with the nodes representing concepts and the arcs representing relations between the concepts.

Primitive concepts are the word sense meanings and the primitive semantic relations are those that the verb of a sentence has with its subject and object(s). The sentence is first reduced to predicate form and then turned into a semantic network using one of the many variations of notation. An argument in favour of semantic networks is that they are easy to understand in their pictorial representation but this is not particularly helpful for programming purposes. Some problems associated with semantic nets are that the semantics are poorly defined and that there are problems defining the nodes and properties.

The next example of a semantic theory to be discussed is that of case. Briefly, Fillmore described the idea of deep case in which a simple sentence consists of a verb with properties such as tense, negation, mood and aspect, and a set of noun phrases labelled with case names. Some examples of deep case are AGENTIVE, INSTRUMENTAL, LOCATIVE and OBJECTIVE with the verbs then classified by the set of cases they require. The idea of case will be discussed in more detail in Chapter Three.

The main idea behind Schank's conceptual dependency theory is that there exists a conceptual base into which natural language utterances are mapped during understanding. To obtain a proper meaning representation, Schank introduced a set of primitive concepts and underlying canonical forms. The representation of a sentence in terms of the primitive concepts is called a conceptualization. Each of the verbs is represented by one of a small set of primitive ACTs. The number of ACTs has varied over the years but are either physical ACTs, global ACTs,

instrumental ACTs, or mental ACTs. Conceptual dependency theory deals only with individual sentences so to handle larger text, the idea of scripts was developed.

2.1.2 Pragmatics

Scripts are structures that describe the appropriate sequence of events in a particular context. For example, at a restaurant a person sits down, orders a meal, eats the meal, pays the bill, and leaves. This is obviously only a bare-bones sketch of what actually may happen in a typical restaurant. Other participants in the script include the hostess, waiter, cook, and cashier. The script represents events and participants with slots and rules about what may fill the slots. A script is a predetermined sequence of actions defining a well known situation, so totally new situations cannot be handled. However, a script does represent the expectations we seem to hold about events in a given familiar situation and therefore does help in understanding restaurant situations.

Research in understanding a sentence is quite advanced now but there are few situations in computer applictions where understanding a single sentence is interesting or important. Most sentences occur in the context of a discourse such as a story, journal article, or a dialogue. The meaning of a sentence can, and usually does, depend on those surrounding it. Some of the current natural language research is in this area.

Considerable work has been done by cognitive scientists, anthropologists and linguists on the comprehension of stories,

especially folk tales. Most folk tales have a type of pattern that has evolved to make their telling easier. Other types of stories follow certain conventions for ease of telling and readability. One model that describes this form of multisentential knowledge is called the "story schema" (Rumelhart 1975) and uses a story grammar to describe it. Studies involving recall of events in stories (Rumelhart 1975, Thorndyke 1977) have supported this theory for simple stories. Another type of theoretical construct for organizing the many sentences in a story are Minsky's frames (Minsky 1975) or Schank and Abelson's scripts. An extension of Schank's scripts has led to BORIS (Lehnert et al 1981), a program to understand and answer questions about stories. Instead of searching the sentences for answers, BORIS tries to understand the story to as great a depth as possible in order to answer fairly complex questions.

Stories have been studied because they are well structured, especially compared to the seemingly free-form oral dialogue. In terms of application on the computer, however, conversation is much more interesting, as well as more practical.

2.1.3 Conversation as a Specific Type of Discourse

Conversation has been analysed from many different points of view. Theories of parsing dialogues depend on what the analysis is for. The simplest type of discourse analysis is an extension of the type of analysis used in sentential parsing. A theory developed as an extension of the

transformational-generative ideas of sentence based linguistics (Hurtig 1977) has problems since there are many other types of knowledge in discourse that are not stated explicitly in the individual sentences.

First of all, any conversation seems to follow a set of rules. These rules or conventions are a set of conditions that are met by a string of utterances such that the utterances put together, according to the rules, are called a conversation. The most basic rule is the idea of turn taking, which creates an orderly conversation. There are several rules that must be followed for turn taking to work. Firstly, every participant should have a chance to talk. Also, only one person should talk at a time so that she/he can be heard and the gaps between turns should be brief for effiency. In most conversations, the order of speakers, and the amount they say, should not be fixed ahead of time. There also must be techniques for deciding who should speak and when. In a two person conversation, the turns just alternate from one speaker to the other. When more people are involved, the turn taking becomes more complicated. A person spoken to directly or asked a question usually speaks next. After that, the first person to speak gets the next turn. If the current speaker resumes speaking before anyone else speaks, then she/he gets the next turn. These basic rules seem to order the turn taking in a conversation.

Turn taking is one of the first rules that children learn when they begin to talk. Studies of children's dialogues (Nelson and Gruendel 1979) and parent-child discourse (Sachs

1979) have shown some of the elements of a successful conversation. Children learn the idea of turn taking early on but this does not mean that a dialogue is taking place. Children can exhibit the idea of turn taking in monologues when they are talking to themselves. Other aspects of dialogue are important and have been studied both in child and adult conversation.

The breakdown of children's conversation can indicate that something necessary is missing from the discourse. There is a need of a common ground for understanding or a dialogue will be abandoned. In any successful conversation, the speaker must take into consideration estimates of the listener's capacities, interests, goals, attentiveness, real world knowledge and linguistic knowledge. The dialogue also depends on shared assumptions and a shared topic. Less sophisticated speakers, such as children, may not recognize the signals of a lack of shared knowledge so conversations will be abandoned more frequently than the conversations of adults. To compensate for the child's lack of sophistication, adults will use simpler language when talking to children. In fact, for most conversations where the participants are not on equal levels, the more knowledgable speaker will tailor the conversation to the listener's level so that she/he can also participate. This is one of many rules that are followed in dialogues.

The interaction at a social level between people is important in the study of conversation. Sociolinguists (Goffman 1974) have studied the sociological rules of interaction in

conversation and have shown that they depend on the culture or belief system of the speaker. The speaker's beliefs, beliefs about the listener, and their social relationship help determine the choice of expression. For example, the phrase "Can you come here?" means something different when spoken by a mother to her child who is learning to walk than by an employer to an employee. The social relationships of the conversants is also important in determining a response. The previous question would probably have different answers for the two situations. The way in which a thought is phrased or the actual words used may also vary from one social situation to another.

Another aspect of understanding dialogue is the different levels of meaning that exist in a sentence. For a question, the true meaning, not the literal meaning, should be answered. The question "Can you pass the salt?" is not asking about the listeners physical ability to move a salt shaker. Such utterances may have multiple meanings or effects.

There are also different levels of meaning in a conversation (Schank and Lehnert 1979). The most obvious is the surface question or answer level. For the above question this corresponds to answering 'yes' or 'no' about passing the salt. Some other levels of meaning are related to psychological issues. There is an emotional meaning as well as one that depends on the relationship between the speakers. An example of "hidden" communication between emotionally related people is the dialogue between husband and wife. The power-oriented or dominance games level meaning could also be present in this

example. There are also levels of truth and trust in the conversation. Either the listener believes or does not believe what the other person is saying and this belief can be implied by the responses to what is said. Many levels of conceptual information can be given in one sentence. A misunderstanding at any one of these levels can cause a breakdown of the conversation. For example, sometimes there are many different responses that all make sense but the speaker may not have considered all of them.

These meanings and social relationships lead to a set of rules that should be followed in conversation. These rules can be listed as conversational postulates (Carbonell 1978) that try to describe a dialogue in general terms or as rules and a sort of social script (Nelson and Gruendel 1979) used to guide the dialogue. A more formal description (Cohen and Levesque 1980) of a plan based theory of speech acts has also been used.

On a more practical level, there are structural aspects of conversation that have to be studied. How does one find the unit of analysis in a dialogue? People do not speak only one sentence at a time so single sentences are not necessarily a unit. It may be a word, phrase, clause, or a sentence that can be considered a conversational move. One must also take into consideration the type of discourse because unplanned or spontaneous discourse has a different linguistic "syntax" than that of planned discourse (Ochs 1979). The unplanned discourse is closer in form to that learned as a child. For our purposes, typing on a computer terminal is probably closer to planned

discourse.

The conversational goals or subgoals are guided by some sort of schema or plan. In turn, there are various conversational strategies to achieve these goals. The discourse can then be broken into several "movements". For example, two types of conversational moves are substantive and "housekeeping" moves. Housekeeping moves are those involved in beginning, ending or topic shifting in dialogues.

One study (Reichman 1978) has broken conversations into groups of utterances about related events or issues which are called "context spaces". She studied the relationships between these context spaces. The first thing to notice is that the participants alternate between two roles in a conversation, the speaker and the listener. Each role has certain obligations and expectations. The conversants each build a discourse structure upon the context spaces and conversational coherency is maintained as long as there is no conflict between the two roles.

The theories mentioned up to now have been mostly just ideas or studies of conversation. The following are some computer implementation descriptions and the theory behind them.

2.1.4 Dialogue System Implementations

There have been several computer implementations that interact with the user in a dialogue situation. Most of these systems have been of the type that can be called one-sided dialogues, the other "speaker" being the computer. There is,

however, useful information to be obtained from the dialogue analyses. The systems are generally of the database question-answering or user helping type and are discussed in the following pages.

Dialogue Games

In 1976, James Levin, James Moore and William Mann of the Information Sciences Institute at the University of Southern California began working on a system involving one person helping another, specifically interactions of users of the TENEX computer system and the system's operators. The basis of the model was goal-oriented multi-sentential knowledge units called Dialogue Games (Levin and Moore 1977). These units contain rules for the kind of language interaction people engage in, not the actual content of these interactions. The dialogues studied were all two party conversations over terminals. This eliminated the need to consider other aspects of conversation such as tone, stress patterns and other factors of interaction such as physical cues.

They concentrated on regularities or rules for the function of the dialogue for the participants as opposed to its topic. Studies of two person naturally occurring dialogues were broken into six types of interaction.

1. Helping: Person 1 wants to solve a problem, and interacts with Person 2 in an attempt to arrive at a solution.

2. Action-seeking: Person 1 wants some action performed and interacts with Person 2 to get her/him to perform it.

3. Information-seeking: Person 1 wants to know some specific information, and interacts with Person 2 in order to learn it.

4. Information-probing: Person 1 wants to know whether Person 2 knows some particular information, and interacts with her/him to find out.

5. Instructiong: Person 1 wants Person 2 to know some information, and interacts with him/her to impart the information.

6. Griping: Person 1 is unhappy about some state of affairs, and interacts with Person 2 to convey that unhappiness.

An example of the type of conversation that takes place is:

L: Do you know that the system clock is an hour fast?

O: Thanks. I didn't reset it.

This is phrased as a question but is in fact imparting information to the operator, a type 4 interaction.

The Dialogue-Game (DG) structure consists of three main parts. The first is a set of Parameters that have specific values for each dialogue type. An example of three Parameters used in the HELPing game are the two participants and the task to be done. Next, the DG contains a set of Specifications that apply to the Parameters for the duration of the Dialogue Game. This includes the goals of the participants and their individual knowledge states with respect to each other and the subject of the Dialogue Game. These Specifications act like a set of rules that must be satisfied for the DG to begin and describe the way the participants respond to requests to begin a DG as well as the terminations conditions. The final part of the Dialogue Game is a partially ordered set of Components. These rules represent those aspects of a conversation type that change in a

particular way. For example, the Components can be a list of the participants subgoals, partially ordered in time.

The main contribution of the Dialogue Game model is the use of a formal knowledge structure to represent the goals and directions of a particular type of dialogue. Multiple utterance parsing was done using common knowledge about language and how it is used to achieve the participants goals.

Train Station Dialogues

Mary Horrigan of the University of Toronto wrote a system to analyze simple two person dialogues between a clerk and passengers at a train information booth (Horrigan 1977). Analysis of tape recordings of actual train station dialogues produced the underlying structures for these types of conversations. The utterances were broken down into discourse units called 'acts' such as confirm.heard.ok and state.question and 'moves' such as respond.state.reply and assert. These 'acts' are loosely based on the idea of speech acts. The 'moves' differ from the 'acts' in that they have a structure or rules that are followed. For example, the 'move'

> ask(A,R): A wants to ask R a question; A utters a state.question and listens for a respond.state.q which R may or may not utter. If R does not utter a respond.state.q, then A assumes that R heard the question correctly.

Using a list of about 14 different such moves, the dialogue is parsed using a grammar made up of these moves. The grammar also enables the system to predict the next type of utterance. The

dialogue model then succeeds if each utterance can be accounted for in this manner.

Susie Software

Gretchen Brown's MIT thesis (Brown 1977) described an English language interface for an automatic programming expert system. The user typed in the sort of input/output behaviour desired from a computer program and the expert system produced a program to these specifications. Interaction was in the form of question-answering, description, and explanations. Only one human was involved in the conversation at a time.

The system used OWL language "methods" (Martin 1974) as a model of dialogue. Methods are like frames or scripts in that they are structures describing how to carry on a dialogue. The dialogue activities are explicitly stated and are also based on speech acts. The methods also contain a recovery path to be followed if the exchange goes wrong. The following is an example of a question-answer method.

ask-and-answer:
object: the question to be asked (not a how or why question)
agent: a person or computer system
co-agent: a person or computer system

method:
1. The agent asks the question.
2. The co-agent now knows what the question is.
3. The co-agent finds the answer.
4. The co-agent gives the answer and the agent gives an (optional) acknowledgement.

recovery path 1: if a stipulation is found along with the answer
R1.1. The co-agent states the stipulation.
R1.2. The agent agrees to it.

recovery path 2: if the answer is unknown
R2.1. The co-agent says that s/he does not know the answer.

It is assumed that each step in the method will occur. The three ways to interpret the steps are to carry out the step, recognize that a step has occurred or to assume that a step has happened if it is implicit.

The system has "core dialogue methods" for each different type of speech act. The sentences are also categorized into different types according to their purpose in the conversation and parsed in the following order:

(1) Metadiscussion (talk about the conversation)
(2) standard path successor steps
(normally expected sequence of events)
(3) recovery path lead-ins
(due to lack of information by either person)
(4) initiators (requests for information by either person)
(5) general failure method lead-ins
(from contradictions and misunderstanding)

This system has some useful ideas on the analysis of types of sentences and the speech acts that they represent.

Task Oriented Dialogues

The Stanford Research International project (Grosz 1979, Robinson et al 1980, Robinson 1981) is a system that helps a user to assemble a pump. The computer acts like a student helper by answering questions and giving instructions as the assembly process continues. The most important feature of this system is the use of what are called "focus spaces". They are a method to maintain and record the focus of a dialogue and are important for determining anaphora referents.

The system is quite goal-oriented. In simple terms, the goal of the computer is to help the user and the goal of the user is to build the pump. There is quite a detailed data structure script that describes the actions the user must go through and the order in which they are done. These tasks are ordered in a "focusing hierarchy" so that the level of focus detail is resolved in a referent. The focus spaces depend on knowing what the person is going to talk about, in other words, which level of task is currently being discussed.

The other type of goal in the system is that of dialogue cooperation. The perspective of both the hearer and the speaker must be considered. The parsing is done with two types of goals in mind. These are either the action goals of following the task script or the dialogue goals of cooperation.

The PARRY System

The PARRY system (Parkison, Colby, Faught 1977) at the University of California, Los Angeles is an attempt by psychologists to understand paranoid thought processes by using a computer program that implements Colby's theory of paranoid behaviour. The program takes on the role of a patient and the user is the interviewer. The idea is to simulate a paranoid patient and to use real psychologists as users to test the program. The transcripts of the dialogues should be indistinguishable from those of a real paranoid patient and psychologist. Thus, the program must have enough linguistic ability to carry on a conversation.

One of the main linguistic efforts of the system was the analysis and parsing of patterned or idiomatic phrases in colloquial English dialogue. In fact, the natural language component of PARRY is based on a few thousand general patterns. The program for this thesis roughly follows the PARRY system in the method of language comprehension and will be discussed in detail later. It was found to be a useful design because the psychological aspect was easy to add. The PARRY system, however, is much larger with a dictionary of 3500 words, two idiom tables totalling 600 entries and a table of about 2000 concept patterns. The large number of idiomatic and colloquial phrases in English explains the size of any system attempting to be complete.

FlexP - Flexible Parsing

Hayes and Mouradian at Carnegie-Mellon University have developed a system using what they call flexible parsing, or FlexP, to handle some of the ungrammaticalities found in dialogue (Hayes and Mouradian 1981). Some of the errors found in conversations are leaving out or repeating words, breaking off and restarting, and using sentence fragments. When conversation is typed on a terminal, additional errors occur such as spelling mistakes or incorrect noun and verb phrase agreement. Human listeners seem to be able to determine the meaning of ungrammatical sentences so any computer program that interacts with humans should have some ability to understand slight grammatical deviations.

FlexP is a bottom-up pattern matching parser designed to work for restricted natural language input to a limited domain computer system. To understand any input to the system, the domain must be limited, otherwise ambiguities would arise quite frequently. The pattern matching part detects idioms and helps find ommisions and substitutions in non-idiomatic phrases with interjections, restarts, and sentence fragments recognized using bottom-up parsing. The problems of breaking off and restarting, interjections, and impicit terminations are dealt with by allowing the parsing to be suspended and possibly continued later on. FlexP has flexible matching in that some elements of the patterns in the patten matching are optional. Other flexibilities in matching allow a relaxation of consistency constraints, such as number agreement, and allow some out of order matches.

The FlexP system does seem to take care of a lot of problems encountered in conversation, especially errors made on a terminal. However, one must take care to find the proper balance between limiting the domain too much and parsing correctly every sentence that is typed in.

Summary

In summary, we have learned that there are many things that make conversation a unique type of discourse with special problems to be solved. Most of the problems arise because conversation involves at least two people explicitly while for other types of discourse, the second person, the reader, is only

implicitly involved. With two or more people, the social and psychological interactions must be considered. There are a set of rules or conventions that must be followed for any conversation to continue, for example, turn taking, consideration of the participants beliefs, and other conversational postulates.

The structure of dialogues also present a set of problems in analyzing a conversation. The utterances can be grouped in context spaces, acts or moves, or focus spaces. The order of the sentences is also important and can follow rules such as those in Dialogue Games or Brown's methods. Parsing systems for dialogue such as PARRY and FlexP, have been designed to deal exclusively with dialogues.

Considering all of the factors that make a conversation a unique type of discourse, we find dialogue understanding to be a difficult task. However, since natural language communication with the computer is very important, the effort should be made to analyze dialogue.

2.1.5 Using Logic for Representing Natural Language

One current way of representing natural language is based on predicate logic. The semantic content of a sentence is represented with a logical clause, usually in first order predicate calculus form. Inferencing or extracting other information from the logical form is easier than from other representations. Systems for translating natural language to logic use conventional logic notation. There may be a small set

of functions and relations that can be used for expressing the most common constructions of natural language in logic (Sandewall 1971).

Programming in logic has become easier since the development of the programming language PROLOG (PROgramming in LOGic) which can be described as a backward, depth-first search strategy with automatic failure-driven backtracking. Grammars such as defininte clause grammars (Pereira and Warren 1980), metamorphosis grammars (Dahl 1981), and extraposition grammars (Pereira 1981) have been developed and used for parsing natural language into logic. Data base query systems with English and other language input sentences have now been written using PROLOG. The program for this thesis in fact uses PROLOG.

2.2 The Psychological Approach

For our purposes, the two main areas of psychology that are concerned with natural language are cognitive and analytic psychology. Although this thesis utilizes a theory of analytic psychology, the contributions from cognitive psychology should be considered. We are not considering such possibly relevant areas as psycholinguistics, developmental psychology, or child aquisition of language.

2.2.1 Cognitive Psychology

Cognitive scientists do not seem to have been influenced by the theories produced by their colleagues in analytic

psychology. They are more interested in the way in which language is understood by humans. The goal of cognitive science can be described as the unique identification of mental structures and processes. This means that linguistic theories are proposed and then tested experimentally. One example of this (Clark and Lucy 1975) is the study of the method by which people determine the meaning of a sentence. The theory suggested is that the literal meaning of an utterance is found first, then the listener checks to see of this is plausible in the given context. If there is a conflict, the listener must use certain conversational rules to deduce the interpretation of the sentence. One such conversational rule might be "If S questions A's willingness to do something when in fact A's willingness is not in doubt, then S is requesting A to do that something". This rule would be used in the sample sentence "Do you mind opening the door?". These results show that a computer program for understanding language should first determine literal meanings of sentences.

Other results by Clark and Lucy show that sentences coded in a negative form take longer to comprehend than those coded in a positive form. Perhaps negation is done after the sentence is interpreted in a positive way. Study of idioms showed that they too have literal meanings but are easily distinguishable from non-idioms and so can be treated separately.

Besides language comprehension, cognitive psychologists are concerned with memory structures, both long term and episodic, perception and problem solving, reasoning, question answering,

and child language development.

Another cognitive model is that of John Anderson (Anderson 1976, Anderson and Bower 1973). His ACT system is an extension of his earlier model HAM (Human Associative Memory) and has two components. The first is an associative network of long term memory that contains propositional knowledge of the world. The second part is a production system of network operators. Nodes is the network represent concepts and arcs are the relationships between the concepts. There is a distinction made between episodic and semantic memory. Semantic memory is the permanent storage of knowledge about words and concepts while episodic memory is compared to short term memory which is represented by having a fixed number (ten) of active nodes in a list. This idea of short term memory may be useful in the problem of anaphora resolution. This model is representative of the work done by cognitive scientists and while it is useful for understanding dialogues, it is completely different from the type of work done in analytic psychology.

2.2.2 Analytic Psychology

One of the most important methods analytic psychologists use to examine human behaviour is the analysis of conversation. This may be on a one to one basis or the setting of group therapy. Analysts are more interested in the deep or psychological meaning of sentences rather than in their surface or literal meaning. The deep level meaning of a sentence corresponds more to the speaker's goal in saying something.

This meaning generally goes beyond the words that were uttered.

It is through this deep psychological meaning that patients express their problems. These problems can be those analysed in psychotherapy such as psychoses or neuroses and are revealed in the one to one dialogue between patient and therapist. Social problems revealed in group or one to one conversation are studied in the field of family therapy. Therefore, understanding the way a person is thinking and expressing herself is important. There are many psychological theories about the meaning of utterances.

2.2.3 Some Analytic Psychology Approaches

Most studies of dialogue from the psychological point of view are not very formal. Some therapists (Troemel-Ploetz 1977) study just one or two sentences and the way in which the therapist can change a patients thoughts by a few carefully chosen phrases. A patient can go from being hostile to rational if the right words are used. Extralinguistic information such as past episodes in the patient's life are used to understand the dialogue. However, this type of information is not always known.

Another type of method (Harris 1980) depends a lot on what are called life scripts by Eric Berne (Berne 1961) but the actual words used are not important in the analysis. Life scripts are personal life plans decided upon at an early age. These are the elements of the basic character structure or personality. The life scripts affect the type of thing that is

discussed and the results of the conversation, but little can be said about specifics of the dialogue.

Work has also been done from the social psychological point of view (Labov and Fanshel 1977). This theory is close to linguistics as the types of discourse are divided up according to various conversational rules. From the social side, the status of the participants, their rights and obligations, and their changing relationships in term of social organizations are all important in understanding the meaning of the conversation.

Very few psychological methods of studying dialogue depend on the actual words used or the semantics of the sentences. However, Transactional Analysis is one such method.

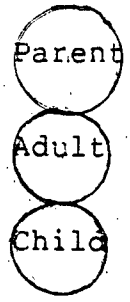
2.2.4 Transactional Analysis

Transactional Analysis (T.A.) followers consider it to be both a philosophy (theory) and a technique. The philosophical part says that everyone is "OK" and is constantly searching for what are called "positive strokes". "OK" in this context means that the basic human core is "good" even though moments of "rottenness" may show through. The reason for the rottenness is a result of the constant desire for the so-called positive strokes. These "strokes" or transactions may be verbal and/or physical communication between two or more people. Positive transactions reinforce the belief that the other person is OK. It is the non-positive strokes a person gets that are the cause of problems.

T.A. is built upon the idea of the existence of three ego

states in a person. The first, called the Parent, is an accumulation of attitudes, feelings, behaviours and thoughts received from parent figures when the child was young. These can be as simple as "Don't cross the street when the light is red", to complex ideas such as political or religious beliefs. The second ego state is called the Adult. It is also called the data processor as it is supposed to organize relevant information, weigh the possible outcomes of actions and make logical decisions or statements. Needless to say, this sensible ego state is the most desirous one to be in. The final ego state is the Child and consists of emotions, thoughts and behaviours typical of children or spontaneous adults.

These three ego states may be broken into further components depending on things such as influence. For example, the Parent could be influenced by the mother, father, older siblings, or other adults. The details are not important here. In a "normal, healthy" person, the three ego states are separate and a person is in one of the states at a time. Problems occur when one of the ego states is cut off (never entered or acknowledged) or when an ego state is contaminated by another (overlaps). T.A. literature uses diagrams of three circles to represent the three ego states as in Figure 1.

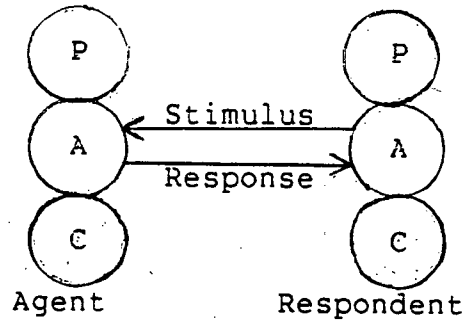


Simplified Form of Structural Diagram

Figure 1

Each circle represents an ego state with the order as given and the juxtaposition of the circles shows the condition of the ego states of the individual. The figure above shows a "normal person". The circles may be separate, overlap or have communication cut off between them depending on the condition of the ego states and the patient's problem.

Communication between two or more people can also be represented with the use of the structural diagrams. The transactions, or single units of social discourse, are represented with one set of circles for each person and vectors from one side of the diagram to the other representing the type of communication going on. Figure 2 shows an Adult to Adult set of transactions.



Complementary Adult-Adult Transactions

Figure 2

The Parent, Adult, and Child ego states are represented by P, A, C respectively. In this example the Adult ego state produced both the stimulus and the response.

Transactions in which the stimulus-response vectors do not cross in the structural diagram are called complementary transactions; that is, the response is both expected and appropriate. Examples of complementary transactions are critical gossip (Parent-Parent), problem solving (Adult-Adult), or playing together (Child-Child or Parent-Child). When crossed transactions, or vectors, occur, the communication will probably break off. For example, the Adult-Adult stimulus "Do you know where I put my glasses?" followed by the Child-Parent response "You always blame me for everything" is a crossed transaction. The first person will then either switch ego states or terminate the conversation.

The important thing about the ego states as far as dialogue is concerned is that a person responds differently to situations depending what ego state he or she is in. Certain verbal or physical clues can help identify the ego states. In some cases

the verbal clues are enough. These are the situations that are interesting for dialogue analysis.

The clues can in fact be stated as rules that are useful in conversational analysis. These rules can be used as an aid in the parsing of a two or more person dialogue but only two speakers are used in the following analysis.

Conversations can follow certain patterns. Several types of interaction were first identified by Eric Berne (Berne 1961, 1964) and classified as withdrawals, rituals, activities, pastimes or games. Withdrawals happen when people are bored and remember or daydream about better times and places. This is fairly harmless unless it happens all the time or someone is talking directly to you.

A ritual is a socially programmed use of time where everyone does the same thing. Examples are greeting rituals, party rituals and worship rituals. This is a safe use of time as there is no commitment or involvement with another person and what happens is predictable. Both withdrawals and rituals are a way of keeping apart from other people.

Activities are comfortable ways of structuring time by doing some sort of project. This can be doing the dishes, writing a book, walking the dog, or other types of work. Again, during the activity there is no need for involvement with other people. Although there may be involvement, it is not necessary. The activity may lead to praise or positive strokes after it is done.

Pastimes are a way of passing time. Social pastimes, such

as the small talk at a cocktail party, are a way of getting to know people without commitment. This is a way of selecting acquaintances and may lead to friendships. However, relationships that do not progress beyond the pastimes level will not survive.

The game is by far the most important and interesting form of interaction. The word 'game' should not be taken as meaning something fun because most games cause trouble. They can make people miserable and ruin relationships. The following is a brief description of games by Eric Berne (Berne 1964).

> A game is an ongoing series of complementary ulterior transactions progressing to a well-defined, predictable outcome. Descriptively it is a recurring set of transactions, often repetitious, superficially plausible, with a concealed motivation; or, more colloquially, a series of moves with a snare, or "gimmick." Games are clearly differentiated from procedures, rituals, and pastimes by two chief characteristics: (1) their ulterior quality and (2) the payoff. Procedures may be successful, rituals effective, and pastimes profitable, but all of them are by definition candid; they may involve contest, but not conflict, and the ending may be sensational, but it is not dramatic. Every game, on the other hand, is basically dishonest, and the outcome has a dramatic, as distinct from merely exciting, quality.

The predictable outcome of the game consists of feelings for each player that result in a discount of the self or someone else. In other words, each player has proven that someone is not OK.

There are many different transactional analysis methods for studying games. The Goulding model was derived from Berne's and is easy to understand. There are five essential elements in Goulding's model.

(1) There is an open message, a stimulus of some sort at the social level of communication.
(2) There is also a secret or hidden message; this is a stimulus at the psychological level.
(3) There is a response to the hidden message; whether given as an open message or hidden message, the response is heard as an open message.
(4) The player collects a payoff of some feeling.
(5) Apart from the open message, the rest of the dynamics occurs as though the persons Adult ego state is out of touch with what he or she has just been doing doing; in other words, it occurs outside Adult awareness.

This model lays out, more formally than Berne's description, the elements of a game. In fact, analysis of conversations and the games behind them can sometimes be specified in enough detail that almost anyone can identify them. One aspect of Transactional Analysis is that people in therapy can understand the ideas behind the theory easily and quickly.

There has been some work done with T.A. and the computer. Oswald Summerton (Summerton 1979) originally wanted to construct a computer program to simulate human behaviour as modelled by T.A. He then got interested in Transactional Analysis modelling, however, and did not get back to using the computer.

2.3 Current Research Issues

Recent natural language research on developing general purpose, user oriented computer systems is quite varied. Most system implementations are tailored to a particular domain to restrict the amount of general knowledge that must be included. However, knowledge about other people as well as knowledge about linguistic and psychological aspects of conversation is also important for studying dialogue.

There are many methods for representing the linguistic component of dialogues and they include scripts, schemas, focus spaces, methods, and Dialogue Games. Less understood are the psychological and sociological aspects of conversation and so far there are no widely accepted methods developed to deal with them. Part of the problem is the lack of formal theories from psychology or sociology that could be applied to computational linguistics. This thesis attempts to integrate one such theory into a language understanding system.

CHAPTER 3

The Integration of Psychological and Linguistic Knowledge in a Language Understander

The object of this chapter is to review, in more detail, the theoretical ideas used in this system. The first section describes, with examples, the type of analysis that is done using psychological methods, with Transactional Analysis (T.A.) being the particular method chosen. Following this are two sections describing the ideas used in the linguistic analysis, namely parsing sentences with the aid of patterns and using verb case to determine the meanings of sentences. The concluding section integrates these theories with an outline of the computer program.

3.1 Use of Transactional Analysis to Aid Parsing

Although the system uses Transactional Analysis as the particular psychological method to analyze conversations, other psychological theories of dialogue could have been used if they had been sufficiently detailed. T.A. theory uses actual words and phrases as indicators of the psychological content of a conversation and so is suited to a parsing system that uses pattern matching.

According to T.A., particular words or phrases indicate two

things, the ego state of the individual and the psychological meaning of the utterance. As mentioned before, there are three ego states, namely ego states resembling parental figures, ego states directed toward objective appraisal of reality, and those ego states still active that were fixated in early childhood. The technical terms for these states are exteropsychic, neopsychic, and archeopsychic, respectively. More commonly, the colloquial terms Parent, Adult, and Child are used in the literature and their use will be maintained here. Capital letters denote an ego state and uncapitalized words describe actual people.

The two ego states Parent and Child may themselves be broken into two subtypes. The Parent in a person consists of ideas and methods to perceive or deal with situations and so contains many judgments, opinions, values, and attitudes. These may be manifested in one of two ways. The Nurturing Parent is caring, worrying, forgiving, warmly protective, reassuring, concerned, and permissive. On the other hand, the Controlling Patent is aggressive, opinionated, strongly protective, demanding, principled, and punitive. A person will be in the Parent state only if she/he is replaying one of the Parent figures.

The Child ego state can function as either the Free Child or the Adapted Child. The Free Child does not care about the reactions of the parents of the world and so will act spontaneously. The Adapted Child, on the other hand, acts as if a parent were watching or listening, and therefore is much more

restrained than a Free Child. This results in behaviour that is rebellious, compliant, industrious, or any other action that will pay off with parent figures.

At any given moment, each individual in a social setting will be in one of the Parent, Adult, or Child ego states and may, with varying degrees of readiness, change from one ego state to another. Indicators of the ego state that a person is in include words used, type of voice, gestures or expressions, posture, and attitude. Since all but actual words are difficult to observe by computer, the other types of behavioural indicators will essentially be ignored.

We must remember that these vocal clues are only indicators and so may guide the search for ego state type but are not absolute rules. The dictionary containing the words and corresponding social ego state levels is listed in Appendix A. According to this dictionary, the word "should" is used most often by the Parent but the following examples show that it can be used from any ego state.

Parent: "You should do it!"

Adult: "To go to the new stadium, you should take the bus."

Child: "I should do it or I'll get in trouble."

Most times, however, the words used will come from the ego state listed in the dictionary.

The other type of information that can be gained from analyzing the specific words spoken is whether or not a Transactional Analysis game is present. If a game is being played by the conversants, then psychological information about

the speakers can be derived.

The following example of the type of analysis involved in a T.A. game illustrates the sort of information to be found. The game called "Why Don't You - Yes But" or WDYYB was the first game discovered by Eric Berne. Since it is the oldest game, WDYYB is probably the best understood of the T.A. games. The text that follows is an example used by Eric Berne (Berne 1964).

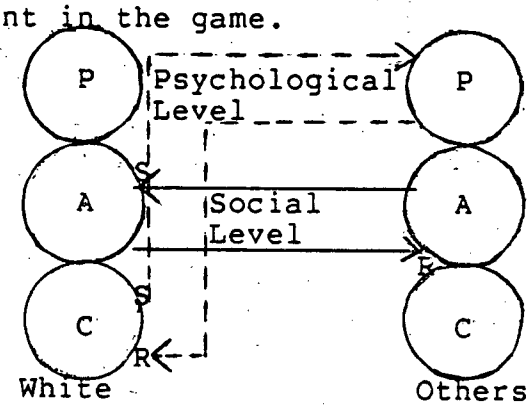
> White: "My husband always insists on doing our own repairs, and he never builds anything right."
> Black: "Why doesn't he take a course in carpentry?"
> White: "Yes, but he doesn't have time."
> Blue: "Why don't you buy him some good tools?"
> White: "Yes, but he doesn't know how to use them."
> Red: "Why don't you have your building done by a carpenter?"
> White: "Yes, but that would cost too much."
> Brown: "Why don't you just accept what he does the way he does it?"
> White: "Yes, but the whole thing might fall down."

The typical response is silence followed by another person, Green, saying something like "That's men for you, always trying to prove how efficient they are."

WDYYB can be played by many people with the agent, in this case White, presenting the problem. The others respond with possible solutions in the form of sentences beginning with words such as "Why don't you". To each suggestion the agent responds with a "Yes but" sentence that objects to something about the solution. A good player can stand off others indefinitely, always finding some fault with the proposed solutions. Eventually the other player or players will give up and at this point White wins the game.

On the surface this exchange sounds like a request for

information or solutions, but since every suggestion is rejected, with rare exceptions, there must be some ulterior purpose for the game. The intent of the game seems to be not to get solutions, but to reject them. The social level ego states are Adult because of the question-answer sequence. Notice, also, that the word 'why' is listed in the ego state dictionary under the Adult category in Appendix A. Psychological analysis showed that White is actually in the Child ego state at the psychological level, searching for some sort of gratification or reassurance. The Child in White is showing how inadequate she is. On the other hand, the other players in the game are playing as Parents at the psychological level and are eager to be able to give advice. The following diagram shows the interaction present in the game.



R:"Yes but..." S:"Why don't you..."

Why Don't You - Yes But

Figure 3

The game can continue because at the social level both stimulus (S) and response (R) are Adult to Adult (shown with solid lines), and at the psychological level (shown with dotted

lines), they are also complementary, with Child-Parent stimulus ("Yes but...") and a Parent-Child response ("Why don't you..."). The message underneath the conversation seems to be a Parent saying "I can make you grateful for my help" and a Child responding with "Go ahead and try".

As well as the psychological information obtained above, a certain amount of linguistic knowledge can be acquired. People playing a Transactional Analysis game follow what can be described as a script in that the utterances are of a predetermined type. Therefore, once a game has been confirmed as being present, the type of sentence and sometimes the actual words used can be predicted. In the above game WDYYB, suggestions will be submitted of the form "Why don't you..." or "Did you try..." and responses will find fault with the suggestions and likely contain the words "Yes, but..." or "I did, but...". The dialogue consists of an interrogative sentence followed by a stative. The program for this thesis uses the linguistic information derived from T.A. game analysis in parsing the dialogue sentences. Descriptions of the psychological analysis of the other T.A. games used in this thesis can be found in Appendix B.

3.2 Pattern-based Sentence Parsing

3.2.1 Eliza

One of the first attempts at conversational computer

systems is that of Weizenbaum (Weizenbaum 1966, 1976). His ELIZA system emulated a psychiatrist having an interview with the user as patient. While the program was successful in that reasonable conversations were carried out, this was more due to accident than a planned approach to understanding dialogue. In computational linguistic terms ELIZA has almost no semantics, restricted syntax and little real world knowledge or memory but works mostly by picking out key words or phrases (patterns) from the users input and responding with preset phrases accordingly. Although this is by no means a reasonable model of conversation, the program works fairly well in the interview setting. It seems that many conversations go from sentence to sentence with few references to previous dialogue but the errors in the system become evident when ELIZA is asked about previous responses. The system does not really know, in any sense of the word, what it is talking about. In spite of this, ELIZA is an interesting study of conversation and what can be done with a very simple system.

3.2.2 Parry

The next major system to use pattern-matching to parse natural language was Colby's PARRY system (Parkison, Colby, Faught 1977). Although the psychiatric interview setting is the same, the motive behind developing PARRY is much different from that of ELIZA. As previously mentioned, Colby wished to implement a computer system that would model his theory of paranoid behaviour. The paranoid model was chosen because the

psychological theory of paranoia is fairly well understood and there is general agreement about what constitutes paranoid behaviour. For the program responses to be indistinguishable from those of a paranoid patient, there must be a certain amount of linguistic competency.

The program for this thesis follows the PARRY system in the syntactic parsing part of the language recognition phase. Two main ideas used in PARRY's parsing are the simplification of the input sentence and the use of a set of language patterns at various stages. Consider the following sequences of steps:

1. Fixed Idiom Replacement

The first patterns are used after input standardization and morphological analysis to condense what are called rigid idiomatic phrases. These consist of about 350 set multi-word phrases which are recognized and then replaced by more literal synonymous words. The types of idioms considered at this phase include:

IN SPITE OF -> DESPITE

UNITED STATES OF AMERICA -> USA

STRAIGHT JACKET -> RESTRAINTS

AT THE MOMENT -> NOW

ON possessive TOES -> ALERT

SEE RED -> BECOME ANGRY

HOW DO YOU DO? -> HELLO

Either exact words or word classes which match any word in that class are the elements which make up the idiom patterns. The

examples include compound words, proper nouns, idioms and formulaic sentences. These parts of speech occur often enough in colloquial English that they must be considered in any complete language analysis system.

2. Noun Phrase Bracketing

For the next part of the parsing, an augmented transition network is used instead of patterns. The noun phrases of the utterance are located and bracketed so that they may be treated as a single unit in later processing. Relative clauses, however, are treated using patterns. The form of a noun followed by a relative clause is converted into a single noun. The reasons given for treating relative clauses this way are that relative clauses occur infrequently in dialogues and that the model's internal belief representation made it difficult to represent the information contained in an arbitrary relative clause.

3. Verb Phrase Simplification

Following the noun phrase identification stage, patterns are used more often. The next phase involves simplification of verb phrases by removing most of the features such as tense, modal verbs, adverbs, and subject-auxiliary inversion. The information from these features is kept in a set of adverbial variables. To invert subject and auxiliary verbs in questions, patterns are matched of the form:

auxiliary noun-phrase verb -> noun-phrase auxiliary verb

The adverbial variable for interrogatives is also set to true. Other similar pattern rules are employed to find tense and to convert passive constructions to active.

4. Flexible Idiom Replacement

The next stage in PARRY's language processing is the detection and replacement of flexible idioms. This section works in the same way as that for the rigid idioms but the idiom identification is different. Some examples of the type of idioms are:

PICK noun-phrase UP -> PICK-UP noun-phrase

LEND noun-phrase (A HAND) -> HELP noun-phrase

Many idiomatic verb constructions let the object of the verb be embedded within the idiom. These particular flexible idioms can undergo bracketing of noun phrases and simplification of verb phrases. Again, this phase depends heavily on stored patterns that indicate the idiom and its replacement.

5. Simple Clause Location

There are about 20 general clause patterns that are used in the next stage to segment the sentence into simple clauses or fragments. The parser goes through the sentence matching for a pattern and when one is discovered, that portion of the sentence is broken off and the remainder of the sentence is then checked for further clause patterns. The patterns are all of the general type "(noun verb noun)".

The resulting clauses are then modified by the adverbial

variables. This information indicates the presence of negatives, presuppositions which are indicated by a negative and interrogative, or just ordinary interrogatives.

6. Subordinate Clause Embedding

To deal with sentences containing more than just simple clauses, the remaining language analysis section embeds any subordinate clauses. The three types of sentences that require clause embedding are those with adverbial clauses, subordinate clauses, or clausal objects. The adverbial or subordinate clauses are indicated by markers such as adverbial conjunctions (e.g. WHILE) or conjunctions (e.g. BECAUSE). Clausal objects can be recognized when the preceding clause is missing an object and its verb belongs to a set of 50 verb classes known to permit clausal objects (e.g. EXPECT, KNOW, THINK).

7. Determining Relevance to Model's Sphere of Interest

In its final phase, PARRY tries to determine the sentence's relevance to the model's sphere of interest. This particular model knows about its own life situation and can talk about its personal background, hospitalization, and interpersonal relations. The memory of the psychological model is represented by a set of about 2000 stored concept patterns and the input is matched against these patterns to determine with which one there is a similarity. Each of the concept patterns is tied to one of about 1000 internal concept names. The concept name and any conditions of the pattern match are then passed to the

psychological modelling processes. Once the area of interest has been determined, an appropriate response is generated.

The PARRY system seems to be a large almost script like system that is driven by the paranoid thought processes. There is little real world knowledge but perhaps a paranoid patient is so self centred that this lack would not show up in the conversation. For more general purposes, however, more world knowledge is necessary. One point in its favour is that PARRY can deal with sentence fragments or syntactically ill-formed sentences by using patterns; however the semantics part of the program is weak. The program for this thesis uses the ideas of PARRY up to and including the clause partitioning but only for syntactic and some semantic parsing. The idea of verb case is used to get more semantic information.

3.3 Using Verb Case in the Syntax-Semantics Interface

Associated with any action are many types of details identified by a question such as "who did what to whom, when, where, how, and why?" There is typically an agent (who) and recipient (whom), and the event occurs at a particular time (when). An instrument (how) may be involved or there may be movement from one point to another along a path (where). These various elements that are contained in an event characterized by the verb, are found in the subject, object, indirect object, and associated phrases, prepositional or otherwise. If there is a preposition in front of a phrase, it can be one of a small set.

For example, a time phrase can use in, on, before, after, and between but not above, under, or without. The individual components of the event are called cases and a verb can be described with the kinds of cases that may be assiciated with it (agent, recipient, instrument, etc.). Some of the cases may be optional, some required, and there may be certain characteristics that the case fillers are expected to have. For example, the verb "talk" has an agent that must be animate. Such descriptions have been used to describe verbs in natural language systems.

There have been many definitions of case for English, some of which are discussed by Bertram Bruce (Bruce 1975). The best known case system is that first described by Charles Fillmore in his paper "The Case for Case" (Fillmore 1968). His definitions of case have been further developed and now contain the eight cases Agent, Counter-Agent, Object, Result, Instrument, Source, Goal and Experience. Most of these have obvious meanings except possibly Counter-Agent which is the force of resistance against which an action is carried out and Experience which is the entity which receives or undergoes the effect of an action.

Other people have used varying numbers of cases to describe English, from seven cases in Simmons system to thirteen by Grimes (Bruce 1975) all the way to twenty-four by Taylor (Taylor and Rosenberg 1975). Although the system for this thesis does not claim to be complete, a total of thirteen cases were found to be sufficient and were derived mostly from Taylor. The addition or deletion of any cases should be a simple operation.

In Appendix C is a list of the cases used, with examples showing the case in question underlined. Most of the cases listed in the appendix have a set of prepositions that flag each case. These prepositions are not unique to each case and so are often not enough to determine the type of case, as the following two sentences show.

(1) The dog sang with its master.

(2) The dog opened the door with its nose.

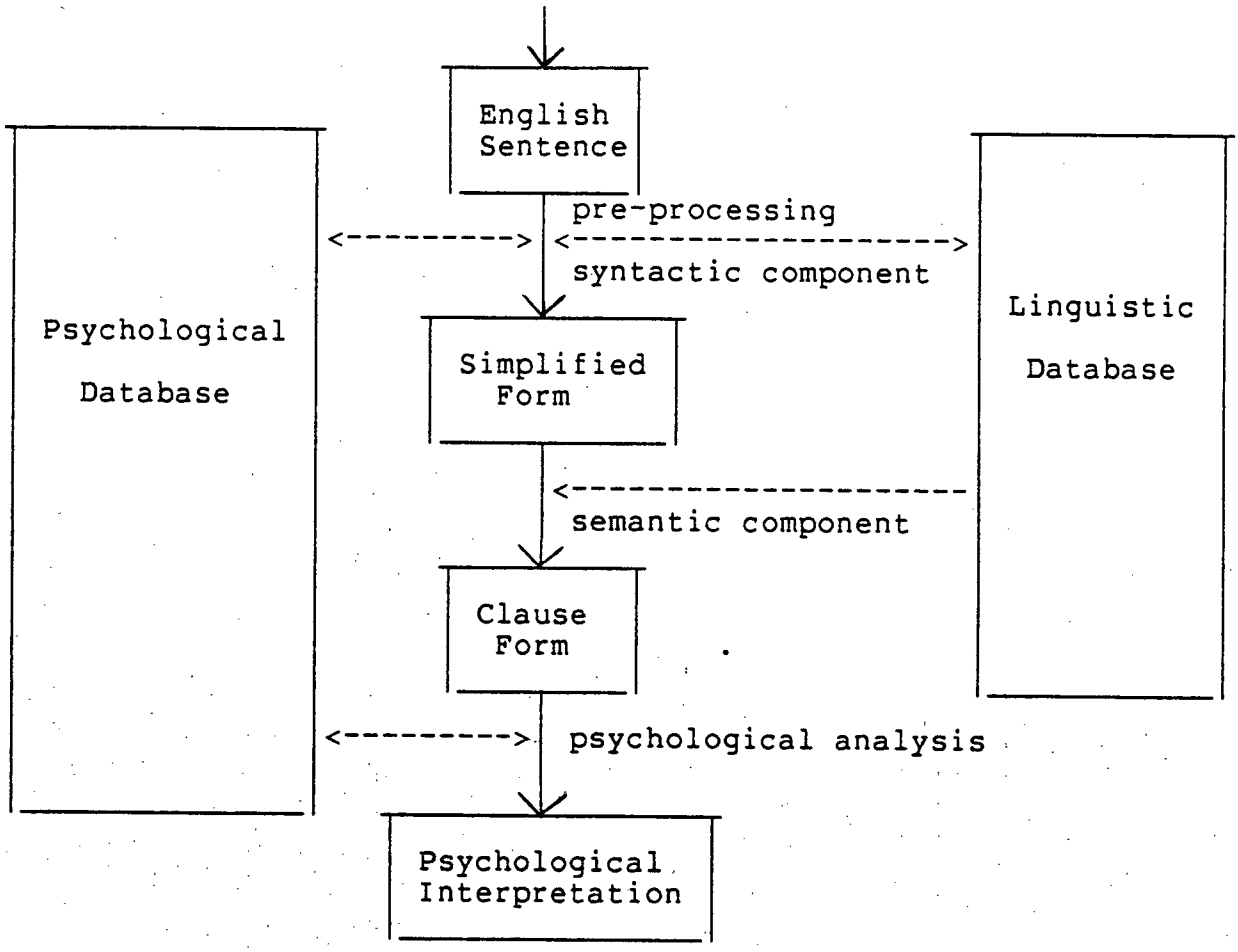
Both of the sentences use the prepositition 'with' but in the first sentence the co-agent case is indicated and in the second, the case is an instrument. In this example, other information must be used to determine the appropriate case.

One solution is to list with every verb the possible cases it can take and conditions on the cases. For example, the verb 'give' has agent, recipient and patient cases. The agent must be animate, the patient cannot be a human (in most civilized societies) and the recipient can be almost anything. In the computer program, this verb case information is stored in a table containing all verbs, the cases they may take and conditions on the cases. The potential cases will be in a list where there is more than one possibility and will be ordered according to to their probability of occurrence. Using both information about the cases that verbs take and conditions on the cases should be sufficient to determine the appropriate case, in most situations. The actual program code for the tables is also listed in Appendix C.

3.4 Outline of System

The strategy implemented in this thesis is to use ideas from the PARRY system to derive a structural description and then to apply a system of verb cases together with the given psychological theory for the semantics.3 Transactional Analysis theory is the part of the system that determines psychological meaning and predicts, if possible, further sentences of a conversation if a T.A. game pattern is present. The T.A. tests are done during various stages of the program execution.

The following is a diagram describing the system.



General System Diagram

Figure 4

The linguistic database contains the word dictionary, prefix and suffix tables for morphological analysis, and verb and case tables. The psychological database contains the Transactional Analysis keyword dictionary and the data structures that describe the T.A. games. In PROLOG, both the data structures and programs are represented by axioms so the programs are also contained in the databases. The program

analysis flows along the solid lines and interacts with the databases as indicated by the dashed lines.

The first part of the program pre-processing is input simplification. Initial passes differentiate the sentences of various speakers and the type of sentence such as declarative or interrogative. Testing for any phrases that indicate a Transactional Analysis game is done then, as well as a scan for idioms, which if located, are converted to a less colloquial form that is easier to parse. Tables containing idioms and their replacements are used to do in a manner similar to PARRY's fixed idiom replacement.

The next step also relies on data tables by scanning the input for any T.A. keywords or phrases that indicate a particular ego state. The words and phrases are stored in tables along with their corresponding ego state types. There are 43 of these words and 16 phrases to be checked for. Information about the social level of the ego state is stored for use in later parsing stages. At this stage a morphological analysis is done of each word and suffixes and some prefixes are removed. Inflectional endings, derivational endings, and contractions are eliminated and replaced by appropriate words or markers. The dictionary consists of around 230 words and about 50 suffixes and prefixes are recognized. Although there are not many words currently in the dictionary, it is a straightforward matter to add more words as needed.

The syntactic component involves simplification of the sentence and is taken almost directly from the noun phrase

bracketing and verb phrase simplification stages of the PARRY system. Since noun phrases can be considered as a single entity in the parsing stage, they are located and bracketed using a simple definite clause grammar. Only the noun phrases are identified at this time and the remainder of the sentence is left as is. The second simplification of the sentence involves a reduction of complex verb phrases as done in the PARRY system.

Once the sentence has been put into simplified form, as described above, it remains to convert the sentence into its clausal form. To achieve this the sentence is matched against about 20 stored general clause patterns similarly to the simple clause location part of PARRY. For example, the sentence "Did you try to write him a note" becomes:

((you) try ((you) write (him) (note)))

Notice that some embedding of subordinate clauses is also done at this time. After this part of the program, the analysis no longer follows the language recognition done in the PARRY system.

Before clause forms are finalized, the program does semantic type checking employing case tables. Using any prepositions in the text as an indication of possible case types, the system checks verbs both for agreement with noun phrases and for verb meanings. To reduce the number of verbs in the system, semantically equivalent verbs are represented by a single verb similarly to the way that Schank uses primitive ACTs as canonical forms.

The final part of the program deals with locating or

confirming any Transactional Analysis games. Using the social ego state indicators or previously found games as a guide to possible T.A. games, the system compares the sentence in clausal form with certain conditions necessary for a game to be present. Either the previous game is continued, a new game is found or no game is present. All of these states have psychological importance and once a game is identified as continuing, predictions can be made about further utterances. The following chapter describes the steps of the program in more detail.

CHAPTER 4

The System

4.1 Introduction

4.1.1 PROLOG as an Implementation Language

This system was implemented in the logic programming language PROLOG. There were several reasons for choosing this language because as previously mentioned, there are advantages to using logic for representing and processing natural language. Logic can be used in LISP but PROLOG is easier as the logic mechanism is already built in. The pattern matching features of PROLOG also make the pattern matching needed for parsing much simpler. Since there are several dictionaries and other data structures that are accessed frequently, the data base facility in PROLOG is also useful.

The rest of this chapter will describe the program in some detail. Special dictionaries and data structures are listed in the appendixes but one of these, the T.A. game structure, is used often enough that is should be discussed in some detail first.

4.1.2 The Transactional Analysis Game Structure

Each T.A. game is stored as a clause with particular distinguishing information. The following is the general structure for a game (with the definitions for variables):

GAME(*name,*s1,*s2,*d1,*d2,*p1,*p2,*c1,*c2)

where:

*name = name of the game as a mnemonic
*s1 = social level of speaker one
*s2 = social level of speaker two
*d1 = deep psychological level of speaker one
*d2 = deep psychological level of speaker two
*p1 = actual words or phrases used by speaker one
*p2 = actual words or phrases used by speaker two
*c1 = clause types or conditions on what speaker one says
*c2 = clause types or conditions on what speaker two says

The game name itself is a mnemonic, such as WDYYB for the game 'Why dont you - yes but', with the long form of the name stored elsewhere for printing. The social and deep levels must be one of Parent, Adult, or Child. The actual words or phrases used by the speakers that can distinguish a particular game are stored in *p1 and *p2. This pattern of words is usually located at the beginning of the sentence but can occur anywhere. For the game WDYYB, the first speaker uses the words 'why don't you' and the second speaker uses the words 'yes but'.

The final variables contain clause types or sentence conditions that must be true for a particular game to exist and they are checked using a pattern matcher that looks for four special symbols, =, %, #, and @. There are two types of sentence condition checks. The first is a match of variable equality and is indicated by use of the symbol "=". These sentence variables are INTERROGATIVE, TENSE, MODAL, AUX, NEGATIVE, WH, ADVERB and CONJ and will be described later.

There are various values that these variables can take. One way to test for a question, for example, is to test if INTERROGATIVE=T. The second method of checking a sentence is to check sentence type which is indicated by the symbol "%". The sentence type may be imperative, stative, or any other designation that could distinguish sentences. An example of this type of sentence condition is "%imperative".

The clause type is indicated by a list of words to be matched against the sentence in clause form. The words may be of a particular class, shown by a "#", or an exact word match, shown by a "@" symbol. The list is usually only a few words long. For example, @you.#verb.NIL checks for a sentence with "you" as the subject, followed by any verb.

Finally, the sentence and clause condition tests are put together in a list form in the variables *c1 and *c2. The individual tests in the list are separated by the symbol "¦", as in:

@you.#verb.NIL¦INTERROGATIVE=F¦%imperative¦NIL.

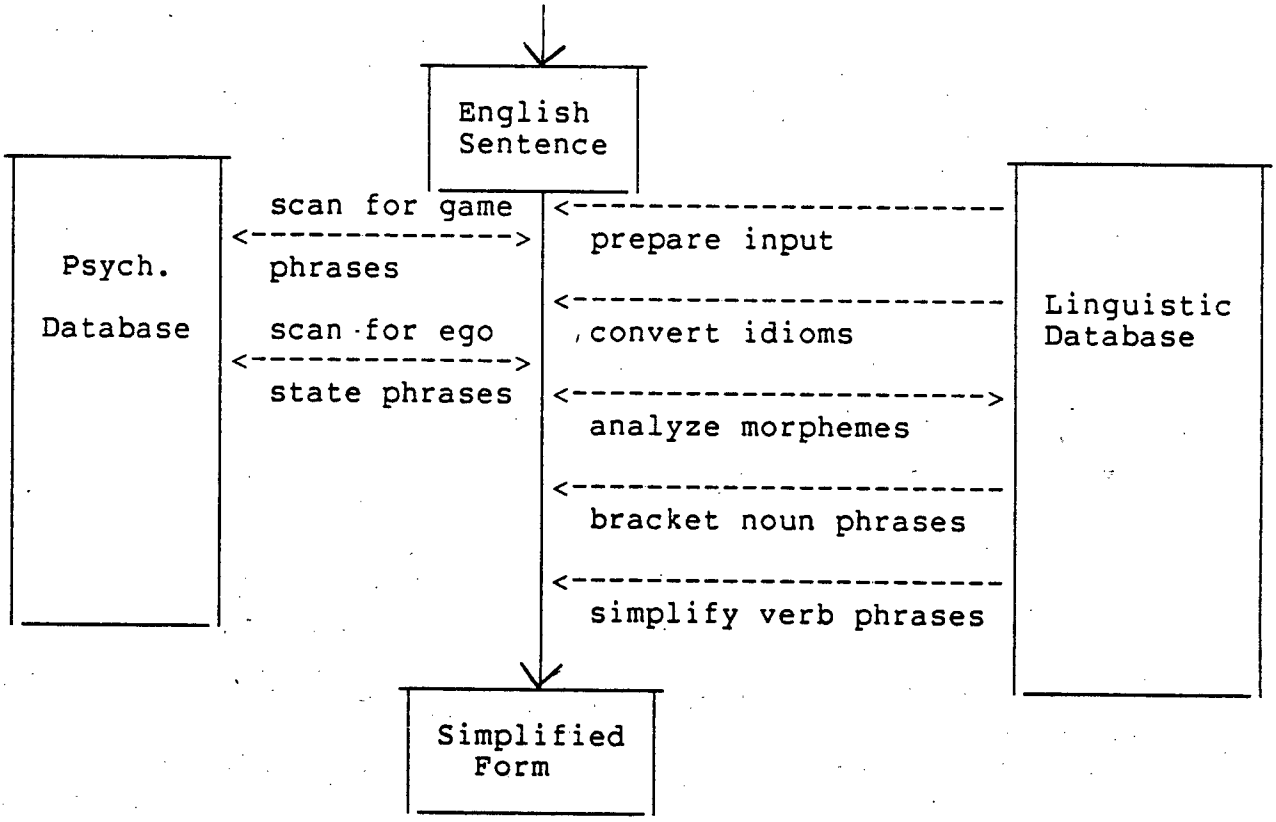
This example matches a noninterrogative imperative sentence whose clause form contains the word "you" followed by a verb. The actual T.A. game structures used in the program are listed in Appendix D.

We will now examine the various components of the system.

4.2 Syntactic Component

To illustrate the various parts of the system, the

following more detailed flowchart is included:



Syntactic Component

Figure 5

Notice that psychological processing occurs during the syntactic processing shown here and also during the semantic processing described later. As in the general diagram, the program analysis flows along the solid lines and interacts with the databases as indicated by the dashed lines.

4.2.1 Input Preparation

One of the poor features of the particular version of

PROLOG used is the limited input facilities. To make the program easier and to require less typing for the user, the entire conversation is entered as a single clause. This form would be more natural when using the program to analyze a dialogue transcribed from tape.

At this stage the program determines one speaker's utterance by locating the terminating punctuation. The punctuation is removed and the INTERROGATIVE variable is set to T for true or F for false. For ease of use in PROLOG, the sentences are then converted into a list of words.

4.2.2 Scan of Sentence for Game Phrases

The sentence is first checked for exact words or phrases that can indicate a game. These are the phrases stored in the *p1 and *p2 variables of the game structure. If such a game phrase is found in the utterance, a global variable is set to indicate that a game has been found. A message is printed if either a new game is found or contradictory information is discovered and in either case, the global game variable is set to the new game. When contradictory phrases are found, the old game has been abandoned and a new one started.

Finding the exact game words in an utterance is quite a strong indication that a game exists. Most games can be uniquely identified by this information; however, not all of the players in a particular game use identifiable phrases, so the global game variable would not be set or changed if no match can be done for a particular speaker.

4.2.3 Conversion of Idioms

There are many expressions such as compound words and idioms that have the property that the meanings of the phrase cannot be derived from the individual meanings of the separate words. Since these expressions are quite common in colloquial English, the system should be able to handle them. The easiest way of accomplishing this is to replace the entire expression with one that has a more literal meaning. The following examples illustrate some compound words and their replacements:

HOW COME -> WHY

HOW GOES IT -> HOW ARE YOU

The idioms and their replacement phrases are stored in a table that is indexed by the idiom phrase. Notice that idiom conversion is done after the game phrase identification process is complete since idioms may be a part of the game phrase.

4.2.4 Ego State Scan and Morphological Analysis

The ego state of the social level of an utterance can be indicated by the use of certain words or phrases. These words do not confirm the ego state but merely suggest it. The words or phrases are stored in a dictionary, PSYCHWORD, along with the ego state they typify. The ego states are divided into Adult, Controlling Parent, Nurturing Parent, Free Child and Adapted Child. For purposes of determining further information about games, there is only one Child and one Parent ego state but the dictionary contains the extra information which is printed as

part of the analysis. For example, words such as "what" and "possible" or phrases such as "it is my opinion" are present in Adult ego level dialogue. The program then sets the social level indicator for the particular speaker to 'Adult'.

The next step in the linguistic analysis is the identification of the individual words of the sentence. Each word is first looked up in the main dictionary that contains the word, its syntactic class, and any additional information useful for later parsing. Such information includes word plurals and classification for nouns and tense, verb forms, and features for the verbs, as well as number and gender for subsequent parsing. If the word is found in the dictionary, attention is then focussed on the next word. If it is not found, any prefixes or suffixes are stripped and the basic morpheme is rechecked in the dictionary.

The semantic effect of prefixes is approximated by the insertion of appropriate adverbs. For example:

UNHAPPY -> NOT HAPPY

IMPOSSIBLE -> NOT POSSIBLE

The table of suffix endings is far larger than that for prefixes with noun plurals, verb endings, and adjective and adverb endings recognized.

The main reason for identifying morphemes is to make the word dictionary as small as possible so that only the basic morphemes and any irregular words have a separate dictionary entry. Many of the most commonly used verbs of English have irregular inflections so these separate forms would entered in

the dictionary. For example, the word WAS is listed as the past tense of the verb BE. Some nouns and pronouns have irregular plurals so they are also listed. For example, both WOMAN and the plural WOMEN are entered in the dictionary.

The words not in the dictionary are determined by morphological analysis. The table of inflectional endings is compared to the ending of the word in question. If the word with the ending removed is located in the dictionary, the dictionary entry and other information from the morph table is returned to the parser. For many words, letters have to be added to the end of the word before the dictionary is searched. For example, after the ING ending is removed from the word WRITING, an E has to be added, giving the verb WRITE, which is in the dictionary. The new word is then entered into the dictionary with its relevant information so that the longer process of morphological analysis would not have to be repeated the next time the word is encountered.

Inflectional endings are removed from plural and possesive nouns, third person singular verbs and tensed verbs. The tensed verbs return information about the type of tense such as past (-ED), present participle (-ING) or past participle (-EN).

Another ending that is treated as a form of suffix is the contraction. It is replaced by the uncontracted word but information is kept to preserve the meaning of the ending. To prevent every word ending with NT being analyzed as contracted words, limits are set on which words may have contractions. In the case of NOT, only the verbs DO, BE, HAVE and the modal

auxiliaries allow contractions.

The final type of ending analyzed is the derivational suffix. When this type of ending is removed, words in one class of word are transformed into semantically related words in another class. For example, the LY ending changes the adjective PRETTY into the adverb PRETTILY. Superlative and comparative forms of adverbs and adjectives are also checked here.

When none of the above analysis determines the word, either the morpheme is not in the dictionary or the word is misspelled. Since the conversation is not typed in interactively, there should be no spelling errors. There is no spelling checker in the system but one would be easy enough to add if necessary. In the case of new morphemes, the user will be given the option of entering the morpheme into the dictionary.

4.2.5 Noun Phrase Bracketing

After the individual words have been identified, the simple noun phrases are located by a partial definite clause grammar (Periera and Warren 1980). This is done so that the noun group can be treated as a single unit in later processing and is similar to the PARRY system except that PARRY uses an augmented transition network.

The noun phrase consists of premodifiers, adjectives, the noun and any trailing prepositional phrases. Proper nouns and pronouns are also considered to be noun phrases for ease of processing later on. The noun phrase, NP, can be described as follows:

NP -> pronoun¦proper noun

NP -> (determiner¦quantifier)(adjective¦ADJP)*(noun)(PP)*

where

ADJP -> (adverb)*(adjective)

PP -> (preposition)(NP)

This noun phrase grammar is very simple and the program just scans through the sentences bracketing off any noun phrases that are located.

Another operation that must be done at this stage is to check the number agreement amongst the various parts of the noun phrase. When the beginning of a new noun phrase is discovered, a global variable is set to the number of the first element of the noun group, either singular, plural or both singular and plural. Further elements in the noun phrase must match this in number. Matching of number is important in the noun phrase because the number determines whether there is a singular or plural subject, which in turn must match the number of the verb form. If there is disagreement amongst the various parts of the noun phrase, then a message is printed stating that the number of the noun phrase is changed to the number of the last element in the noun phrase, which is the noun.

4.2.6 Verb Phrase Simplification

A verb phrase is defined as a main verb, a set of auxiliaries that indicate tense, voice and modality, some adverbs and a possible inversion that signals interrogation. The goal of this part of the processing is to remove everything

except the main verb and to save the significance of the removed words in a set of adverbial variables. These are the variables INTERROGATIVE, TENSE, MODAL, NEGATIVE, WH, ADVERB, and CONJ mentioned previously.

The first pass of the sentence deletes all forms of adverbials. Most types of adverbs are deleted and stored in the variable ADVERB. However, two common types of adverbials have been singled out for their frequency of use and importance to the meaning of the sentence. These are NEGATIVE and WH. Any negative word such as NOT or NEVER or negative modal (from a contraction) are deleted and the word put in the variable NEGATIVE. The variable WH contains questions words such as WHEN, WHERE, or WHY that have been deleted from the sentence. Simple modal auxiliaries are also removed at this stage and placed in the variable MODAL. The word WILL is treated as a modal instead of a verb denoting the future tense.

The next step is slightly more complicated and deals with simplifying the auxiliary phrases. The subject-auxiliary verb inversion of question sentences is replaced using the following type of pattern:

auxiliary noun-phrase verb -> noun-phrase auxiliary verb

The variable INTERROGATIVE is also set to T for true if it has not already been set.

The TENSE variable is set to the tense of the auxiliary verb, if any, or of the main verb. The auxiliary verb is also deleted and put into the variable AUX. The following are some examples:

DO verb -> verb

verb-ED -> verb (TENSE=past)

HAVE verb-EN -> verb (TENSE=past)

BE verb-ING -> verb (TENSE=progressive)

Sentences combining auxiliaries are simplified by repeated applications of the basic auxiliary rules. Thus:

HAVE BEEN verb-ING -> verb (TENSE=past progressive)

The system next checks for passive sentences and then converts them to an active construction. The following two rules move the subject and object into their usual positon.

noun-phrase1 BE verb-EN BY noun-phrase2

-> noun-phrase2 verb noun-phrase1

noun-phrase BE verb-EN -> SOMEBODY verb noun-phrase

The variable TENSE is also set to the tense of the auxiliary "be".

Finally, there are a group of verbs called semi-auxiliaries that can be converted into modals. These phrases are treated somewhat like idioms because of the use of equivalent phrases. The modals, however, are then deleted and stored in the MODAL variable. The following are some examples:

HAD BETTER -> SHOULD

BE ABOUT TO -> SHALL

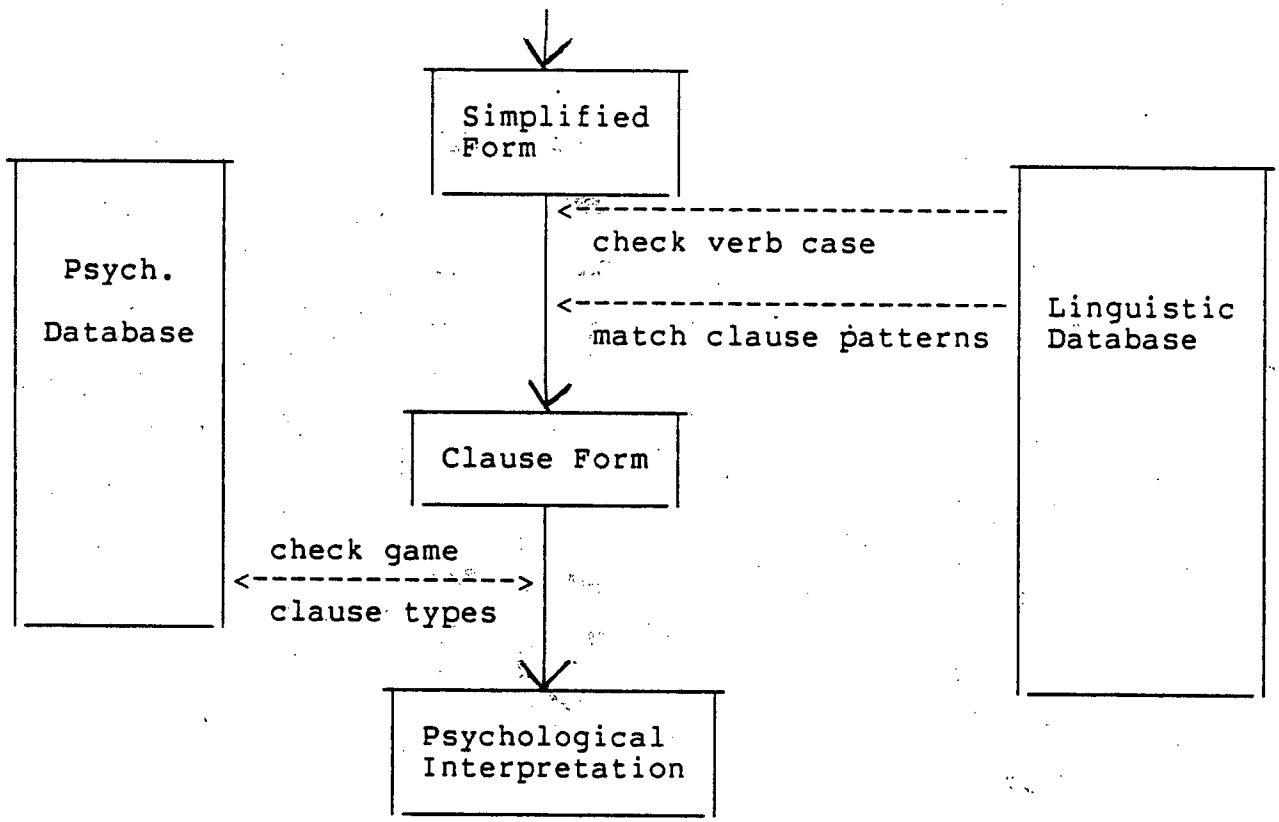
BE ABLE TO -> CAN

The method of treatment of adverbial variables is based on the PARRY system (Parkison, Colby, and Faught 1977). Although no claims are made for similar methods in formal English grammar, parsing clauses is made easier with this technique.

4.3 Semantic Component

4.3.1 Clause Form Location

The following diagram illustrates the semantic component of the system:



Semantic Component

Figure 6

This next stage in the parsing puts the sentence into logical clause form. The simplified sentence is matched against 17 general clause patterns to determine the clause type. These clause patterns are of the general form "(noun verb noun)" and

are distinguished by such things as prepositional phrases and verb types. There are only a couple of clause patterns for incomplete sentences but more could easily be added.

Verbs may be transitive, intransitive, copula and/or those verbs that can take an indirect object. This information is stored in the syntactic dictionary entry for the verb.

Other sources of information about the verbs are the case table and semantic dictionaries. The verb, subject, and any objects must now pass the semantic case checking stage before a clause type can be confirmed.

There are four verb semantic dictionaries or tables (listed in Appendix E), one for each type of verb. Any one verb may have an entry in more than one table. The best way to illustrate the table entries is with an example:

INTRANS(go,move,agent:animate)

The verb 'go' is intransitive. The second entry is a replacement verb that is semantically equivalent. The purpose of a replacement verb is to reduce the number of different verbs to a reasonable size and for some verbs, the replacement may be the verb itself. These replacement verbs are loosely based on the ideas of Schank's primitive ACTS (Schank 1973) but more verbs that Schank's small set are needed to convey the nuances of meanings of verbs that are needed for the clause type matching described in the next section. The last entry in this table is the case information. Since the verb 'go' is intransitive, there is only one case, an agent, and it must be animate.

The other tables have entries for the number of cases each verb needs. The individual entry for a particular verb may also be a list. The following three examples illustrate the various features of the semantic specification tables:

INDOBJ(give,transfer,agent:animate,recip:T,patient:¬human)

TRANS(listen,listen,agent:animate,patient:human.music.T.NIL)

TRANS(read,read,agent:human,recip:animate;patient:literature)

The verb 'give' is of the semantic class of verbs that describe 'transfers' by an animate agent to any recipient (T means any classification). The only limit on the indirect object is that it cannot be a human. The transitive verb 'listen' is an action by an animate agent done to a patient that may be a human, music or anything else. The transitive verb 'read' is an action done by a human agent to either an animate recipient or a patient of type literature. To determine which type of case is the first to be checked, there is a case table with a list of prepositions and the cases that they indicate. This is usually enough to disambiguate the possible verb case meanings.

The objects are now compared with the classifications given in the verb semantics tables to make sure that the types match. Using the features of the nouns obtained from the main dictionary, the program tests the possible classification against the features list. If the classification is contained in the features list, then there is case agreement. There may be a list of possible classifications, in which case, only one element has to be on the noun features list. The classifications can also contain a "T" which matches anything

and a "¬X" which matches anything that is not of type X. There are also special matching rules of the type "a human is animate". These rules define subclasses or hierarchies of classifications so that correct matching will occur.

After the various objects are checked for case agreement, the subject-verb agreement is tested. The number and gender of each word is stored in the information from the syntactic dictionary and morph table so the test is just a simple match.

Finally, the sentence is printed out in clause form along with any modification caused by the adverbial variables. The NEGATIVE feature reverses the meaning of the clause but when the NEGATIVE is present and the INTERROGATIVE is true, this is just an indication of the speaker's presuppositions. Any other adverbs or WH words are placed in front of the clause. If there was a conjunction in the original sentence, the result will be more than one clause or one clause joined by the conjunction contained in the variable CONJ. For example:

```
"Why don't you talk to him"
        =>(IS-why?  (you talk him))

"We need to discuss the report"
        =>(we need (we talk (report)) )

"If it weren't for you I could be having fun"
        =>(not (if (it is you)(i possess (fun))))

"You stay home and watch the house"
        =>(and (you stay (home)) (you see (house)) )
```

Notice that nouns are bracketed and that some verbs are changed to their semantic equivalents. There was a problem finding a reasonable equivalent phrase for the idiom "if it weren't for you" so this program leaves the phrase as it is for processing.

4.3.2 Check of Clause Types Used in Games

This phase of the system compares the sentence in clause form with the clause types and conditions listed in the *c1 and *c2 variables of the Transactional Analysis game structure described at the beginning of this chapter. The clause form must match all of the conditions listed there. The sentence type and adverbial variables must agree with any values in the *c1 or *c2 variable. Partial phrases consisting of actual words or syntactic word type must also be present in the clause. If all of the conditions are not met, one of two actions occurs. If no TA game had been discovered yet in the conversation, there would still be no game present. If, on the other hand, a TA game was present, then a violation of the clausal conditions signals that the game has been terminated.

If all of the clausal conditions are met, then the TA game is still in progress. In the case that no Transactional Analysis game had previously been indicated, a new game is started.

For some games the clausal condition checks just confirm the game found using the exact words in the variables *p1 and *p2 of the TA game structure. However, there are some games in which one or both speakers do not use specific words but it is the meaning of the sentences that indicates that a game is being played.

4.4 Use of T.A. Variables to Aid Parsing

The players or speakers in a confirmed Transaction Analysis game sequence follow a type of script. Either the exact words or the meaning of a phrase is defined for one or both speakers. This information can be used to predict the content of the next sentence and so limits the amount of search to be done in parsing. In the program, the T.A. game can be identified either by specific words (done at the word match and idiom match stage), or by types of words or sentences (done at the clause type matching stage). Using the knowledge that a game is present, the program knows the exact words or types of phrases that may be in the next utterance. An exception occurs if the next speaker decides to stop the game.

Even when no T.A. game exists in a conversation, certain things can be said about the social level of the psychological ego state of the speakers. Certain types of words are used more by one ego state than another and are those contained in the T.A. word psychological dictionary. Examples of the way in which Transactional Analysis games and ego states occur in conversations are shown in the following chapter.

CHAPTER 5

System in Operation: Examples and Discussion

This chapter shows some of the results of tests of the computer program. The examples were taken mostly from texts about Transactional Analysis and are fairly representative of the type of conversations analyzed in therapy. There are only a limited number of different types of transactional analysis games in the examples because many games are signalled by extralinguistic clues such as tone of voice or gestures and so cannot yet be analyzed by computer.

For each dialogue, the program produces a linguistic analysis of each sentence and a psychological analysis consisting of the social level ego state of the speaker, if decidable. The linguistic analysis consists of a line stating the verb and case information found, the adverbial and sentence variables, and a line with the resulting clause form. When any T.A. game is recognized, its name is printed as well as the social ego states associated with it. The fact that a game is terminated is important psychologically; so if that happens, appropriate information will be printed. After the parse is complete, more information is printed about the name of the game present at the end of the conversation and the ego state levels of the speakers according to that game.

The test dialogues include the following features:

(1) starting and stopping a T.A. game

(2) no T.A. game present

(3) change in game played

(4) recognizing a T.A. game at various stages

Each of the dialogues is numbered so the program starts when the user types in "<-analyse(X)" where X is the number of the conversation to be tested. For a description of the test dialogue input, turn to Appendix F.

The first example shows the game "Why Don't You - Yes But" or WDYYB being recognized during the first sentence of the dialogue. This game is discovered by matching the speaker's words against those in the game data structure that indicate a T.A. game is present. The social level ego state is suggested to be an Adult because of the use of the word "why" and the global social ego level of WDYYB confirms this to be so. Further utterances by both speakers indicate that the game WDYYB is still being played so no extra information is printed except for the summary information at the end.

```
<-analyse(1).

-----------------------------------
why dont you talk to him.

 * New Game = WDYYB
   with global social levels:
                    speaker 1 = adult
                    speaker 2 = adult

---Linguistic Analysis---

Verb:talk agent:you recip:him
```

```
SUMMARY OF PARSE VARIABLES
 INTERROGATIVE = T
 TENSE = present
 AUX = do
 NEGATIVE = not

(IS-why?(you talk him ))

---Psychological Analysis---

SUMMARY OF POSSIBLE TA KEYWORDS
 ADULT = why

SENTENCE MAY HAVE SOCIAL LEVEL = adult.

-----------------------------------
yes but he doesnt listen.

---Linguistic Analysis---

Verb:listen agent:he

SUMMARY OF PARSE VARIABLES
 INTERROGATIVE = F
 TENSE = present
 AUX = does
 NEGATIVE = not

(not (yes (he listen )))

---Psychological Analysis---

SUMMARY OF POSSIBLE TA KEYWORDS
 No keyword indicators in this sentence

-----------------------------------
did you try to write him a note.

---Linguistic Analysis---

Verb:write agent:you recip:him patient:note

SUMMARY OF PARSE VARIABLES
 INTERROGATIVE = T
 TENSE = past
 AUX = did

(IS-?(you.try (you write him (note ) )))

---Psychological Analysis---

SUMMARY OF POSSIBLE TA KEYWORDS
```

```
 A CHILD = try

SENTENCE MAY HAVE SOCIAL LEVEL = adult.

-----------------------------------
yes but he does not read notes.

---Linguistic Analysis---

Verb:read agent:he patient:note

SUMMARY OF PARSE VARIABLES
 INTERROGATIVE = F
 TENSE = present
 AUX = does
 NEGATIVE = not

(not (yes (he read (note ) )))

---Psychological Analysis---

SUMMARY OF POSSIBLE TA KEYWORDS
 No keyword indicators in this sentence

-----------------------------------
PARSE COMPLETE.

 -- SPEAKER1 (TH) --
why dont you talk to him
did you try to write him a note

SOCIAL LEVEL = adult
  DEEP LEVEL = parent

 -- SPEAKER2 (P) --
yes but he doesnt listen
yes but he does not read notes

SOCIAL LEVEL = adult
  DEEP LEVEL = child

GAME WDYYB FOUND - Why dont you _ Yes but

analyse(1)<-
```

The above example shows the simplest case of a T.A. game occurring. The same game is maintained throughout the conversation and the game is initially recognized by word matching. The words "why dont you" are listed in the WDYYB game

structure as evidence that the game "Why Dont You - Yes But" is being played so the program prints out a statement showing that a new game has begun and the social level of the ego states associated with it.

Linguistic analysis of the sentence "Why dont you talk to him?" begins with identifying the verb as "talk", the agent as "you", and the recipient as "him". The adverbial or parse variables show that the sentence is a present tense interrogative that contains a negative and an auxiliary verb. The auxiliary verb "do" is not very important since it acts mostly as a place holder in the question. The negative, however, is important because it indicates a presupposition. In this case, the speaker is assuming that the listener has not yet tried talking to 'him'.

The final step in the linguistic analysis is to print out the clausal form of the sentence. The general form "(noun verb noun)" was chosen over the common clause form "(verb noun noun)" because it keeps more of the structure of the original sentence and hence is easier to read. Any adverbs or WH-words are placed in front of the clause as well as any negatives when the sentence is not an interrogative.

Psychological analysis begins when the sentence is scanned for the Transactional Analysis ego state level indicators; any such words discovered at this stage, plus their ego states are printed. For example, in the first sentence, the adult word "why" is found. The next step determines the probable social level of the sentence. If a game is present, the social level

is the one found in the corresponding game structure; otherwise, the social level is that of any keywords found or may in fact be unknown if no such keywords exist. The social ego state level associated with the T.A. game structure is referred to as the global social level by the program. For the first sentence, both the keyword check and game social ego levels indicate Adult social level.

The word match done to find games at the beginning and the clause type check done after linguistic analysis are also considered to be part of the psychological analysis. Since the first sentence conformed to the clause type rules in the WDYYB game structure, no exceptions were printed.

The remaining utterances in the conversation follow the same type of analysis. The summary at the end of the dialogue reprints the sentences of each speaker and the corresponding social and deep levels of the ego states found in any game. Notice that if no game had been found, the deep ego state levels could not have been printed. Finally, the name of the game present at the end of the conversation is printed, if one exists. For this example, the game WDYYB was present throughout the dialogue.

The second example shows what happens when the conditions for recognizing two games are almost the same. Both the games WDYYB and "Why did you - No but" or YDNB have the same type of opening sentence. When the second sentence is read, however, this conflict is resolved. To simplify reading the results, many of the conversations tested were only two sentences long.

```
<-analyse(6).

-----------------------------------
why dont you give him the information.

 * New Game = WDYYB
   with global social levels:
                    speaker 1 = adult
                    speaker 2 = adult


---Linguistic Analysis---

Verb:transfer agent:you recip:him patient:information

SUMMARY OF PARSE VARIABLES
 INTERROGATIVE = T
 TENSE = present
 AUX = do
 NEGATIVE = not

(IS-why?(you transfer him (information ) ))

---Psychological Analysis---

SUMMARY OF POSSIBLE TA KEYWORDS
 ADULT = why

SENTENCE MAY HAVE SOCIAL LEVEL = adult.

-----------------------------------
no but i was talking to him.

**Conflict, Old Game = WDYYB
            New Game = YDNB
                with global social levels:
                   speaker 1 = adult
                   speaker 2 = adult


---Linguistic Analysis---

Verb:talk agent:i recip:him

SUMMARY OF PARSE VARIABLES
 INTERROGATIVE = F
 TENSE = pastprogressive
 AUX = was
 NEGATIVE = no

(no (i talk him ))
```

```
---Psychological Analysis---

SUMMARY OF POSSIBLE TA KEYWORDS
 No keyword indicators in this sentence

-----------------------------------
PARSE COMPLETE.

 -- SPEAKER1 (TH) --
why dont you give him the information

SOCIAL LEVEL = adult
  DEEP LEVEL = parent

 -- SPEAKER2 (P) --
no but i was talking to him

SOCIAL LEVEL = adult
  DEEP LEVEL = child

GAME YDNB FOUND - Why did you _ No but

analyse(6)<-
```

In this second test dialogue, the first speaker may have been trying to start either of the games YDNB or WDYYB or in fact, may have been simply asking a question with no thought of trying to enter any Transactional Analysis game. Following speaker one, however, speaker two responds with a sentence that confirms that YDNB is the game to be played.

The first sentence is analysed the same way as the first sentence of the previous example in that WDYYB is thought to be the T.A. game present. Using word matching, the program could have chosen YDNB as the current game but PROLOG will chose axioms in the order in which they are entered in the database, and as shown in Appendix D, the WDYYB game structure is entered before that of YDNB. Since the first sentence of both games can be similar, it is not until the second sentence is tested that

the conflict is resolved.

The third example in this chapter illustrates the termination of a T.A. game such that at the end of the conversation, no game is present. The particular game found is ICBYSOB or 'I Can Beat You at Your Own Game You SOB'. The second utterance of speaker two indicates that the game is to be discontinued.

```
<-analyse(7).

-----------------------------------
we need to discuss the report.

 * New Game = ICBYSOB
   with global social levels:
                    speaker 1 = adult
                    speaker 2 = adult


---Linguistic Analysis---

Verb:talk agent:we topic:report

SUMMARY OF PARSE VARIABLES
 INTERROGATIVE = F
 TENSE = present

(we.need (we talk (report ) ))

---Psychological Analysis---

SUMMARY OF POSSIBLE TA KEYWORDS
 No keyword indicators in this sentence

-----------------------------------
i will do my own work.

---Linguistic Analysis---

Verb:do agent:i recip:work

SUMMARY OF PARSE VARIABLES
 INTERROGATIVE = F
 TENSE = present
```

```
 MODAL = will

(i do (own work ) )

---Psychological Analysis---

SUMMARY OF POSSIBLE TA KEYWORDS
 No keyword indicators in this sentence

-----------------------------------
now we must talk about your work.

---Linguistic Analysis---

Verb:talk agent:we topic:work

SUMMARY OF PARSE VARIABLES
 INTERROGATIVE = F
 TENSE = present
 MODAL = must

(now (we talk (work ) ))

---Psychological Analysis---

SUMMARY OF POSSIBLE TA KEYWORDS
 C PARENT = must

SENTENCE MAY HAVE SOCIAL LEVEL = adult.

-----------------------------------
what do you want to know.

---Linguistic Analysis---

Verb:know agent:you

SUMMARY OF PARSE VARIABLES
 INTERROGATIVE = T
 TENSE = present
 AUX = do

(IS-what?(you.want (you know )))

---Psychological Analysis---

SUMMARY OF POSSIBLE TA KEYWORDS
 ADULT = what
 F CHILD = want


SENTENCE MAY HAVE SOCIAL LEVEL = adult.
```

```
 ** TA GAME - ICBYSOB STOPPED

-----------------------------------
PARSE COMPLETE.

 -- SPEAKER1 (Boss) --
we need to discuss the report
now we must talk about your work

SOCIAL LEVEL = adult

 -- SPEAKER2 (Emp) --
i will do my own work
what do you want to know

SOCIAL LEVEL = adult


NO GAME PRESENT

analyse(7)<-
```

The employer 'Boss' begins the game ICBYSOB by wanting to discuss something and the employee 'Emp' is at first defiant but later decides to be obedient so the game is stopped. Again, the game, here ICBYSOB, is discovered by matching the words of the first utterance against the game structures. The next two sentences obey the rules that show that ICBYSOB is present but a problem occurs with the last sentence. The clause type rules for the game ICBYSOB show that speaker two must use noninterrogative sentences containing the modal "will" of the form @i.#verb.NIL or the word "I" followed by a verb. Since the last sentence does not follow this pattern, the game is stopped and no game is present at the end of the conversation.

For more examples of the system in operation, turn to Appendix G. Included there are sample conversations that contain no games, conversations where the game is recognized

other than by word matching, or various combinations of the other games that the system knows about.

In general, the system seems to work well on the Transactional Analysis model for which it was designed. The main thing to consider when testing the program on additional game types is that the game structures for each game must be different in some way from every other game. It is this uniqueness that identifies each game and permits the parser to predict the contents of additional sentences. The more general problems involved in the approach of understanding a dialogue psychologically as an aid in linguistic parsing are discussed in the next chapter.

CHAPTER 6

Conclusion

One of the areas neglected in the attempt to understand natural language dialogue is the psychological import of an utterance. The lack of consensus amongst psychologists as to what is, or determines, psychological meaning is one reason this type of analysis has been missing. However, since psychological content can affect the overall meaning of a sentence, some consideration should be made to include psychological theory as part of sentence parsing in conversation. Some of the current psychological theories depend on the actual words said or the meaning of a sentence or both. This means that any system including such theories would have to be constructed so that the psychological testing can be done at various stages of parsing.

This thesis is an attempt to build a system upon which psychological analysis could be added. However, we must be careful when adding more levels of analysis that there is not a corresponding increase in program inefficiency or complexity. One example of adding more analysis in this system is the step where the program scans the sentence for Transactional Analysis ego state keyword indicators and for phrases particular to games. If this is done at the same time as the scan for idiomatic phrases, then all word and phrase scanning can be done at once.

An area where further work can be done in the linguistic analysis component of the program is in the choice of a primitive set of verbs. The system currently uses a set of verbs chosen mostly in an ad hoc manner but ideas such as Schanks's primitive ACTS could be used. Schank's ACTs by themselves are not a large enough number of verbs because some of the T.A. games are identified using specific types of verbs and the generalized ACTs do not contain enough detail. The verbs chosen for the system seem to be sufficient but if the number of verbs grows, the selection of a primitive verb set would probably have to be made more formal.

The diversity of spoken language has also caused problems in the system. Dialogue contains more idiomatic phrases and incomplete sentences than written text. For example, the phrase, "If it weren't for you," is idiomatic but it is difficult to find an equivalent non-idiomatic phrase that means the same thing. Currently the system just translates the phrase into clause form directly without any attempt at simplifying. Adding the capability to process incomplete sentences, such as in the Hayes and Mouridian system (Hayes and Mouridian 1981), would ensure that more sentences could be parsed correctly. The addition of more rules at the clause location step of the parsing is an easy task and would allow more incomplete sentences to be accepted but there would have to be routines to solve the additional anaphora reference problems that would occur.

One other area for possible extensions is better use of the

Transactional Analysis game structure variables. Each game has variables associated with it that describe conditions on the clause form of the two speakers' utterances. If the conditions are not met, then the particular game is not present. The conditions to be matched are of four types; exact word matches, word class types, sentence variable equalities, and something that has loosely been called sentence type. At the moment, sentence type means that the sentence is interrogative, imperative, or declarative and there is a routine called by the condition matcher to identify the specific sentence type. This sentence type variable could be extended to include other features of sentences not necessarily captured by the clause type conditions of exact words or word classes. For example, some phrases have a sort of real world social or psychological knowledge that most people would interpret the same way. If a person asks a reasonable request and someone else responds with, "I won't do it", then that person is being petulant and uncooperative. This type of analysis could be added to the system to identify more types of games. There is, however, a limit on the number of T.A. games in existence and of these games, some must be eliminated because they are identified by physical actions and tone of voice.

This presents the question of whether or not Transactional Analysis is a good technique for determining psychological meaning in a conversation. T.A. is a method that, although easy to incorporate in a program, is not all that it should be. Not all psychologist believe that Transactional Analysis is the

answer and at the moment it is out of style as an analysis technique. In spite of this, T.A. can be, and is, used in some circumstances.

This thesis has shown that T.A. can be added to general linguistic analysis as a psychological analysis method. Most other psychological dialogue analysis techniques are not well defined or seem to be the result of intuition and cannot be described formally enough to add to a computer program. Since T.A. has been used successfully by therapists, it must have some validity, and so is a reasonable choice as an analysis technique to demonstrate a way of finding psychological meaning.

Although the system has a few linguistic problems, some of which are caused by the wide variation in conversational sentence form, the general design of the program makes the addition of the psychological understanding method quite easy. Just as syntactic and semantic parsing are dependant on one another, psychological meaning also seems to be dependant on them. Using Transactional Analysis also means that further utterances of a small set of conversations can be predicted.

The psychological meaning of an utterance is important because it sometimes shows the reason for saying a particular sentence. For example, in the T.A. game "Why Don't You - Yes But", the second speaker is not really interested in hearing the first speaker's suggestions but just wants to turn down suggestions. When such a situation arises in the conversation, the first speaker should realize that help is not really wanted. In a computer system where the computer is helping the user, (as

in Levin and Moore 1977), the computer should realize that a user wanting to play the game WDYYB does not want help and that another tactic should be tried. If the psychological meaning of an utterance is known, then that meaning should be responded to instead of the literal meaning. In another example, natural language interfaces for data bases, being able to recognize some psychological clues may be helpful in determining what the user really wants.

The programming language used for developing the system also plays an important role. The language PROLOG, based on symbolic logic, has been used for symbolic integration, plan formation, compiler design, data base description and query, expert systems, and natural language. The pattern matching in PROLOG makes it especially useful for natural language systems that use patterns and for matching exact words or clause types as done in the psychological analysis section. The depth first search with automatic failure driven backtracking directs the choices in parsing so that the only worry is the order in which clauses are written. Since PROLOG chooses clauses in the order in which they are entered, the clauses that are most likely to be chosen should be entered first for efficiency reasons. Overall, the language PROLOG is easy to use, contains features that were useful, and seems to run very efficiently. The conversation analyses did not take very long and the poor garbage collection in MTS PROLOG did not become a factor in using up the available space until several conversations had been tested.

Many of the current techniques in analyzing conversations also use the language PROLOG. Warren and Pereira's newest system, (Warren and Pereira 1982), uses PROLOG to translate English language queries to a logic representation that is in fact PROLOG. For accessing databases and answering queries, this is a good idea that is simple to implement. One extension to the program for this thesis could be changing the current clausal logic representation to a PROLOG logic representation.

Some systems are even developing specialized grammars just for parsing dialogue. Robinson's DIAGRAM (Robinson 1982) is one such grammar. There are so many problems that are specific to analyzing conversations, that using parsing techniques developed solely for dialogues may be what has to be done. The presence of problems in analyzing dialogues, however, does not mean that extra analysis, such as that for psychological meaning, should not be included.

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APPENDIX A

T.A. Keyword Dictionary

MTS PROLOG Anomalies

Some aspects of the MTS version of Prolog are irregular when compared with the more common version described by Clocksin and Mellish (Clocksin and Mellish 1981). Lists are represented by a string with the elements separated by periods as in "a.b.c.NIL", and variables are represented with an asterisk in front as in "X", where X is the variable. Any other special symbols have been introduced as operators and will be described later.

Transactional Analysis Key Words

The Transactional Analysis keyword dictionary lists the key word or words used to indicate possible ego state levels. The ego states are Parent, Adult, and Child with the Parent and Child ego states further divided into Controlling Parent, Nurturing Parent, Free Child, and Adapted Child.

```
/**********************************/
/* T.A. keyword dictionary        */
/**********************************/

 /* adult clues */

PSYCHWORD(adult,what).
PSYCHWORD(adult,why).
PSYCHWORD(adult,where).
PSYCHWORD(adult,when).
PSYCHWORD(adult,who).
PSYCHWORD(adult,how).
PSYCHWORD(adult,comparative).
PSYCHWORD(adult,true).
PSYCHWORD(adult,false).
PSYCHWORD(adult,probable).
PSYCHWORD(adult,possible).
PSYCHWORD(adult,unknown).
PSYCHWORD(adult,objective).
PSYCHWORD(adult,correct).
PSYCHWORD(adult,practical).
PSYCHWORD(adult,quantity).

PSYCHWORDS(adult,how.much.NIL).
PSYCHWORDS(adult,in.what.way.NIL).
PSYCHWORDS(adult,i.think.NIL).
PSYCHWORDS(adult,i.see.NIL).
PSYCHWORDS(adult,it.is.my.opinion.NIL).

 /* controlling parent clues */

PSYCHWORD(cparent,bad).
PSYCHWORD(cparent,should).
PSYCHWORD(cparent,ought).
PSYCHWORD(cparent,must).
PSYCHWORD(cparent,always).
PSYCHWORD(cparent,never).
PSYCHWORD(cparent,ridiculous).

 /* nurturing parent clues */

PSYCHWORD(nparent,good).
PSYCHWORD(nparent,nice).
PSYCHWORD(nparent,cute).
PSYCHWORD(nparent,splendid).
PSYCHWORD(nparent,tender).

PSYCHWORDS(nparent,i.love.you.NIL).
PSYCHWORDS(nparent,now.always.remember.NIL).
PSYCHWORDS(nparent,i.cannot.for.the.life.of.me.NIL).
PSYCHWORDS(nparent,once.and.for.all.NIL).
```

```
 /* free child clues */

PSYCHWORD(fchild,wow).
PSYCHWORD(fchild,fun).
PSYCHWORD(fchild,want).
PSYCHWORD(fchild,wont).
PSYCHWORD(fchild,ouch).
PSYCHWORD(fchild,hi).

 /* adapted child clues */

PSYCHWORD(achild,cannot).
PSYCHWORD(achild,wish).
PSYCHWORD(achild,try).
PSYCHWORD(achild,hope).
PSYCHWORD(achild,please).
PSYCHWORD(achild,big).
PSYCHWORD(achild,bigger).
PSYCHWORD(achild,better).
PSYCHWORD(achild,best).

PSYCHWORDS(achild,i.guess.NIL).
PSYCHWORDS(achild,thank.you.NIL).
PSYCHWORDS(achild,when.i.grow.up.NIL).
PSYCHWORDS(achild,i.wish.NIL).
PSYCHWORDS(achild,i.want.NIL).
PSYCHWORDS(achild,i.dunno.NIL).
PSYCHWORDS(achild,i.gonna.NIL).
```

APPENDIX B

More About T.A. Games

This appendix lists the Transactional Analysis games used in the thesis program, their analysis, and sample dialogues typifying the game. The game WDYYB is not included as a detailed description of it is contained in chapter 3. The first game "Ain't it Wonderful" is considered a "good" game because no speaker has a motive of "getting" the other speaker. The remaining games are considered bad games.

Aint't It Wonderful (AIW)

The respondant finds a good point in anything.

Ex. If the lights go out, says "Aint't it wonderful, now we can rest our eyes."

Social Level: A -> A

Psychological Level: C -> C

I Can Beat You at Your Own Game, You SOB (ICBYSOB)

The respondant is seeking reassurance by saying that the first speaker is not better/tougher/smarter.

Ex 1. I can do that better than you.

2. Envious spouse, peer group.

Social Paradigm: A -> A

A: We need to discuss what I've worked out.

A: Since it is related to my interests, I'll do it.

Psychological Paradigm: C -> C

C: You're not better than me, ha-ha.

C: Yes, you're right. I'm not better than you.

I Really Know the Answer, But (IRKTAB)

The respondant is seeking reassurance by saying that he/she has all the answers.

Ex 1. I know where it is, but I won't tell you.

2. I can't tell you until...

Social Paradigm: A -> A

A: The answer is not available until...

A: Could you please elaborate on that.

Psychological Paradigm: P -> C

P: You are unworthy of benefitting from my superior ability.

C: I knew you were going to let me down.

Now I've Got You, SOB (NIGYSOB)

This game is played by someone who interacts with another in a reasonable way until a moment of climax when he switches tactics and says "Now I've got you...", "I knew you would...", or something similar. At this time the player collects some feeling of payoff or triumph. This game is closely related to ICBYSOB.

Social Level: A -> A

Psychological Level: P -> A

<u>If it Weren't For You</u> (IWFY)

The aim of the game is most commonly reassurance but sometimes is vindication. The game players are usually a married couple.

Ex 1. It's not that I'm afraid, it's that he won't let me go.

2. It's not that I'm not afraid, it's that he holds me back.

Social Paradigm: P -> C

P: You stay home and take care of the house.

C: If it weren't for you, I could be having fun.

Psychological Paradigm: C -> C

C: You must always be here when I get home. I'm afraid of desertion.

C: I will be if you help me avoid phobic situations.

<u>Why Did You - No But</u> (YDNB)

As the name suggests, YDNB is closely related to the game "Why Don't You - Yes But". IN YDNB, however, it is the Parent who eventually wins and the Child who retires in confusion. The person receiving the suggestions will immediately accept the ideas and it is only when he is deeply involved that the suggester perceives that is being turned against.

Social Level: A -> A

Psychological Level: P -> C

APPENDIX C

List of Cases

The following is a list of the cases used, with examples showing the case in question underlined. Those cases which are identified by particular prepositions will have those prepositions listed. Some of the examples are from Lewis Caroll's "Alice in Wonderland" or inspired by the text in the book.

Agent

The wind called his name.

The Queen of Hearts, she made some tarts.

The tarts were stolen by the Knave of Hearts.

"Why is a raven like a writing-desk?"

Tara is the ancient home of Irish kings.

Patient

The elegant cat tried on a rhinestone-studded collar.

The elves grew gigantic mushrooms in the woods.

"Do cats eat bats?"

The leprechaun by the fire was reading the Book of Kells.

Preps: after, on

Location

The master says you've to go down the chimney.

Suddenly a White Rabbit with pink eyes ran close by her.

There is a lovely beach near the river.

They very soon came upon a Gryphon, lying fast asleep in the sun.

Preps: at, before, beside, by, down, in, near, on, under, up, upon

Time

The Duchess took her choice, and was gone in a moment.

"I wonder how many miles I've fallen by this time?" she said aloud.

During tea time, the children played with the dogs.

After watching it a minute or two, she made it out to be a grin.

Preps: about, after, at, before, by, during, in, near, when, while

Recipient

She was going to give the hedgehog a blow with its head.

The Vikings gave Ireland the idea of coinage.

She picked up a little bit of stick, and held it out to the puppy.

Preps: for, to

Source

She took down a jar from one of the shelves as she passed...

An invitation from the Queen to play croquet.

The silver ship shot down from the sky.

Preps: from

Destination

...the next thing is, to get into that beautiful garden..

...and soon found herself safe in a thick wood.

Alice clambored onto the mushroom.

Preps: at, beside, in, into, on, onto, to, with

Duration

...she had grown so large in the last few minutes that she wasn't a bit afraid of interrupting him.

The rainbow waited for an hour before leaving.

Preps: for, in

Instrument

She opened the garden gate with a large golden key.

You find some children digging in the sand with wooden spades.

The Queen struck the hedgehog with a flamingo.

Preps: with

Manner

They left in a hurry.

The tiger striped cat lashed its tail with menace.

...and the poor little thing was waving his tail about in a melancholy way.

Preps: by, in, with

Co-agent

"The reason is", said the Gryphon, "that they would go with the lobsters to the dance."

The man with his dog ran around the seawall.

...the great hall, with the glass table and the little door, had vanished completely.

Preps: with

Topic

"Tell her something about the games now."

Last night I dreamt of candlesticks and marshmallows.

...thinking of little Alice and all her wonderful Adventures...

Preps: about, of, to

Description (A case of the noun)

There was a table set out under a tree in front of the house.

Read me the story of Alice in Wonderland.

The Celts of Ireland were a hardy race.

Preps: after, at, before, by, from, in, near, of, on, under, with

Case Table Used in Program

The case table contains the prepositions and the possible cases that they indicate and is used in determining what cases the verb can take. The case types for each preposition are ordered in a list with the most likely types ordered first so that, on average, this part of the program will run faster than if the types were ordered arbitrarily.

```
/*************************************/
/* Casetable is a list of prepositions */
/* and their possible cases. This is   */
/* used to disambiguate possible       */
/* verb case meanings.                 */
/*************************************/

CASETABLE(about,time.topic.NIL).
CASETABLE(after,time.desc.patient.NIL).
CASETABLE(at,loc.desc.time.destn.NIL).
CASETABLE(before,time.loc.desc.NIL).
CASETABLE(beside,loc.destn.NIL).
CASETABLE(by,loc.desc.time.agent.instr.manner.NIL).
CASETABLE(down,loc.NIL).
CASETABLE(during,time.NIL).
CASETABLE(for,recip.duration.NIL).
CASETABLE(from,source.desc.NIL).
CASETABLE(in,loc.time.desc.manner.destn.duration.NIL).
CASETABLE(into,destn.NIL).
CASETABLE(near,loc.desc.time.NIL).
CASETABLE(of,desc.topic.NIL).
CASETABLE(on,loc.desc.destn.patient.NIL).
CASETABLE(onto,destn.NIL).
CASETABLE(to,recip.destn.topic.NIL).
CASETABLE(under,loc.desc.NIL).
CASETABLE(up,loc.NIL).
CASETABLE(upon,loc.NIL).
CASETABLE(when,time.NIL).
CASETABLE(while,time.NIL).
CASETABLE(with,coagent.instr.with.manner.desc.destn.NIL).
```

APPENDIX D

T.A. Game Structures

The following Transactional Analysis game forms are of the type discussed in Chapter 4. The game structure includes the ego state levels and various conditions or clues about the game for the two speakers. The full names of the games are listed in the GNAME variables.

```
/*********************************/
/* T.A. game forms.              */
/*********************************/

GAME(WDYYB,adult,adult,parent,child,
     why.dont.you.NIL,yes.but.NIL,
     @you.#verb.NIL¦INTERROGATIVE=T¦NIL,
     INTERROGATIVE=F¦NEGATIVE=not¦ADVERB=yes¦CONJ=but¦NIL).

GAME(IWFY,parent,child,child,child,
     NIL,if.it.werent.for.you.NIL,%imperative¦NIL,
     @it.@is.@you.NIL¦CONJ=if¦INTERROGATIVE=F¦NEGATIVE=not¦NIL).

GAME(YDNB,adult,adult,parent,child,
     why.did.you.NIL,no.but.NIL,
     @you.#verb.NIL¦INTERROGATIVE=T¦NIL,
     INTERROGATIVE=F¦NEGATIVE=no¦CONJ=but¦NIL).

GAME(NIGYSOB,adult,adult,adult,parent,
     NIL,i.knew.you.would.NIL¦now.i.have.got.you.NIL,
     INTERROGATIVE=F¦@i.#verb.NIL¦NIL,
     INTERROGATIVE=F¦ADVERB=now¦@i.#verb.@you.NIL¦NIL).

GAME(IRKTAB,adult,adult,parent,child,
     the.answer.is.not.NIL¦i.cant.give.you.the.answer.NIL,
     could.you.please.NIL,
     NEGATIVE=not¦INTERROGATIVE=f¦@answer.NIL¦NIL,
     INTERROGATIVE=T¦MODAL=could¦@you.#verb.NIL¦NIL).
```

```
GAME(ICBYSOB,adult,adult,child,child,
    we.need.to.discuss.NIL¦we.must.talk.about.NIL,i.will.do.NIL,
    INTERROGATIVE=F¦@we.#verb.NIL¦NIL,
    INTERROGATIVE=F¦MODAL=will¦@i.#verb.NIL¦NIL).

/* A "good" game. */

GAME(AIW,adult,adult,child,child,
     NIL,now.we.can.NIL,
     INTERROGATIVE=F¦#noun.NIL¦NIL,
     INTERROGATIVE=F¦@we.#verb.NIL¦MODAL=can¦NIL).

/* Long form of game names. */

GNAME(WDYYB,'Why dont you _ Yes but').
GNAME(IWFY,'If it werent for you').
GNAME(YDNB,'Why did you _ No but').
GNAME(NIGYSOB,'Now I''ve Got You SOB').
GNAME(AIW,'Ain''t it Wonderful').
GNAME(IRKTAB,'I Really Know the Answer, But').
GNAME(ICBYSOB,'I Can Beat You at Your Own Game You SOB').
```

APPENDIX E

Verb Tables

The following tables list the verbs, their semantic meanings, and possible cases. A verb may be transitive, copula, intransitive, or take an indirect object and each verb will have a separate listing under the appropriate table. The general form of the entries is:

INDOBJ(*verb,*rep,*c1,*c2,*c3) where

INDOBJ = the type of verb, here indirect object

*verb = the verb to be checked

*rep = the semantically equivalent replacement verb

*c1,*c2,*c3 = various cases of the verb

The cases are of the form "casename:casetype" where the casename is one of agent, patient, source, etc. and casetype is a classification and may be in a list format. There can be several possible case types which will be ordered in a special type of list separated by the symbol ";". The symbol T means that the casetype can be of any classification. There are a number of cases according to the number possible for the various types of verbs as in the above example, where the indirect object verbs take three cases.

```
/*************************************/
/* Semantic dictionary for verbs.    */
/*************************************/

/* Intransitive verbs. */

INTRANS(be,exist,agent:T).
INTRANS(exist,exist,agent:T).
INTRANS(go,move,agent:animate).
INTRANS(grow,grow,agent:animate).
INTRANS(hope,want,agent:human).
INTRANS(listen,listen,agent:animate).
INTRANS(look,see,agent:animate).
INTRANS(move,move,agent:animate).
INTRANS(read,read,agent:human).
INTRANS(run,move,agent:animate).
INTRANS(see,see,agent:animate).
INTRANS(stay,stay,agent:T).
INTRANS(talk,talk,agent:human).
INTRANS(think,think,agent:human).
INTRANS(try,try,agent:animate).
INTRANS(walk,move,agent:animate).
INTRANS(wish,want,agent:human).
INTRANS(write,write,agent:human).

/* Copula verbs. */

COPULA(be,is,agent:T,patient:T).


/* Transitive verbs. */

TRANS(be,is,agent:T,source:loc;recip:animate;patient:T;
                    duration:T;NIL).
TRANS(come,move,agent:animate,destn:loc;source:loc;NIL).
TRANS(discuss,talk,agent:human,topic:T).
TRANS(do,do,agent:T,time:time;loc:loc;recip:T;topic:T;NIL).
TRANS(get,possess,recip:¬abstract,patient:T).
TRANS(give,transfer,agent:animate,patient:T).
TRANS(go,move,agent:animate,source:loc;destn:loc;NIL).
TRANS(grow,grow,agent:human,patient:animal.vegatable.NIL).
TRANS(have,possess,agent:¬abstract,patient:T).
TRANS(hope,want,agent:human,patient:T).
TRANS(know,know,agent:animate,patient:T).
TRANS(listen,listen,agent:animate,source:human.music.T.NIL).
TRANS(look,see,agent:animate,patient:T).
TRANS(move,move,agent:animate,loc:loc).
TRANS(need,want,agent:animate,patient:T).
TRANS(possess,possess,agent:¬abstract,patient:T).
TRANS(read,read,agent:human,recip:animate;
                patient:literature.abstract.NIL;NIL).
```

```
TRANS(run,move,agent:animate,source:loc;destn:loc;
                coagent:animate;NIL).
TRANS(see,see,agent:animate,patient:T).
TRANS(stay,stay,agent:T,loc:loc).
TRANS(talk,talk,agent:human,recip:animate;topic:T;NIL).
TRANS(take,transfer,agent:human,source:loc;destn:loc;recip:T;
                     patient:T;NIL).
TRANS(thank,thank,agent:human,patient:animate).
TRANS(think,think,agent:human,topic:T).
TRANS(transfer,transfer,agent:animate,patient:T).
TRANS(try,try,agent:animate,patient:clothing).
TRANS(walk,move,agent:animate,source:loc;destn:loc;
                 coagent:animate;NIL).
TRANS(want,want,agent:animate,patient:T).
TRANS(wish,want,agent:animate,patient:T).
TRANS(write,write,agent:human,patient:literature;recip:human;
                  instr:pen;NIL).

/* Indirect object verbs. */

INDOBJ(discuss,talk,agent:human,topic:T,coagent:human).
INDOBJ(get,possess,recip:¬abstract,patient:T,agent:¬abstract).
INDOBJ(give,transfer,agent:animate,recip:T,patient:¬human).
INDOBJ(read,read,agent:human,recip:T,
                 patient:literature.abstract.NIL).
INDOBJ(transfer,transfer,agent:animate,recip:T,patient:¬human).
INDOBJ(write,write,agent:human,recip:human;instr:pen;NIL,
                   patient:literature).
```

APPENDIX F

Sample Conversations

The following are the sample conversations used to test the system. It was found to be easier to enter the conversations as a variable instead of retyping the conversations each time they were to be tested so the conversations are numbered so that they can be accessed individually. Each speaker has a name that is placed before the ":" as in a play script and the sentence is surrounded by single quotes. To add to the input problems, the MTS Prolog used does not like the "?" symbol and the "." is reserved for separating list elements. In place of the obvious, but unusable, sentence ending symbols, the "!" takes the place of a question mark and ";" represents a period. Finally, the entire conversation is considered to be a list of utterances so there is a NIL at the end.

```
/************************/
/* Conversation input. */
/************************/

CONVERSATION(1,TH:'why dont you talk to him'!
                P:'yes but he doesnt listen';
               TH:'did you try to write him a note'!
                P:'yes but he does not read notes';
               NIL).

CONVERSATION(2,J:'you stay home and look after the house';
               M:'if it werent for you i could be having fun';
              NIL).
```

```
CONVERSATION(3,J:'you stay home and look after the house';
               M:'i dont want to stay home';
              NIL).

CONVERSATION(4,TH:'why dont you run'!
                P:'yes but i dont want to run';
               TH:'why dont you walk'!
                P:'i will';
                 NIL).

CONVERSATION(5,M:'why did you give him the information'!
               F:'no but i was talking to him';
               NIL).

CONVERSATION(6,M:'why dont you give him the information'!
               F:'no but i was talking to him';
                  NIL).

CONVERSATION(7,Boss:'we need to discuss the report';
                Emp:'i will do my own work';
               Boss:'now we must talk about your work';
                Emp:'what do you want to know'!
              NIL).
```

APPENDIX G

More Examples of the System in Operation

The following conversations illustrate more of the features of the system. The first example shows that a Transactional Analysis game can be identified other than by word pattern matching on the first sentence. In this case, the game is not identified until the second sentence has been read. The condition for identifying the game IWFY or "If it Werent For You" is that the second speaker responds to a suggestion with the words "if it werent for you".

```
<-analyse(2).

-----------------------------------
you stay home and look after the house.

---Linguistic Analysis---

Verb:stay agent:you loc:home

Verb:see agent:you patient:house

SUMMARY OF PARSE VARIABLES
 INTERROGATIVE = F
 TENSE = present

(and (you stay (home ) )(you see (house ) ))

---Psychological Analysis---

SUMMARY OF POSSIBLE TA KEYWORDS
 No keyword indicators in this sentence

-----------------------------------
if it werent for you i could be having fun.
```

```
 * New Game = IWFY
   with global social levels:
                    speaker 1 = parent
                    speaker 2 = child


---Linguistic Analysis---

Verb:is agent:it recip:you

Verb:possess agent:i patient:fun

SUMMARY OF PARSE VARIABLES
 INTERROGATIVE = F
 TENSE = past.progressive
 MODAL = could
 AUX = be
 NEGATIVE = not

(not (if (it is you )(i possess (fun ) )))

---Psychological Analysis---

SUMMARY OF POSSIBLE TA KEYWORDS
 F CHILD = fun


SENTENCE MAY HAVE SOCIAL LEVEL = child.

-----------------------------------
PARSE COMPLETE.

 -- SPEAKER1 (J) --
you stay home and look after the house

SOCIAL LEVEL = parent
  DEEP LEVEL = child

 -- SPEAKER2 (M) --
if it werent for you i could be having fun

SOCIAL LEVEL = child
  DEEP LEVEL = child

GAME IWFY FOUND - If it werent for you

analyse(2)<-
```

The next conversation shows what happens when there is no

game present in the conversation. The conversation begins as does the previous example, but the seond speaker does not decide to begin the game IWFY, therefore, only analysis of the keyword types present is possible. In this case, the second speaker uses a word that may indicate a Child ego state and nothing can be said about the first speaker.

```
<-analyse(3).

-----------------------------------
you stay home and look after the house.

---Linguistic Analysis---

Verb:stay agent:you loc:home

Verb:see agent:you patient:house

SUMMARY OF PARSE VARIABLES
 INTERROGATIVE = F
 TENSE = present

(and (you stay (home ) )(you see (house ) ))

---Psychological Analysis---

SUMMARY OF POSSIBLE TA KEYWORDS
 No keyword indicators in this sentence

-----------------------------------
i dont want to stay here.

---Linguistic Analysis---

Verb:stay agent:i

SUMMARY OF PARSE VARIABLES
 INTERROGATIVE = F
 TENSE = present
 AUX = do
 NEGATIVE = not

(not (here (i.want (i stay ))))

---Psychological Analysis---

SUMMARY OF POSSIBLE TA KEYWORDS
 F CHILD = want
```

SENTENCE MAY HAVE SOCIAL LEVEL = child.

PARSE COMPLETE.

-- SPEAKER1 (J) --
you stay home and look after the house

NO TA EVIDENCE PRESENT

-- SPEAKER2 (M) --
i dont want to stay here

SOCIAL LEVEL = child

NO GAME PRESENT

analyse(3)<-