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THE DYNAMICS OF DIALOGUE IN A RESTRICTED REFERENCE DOMAIN

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Thesis submitted for the Degree of Doctor of Philosophy in the Department of Psychology, Faculty of Social Science, University of Glasgow, July 1989.

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CONTENTS

ABSTRACT

This thesis is concerned with the development of interactive communication skills in young school children, that is, skills which depend upon the linguistic interplay between dialogue participants. Semantic negotiation is investigated in the restricted context of a task-oriented game to examine how communicators co-ordinate their use and interpretation of language.

The conversations considered were generated from pairs of same-aged 8-, 10-, and 12-year-old children playing a specially designed computer maze-game which elicits spontaneous dialogue, yet within a very restricted domain. The dialogues typically contain a number of location descriptions within a pre-defined spatial network, and such description sequences enable an exploration of the emergence of co-ordinated description schemes. As well as this, various aspects of problem solving abilty were investigated since the task involved a joint co-ordination problem.

Results indicated that all age groups were able to engage in semantic negotiation and develop co-ordinated description schemes to describe locations on the maze, however there were certain developmental differences in their choice of schemes and their ability to increase co-ordination over the games. Furthermore, it appeared that the younger children were co-ordinating on the expressions to use, without fully understanding each other.

Yet these results indicate that interactional processes are essential to the establishment of meaning, and that young children are able to infer meaning from the interaction in specific contexts of use. These findings tend to suggest that social-pragmatic factors play a critical role in the development of meaning, and indicate that the general process of co-ordination (in respect to language), may be a basic component of all human interactional dialogue.

THESIS OVERVIEW

"Each of us is a prisoner in a solitary tower,
and he communicates with the other prisoners who
form mankind, by conventional signs that have
not quite the same meaning."
Somerset Maugham (1951)

The experimental studies reported in this thesis explore the processes of semantic co-ordination in natural dialogue and how these processes develop in school age children. The aim is to investigate the meaning of expressions in natural dialogue empirically, which involves concentrating on one particular area. The area chosen examines the meaning of location descriptions which are generated within the context of a specially designed computer maze-game task. The approach is to look at different pairs of children engaged in a task-oriented dialogue and examine how their interpretation and use of language converges to fit the particular functional and interactional context of the exchange.

The thesis is based on the standing assumption that successful communication relies on the co-ordinated use of a shared meaning system, which rests on the dynamic relationship between the users of the language and language itself. Several aspects of communication are explored, in particular, how speakers and listeners negotiate and co-ordinate on the meaning of natural language expressions.

The focus of attention in this thesis is therefore on how young school children converge and enter into a shared local system of meaning, within particular dialogues. This semantic and conceptual development is examined with a view to chronicling the development of a major pragmatic and interactional skill.

A computer controlled maze-game was used for this investigation, where pairs of subjects spontaneously described positions on a maze. This restricted reference domain allows empirical control over the topic being discussed yet subjects were free to discuss maze locations when and how they pleased. Subjects played the game in pairs, seated in separate booths and communicated through headphones. Each player's task was to manoeuvre an X through the maze to an *, with the game only terminating when both players were in their respective goals. However, a number of barriers were placed in the paths of subjects, which could only be removed by requesting the co-operation of their partner, and finding out each others maze location.

Thus the dialogue elicited contained several location descriptions since success depends, to a certain extent, on establishing a co-ordinated spatial description scheme between two players.

The advantages of such a technique are that detailed comparisons of a large sample can be made, and comparisons across a wide range of age groups. The dialogues typically contain a number of location descriptions within a pre-defined spatial network, and it is the analysis of such sequences which enables one to explore the emergence of co-ordinated description schemes. Furthermore, task involvement generally produces natural and spontaneous speech since subjects typically become involved in solving the task and less aware of the language they produce.

Part I of the thesis (Chapters 1 to 3) covers the general background area while reviewing some of the relevant literature in this field. Part II (Chapters 4 to 8) reports the empirical work from the computer maze-game and the results.

Chapter 1 focuses on how communicators co-ordinate on the meaning of natural language expressions, and the role shared and mutual knowledge play in this process. It is argued that speakers and listeners use the interaction to infer the meaning of expressions in a dynamic way. This interactionist approach emphasises the speaker and listener, their common knowledge, and the social context of the exchange, in order to deduce meaning and communicate successfully.

The relevant literature was reviewed and semantic negotiation discussed both at a general and local level. For example, in relation to populations of speakers and then in terms of definite reference between particular communicators.

Chapter 2 focuses on the development of communication skills as they relate to language, and outlines various theoretical issues in this field. In particular, how the child develops and acquires the skills to enable them to communicate successfully, and how they learn to use terms in a shared and mutually effective way. This covers a very broad and complex area, so only the key issues that are relevant to the work in this thesis are focused upon.

An outline of the computer maze-game used in the thesis is provided in Chapter 3, followed by a review of some experiments which have used similar methods.

For example, co-operative games, explicit description from spatial arrays, and other types of experiment that constrain the topic of discourse in a similar way. The chapter concludes with a review of work carried out by Garrod and Anderson (1983, 1987) who used the same computer maze-game on adults. This proved useful as a comparison for the children's data.

Part II of the thesis covers the empirical studies and the results found. Chapter 4 describes the computer maze-game in depth with the procedure and experimental design. The following sections discuss children's general performance at solving the task in terms of efficiency and problem solving ability, and their language performance.

Chapter 5 deals with a more specific statistical analysis of the speech in relation to the semantic contents of location descriptions. It investigates the way that subjects refer to positions on the maze and the meaning behind their descriptions.

The co-ordination of descriptive patterns is investigated in Chapter 6, both between and within different subject pairs. This investigates dialogue co-ordination, any improvements in co-ordination across games, and subjects dynamics of choice of descriptive scheme across game.

Chapter 7 describes an independent study which was carried out to investigate dialogue descriptions which were produced in a less interactive environment than the computer maze-game. This may then be compared with results from the computer maze-game study.

The conclusions from the thesis are considered in Chapter 8 in relation to the theoretical issues and research discussed in Part I of the thesis. The results from the studies are incorporated into a wider context along with the issues and ideas produced from them.

In summary, the thesis explores how meanings may be established within particular dialogues, and considers social-pragmatic aspects as essential to this process - in particular, the interaction between the communicators. For example, where communicators use the interaction to infer the meaning of expressions rather than depending on any other isolated aspects of the individual. The development of these abilities are explored in young children, since such understanding seems critical for greater appreciation of the development of meaning.

PART I

BACKGROUND AND REVIEW

CHAPTER 1

THE ROLE OF SOCIAL-PRAGMATIC FACTORS IN COMMUNICATION

A. INTRODUCTION

This thesis explores the development of communication skills as they relate to language and investigates how speakers and listeners co-ordinate on the shared meaning of natural language expressions. It takes the view that communication is inherently a social process using language as the instrument to relate to others, and emphasises social-pragmatic aspects of dialogue. This interactionist approach takes into account language use, the users of that language, the knowledge they share with each other, and the context of the exchange. The thesis develops a certain approach to communication in language which will be explored in this chapter. For example the approach emphasizes dynamic aspects of natural language and how communicators use the interaction to infer the meaning of expressions. It relates meaning to the users of the language and discusses the role of shared knowledge for communication. However, this is not the only view one may take, and these social-pragmatic factors have often been underrated in the study of language.

The origins of pragmatics being a factor in language comes from Peirce (1957). He discussed three main levels of semiotic in language which are distinct but not necessarily independent. These are: syntactics, which involves the signs of that language and the relations between the signs; semantics, which investigates the relations between the signs and what they designate, that is their meaning; and pragmatics, which involves the relations between the signs, and what they specify in relation to the users of those signs. In its most general sense the meaning of natural language expressions depends on all three levels, however, social-pragmatic factors will be focused on throughout this thesis.

1. THE DYNAMICS OF NATURAL LANGUAGE

Language in relation to communication, basically involves two parties, and occurs over time. This extended interaction raises questions on the dynamics of natural language. Studying communication involves adopting one of two contrasting assumptions. One assumes that words have enduring and conventional meanings that can be represented in static structures, while the other highlights the flexibility of natural language where the speaker can manipulate words to convey different meanings in various situations (see Anderson (1983) for a full review on theories of meaning). Nelson (1985) stated that:
"These two approaches to meaning exemplify semantic models as a structural system on the one hand and as the functional realization of communicative intentions on the other."

While this thesis focuses on the latter, previous literature often adopted the former view and analysed the speaker, listener, and sentence, as isolated entities without reference to the wider social situation. Traditional work often concentrated on the rules, sound, and symbols of a language, and their interpretation.

Noam Chomsky (1957), responsible for the syntactic revolution, made researchers aware of the complexities of natural language. However, his syntactical structures approach emphasised the isolated sentence as the main unit of focus, devoid of the speaker, listener, and social context of the exchange.

Although relevant to contemporary research, this approach is now criticised for concentrating solely on the literal meaning and propositional content of the exchange. The interpretation of a sentence is not only dependent on these phonological, syntactical, and semantic rules, but also depends upon pragmatic factors. In the 19th century, Frege had considered such an approach, and defined the term proposition. He discussed how the meaning of expressions may be deduced independently of the communicators. This opposes the notion that meaning may evolve from the interaction between the communicators.

Alternatively, Rommetveit (1968, 83) has argued that what we convey in an utterance does not depend on the propositional content of the expression, but rather, who the listener is. Similarly our interpretation may depend on who the speaker is, and the target of the communication. For example, a statement such as:
"I felt the painting crying out to me"
would be interpreted differently, depending on whether it was uttered by a schizophrenic or an artist. Thus it appears that the meaning of expressions depends on the perceived relationship between speaker and listener. Successful communication relies on the co-ordinated use of a shared meaning system, something which only arises out of the dynamic relationship between the users of the language and the language itself.

Rommetveit (1983) stressed the dynamic nature of the meaning of expressions, and proposed that conversants may not be totally dependent on the set of predetermined assumptions, as defined by the conventional, dictionary definition of a word. Indeed Rommetveit (1983) argued:

"What is meant by what is said is neither fixed nor perfectly determinable in the way it is in Chomsky's idealized and perfectly homogeneous speech community."

He proposed that expressions have 'semantic potentialities' which are alternative meanings of the phrase in different contexts. These were far more important than their literal meaning. He compared conversations to contracts, where the interlocutors control the boundaries and limits of expressions and their extensional semantics - which is the set of meanings the terms may refer to in certain contexts.

Thus conversants are viewed as adopting a type of 'tacit contract' during an interaction which defines the meaning of expressions at a local level. Thus while global meanings are obviously central for communication, Rommetveit, and others such as Garrod and Anderson (1987), point out that local conventions of meaning may be central to our everyday use of language. As Garrod and Anderson conclude:

"...general conventions of meaning may serve only as starting points for interpretation, perhaps giving a default which may be overwritten by more local and transient conventions set up during the course of a dialogue."

According to such a view the meaning of expressions is often constructed dynamically in the course of a conversation. Communicators appear to negotiate and control meaning at a more local and informal level. In this way existing words can be used more effectively by adapting their meaning to suit the particular function of the exchange.

From a somewhat different standpoint arising from a computational model for representing meaning, Woods (1981) argued that ambiguity in natural language is actually a solution rather than a problem. He distinguished between an internal and external language, where our internal language refers to our thoughts and intelligence, and our external language the means to communicate with others. Our internal language is clearly far more discriminating than our communicative ability, since we can make many more distinctions than are actually lexicalised. He points out that were there a one-to-one relationship between conceptual distinctions and vocabulary it would inevitably result in a huge unmanageable lexicon.

To summarise the position we can say that most sentences in our language are highly ambiguous, and so the listener must infer the intended meaning from the set of possible alternatives. There are two ways of doing so which are by no means independent of each other. One involves making various inferences in an attempt to deduce the most likely meaning in that situation. The second concerns the view of Rommetveit and others, who argue that communicators take advantage of the interaction in order to constrain the meaning, as well as taking into account the relationship between the speaker and listener.

2. THE ROLE OF SOCIAL-PRAGMATIC FACTORS IN COMMUNICATION

It appears that communicators use the interaction to their advantage to infer the meaning of expressions, where comprehension is dependent on the interaction itself. The notion that meaning is negotiable has been around for some time. The first possible indication of this began as far back as 340 BC with the debate between Aristotle and Plato, who were concerned with the issue of what things mean. For example, was meaning determined by the world we live in as a property of that world, or a property of the discourse we use. Aristotle argued that the way we perceive things is an inseparable part of our conceptual framework. Whereas his instructor Plato believed that philosophy concerned 'going beyond' or 'getting out' of everyday experiences, Aristotle argued that we cannot coherently go beyond our experience, and thus:

"we cannot provide, for any principle, a foundation that stands altogether outside of our discourse and our conceptual scheme."

According to this doctrine, that which is completely external cannot enter into our discourse and thought, and we may only use certain terms in speech when they have entered into the experience of someone in the linguistic community. However, where Aristotle argued that meaning is in the mind of the individual rather than in the actual world, the view taken in this thesis is that meaning evolves from the interaction between speakers and listeners.

More recently Cherry (1971) argued that language develops socially through a process of verbal interactions in a variety of different situations, where views, beliefs, and knowledge, gradually transmit to the learner. This view assumes that we cannot have any concepts of our own apart from those expressible within the language, symbols and signs, taught by our society. Cherry suggests that communication depends upon a mutual acceptance of the signs of the language and a common usage of these, and that language only succeeds because of this common bond in the population. He considered language in general and stressed the social nature of communication.

This implies that languages encompass culture. For example, since Eskimos require the differentiation of more types of snow than the British do, then they accordingly have more words for snow than English. In this vein Miller (1981) emphasised the close link between language and communication, comparing the difficulties of composing a Zulu/English dictionary with a French/English one, as a result of similarities and differences between the cultures involved.

The linguistic relativity thesis also maintains that these properties will influence the way people from different cultures think. For instance Whorf (1956) argued that the language we use determines the way we perceive and organize things.

Cross-cultural and inter-cultural studies illustrate how languages are directly associated with their users, where meaning may be in part a function of the society. Yet it is unclear whether the functions of the society fully determine a language. Many aspects of language and communication are not yet sufficiently well understood to determine if language evolved directly from the need to communicate (Bierwisch, 1981).

3. CONVENTIONS OF MEANING

This section relates meaning to the users of the language and discusses some of the mechanisms involved. It relates populations of speakers to meaning and investigates how a society can support shared meaning.

Within, as well as between different societies, it is evident that various groups tacitly evolve meanings and language codes, which are mutually and exclusively shared by the members. These specific terms evolve as a by product of the interaction itself, and may in turn develop into more stable conventions such as jargon terms, colloquialisms or neologisms, relative to the group's function. For example, various groups within the language community often require a greater differentiation of their field to develop their own expertise, such as surgeons, mechanics, and most large organizations requiring various departmental codes. When experts communicate with fellow experts they attempt to affect them as they specifically intended, using terms which outsiders may find obscure or unintelligible, but which are necessary to achieve their goal.

Local conventions are also popular in the political sphere, where terms may be interpreted one way by the public, yet indicate something quite different to those who use them.

In particular, Chomsky (1985) discovered some specific examples of this while researching USA foreign policy in Central America. For example, the U.S.A. regularly "justifies" their intervention in the area as "defending" the USA against Central American agression:

"where 'aggression' (by any third world country) has its usual Orwellian meaning: defense against US attacks"

Chomsky mentions countless examples of double standards and 'newspeak' (*) of the USA government, enough to impress Orwell. (*) Orwell's (1948) version of a language imposed by a government in his book Nineteen Eighty-Four.

This process may occur as a neccessity, as when specialists become very esoteric to differentiate a certain field, or on the other hand to exclude others, where certain elitist groups often develop shared meaning systems. Another specific example is "nukespeak" jargon where terms are deliberately misleading to confuse the public over the realities of nuclear war. Paul Chilton (1982) describes 'nukespeak' as:

"a specialised vocabulary for talking about nuclear weapons ... which is not neutral and purely descriptive but ideologically loaded in favour of the nuclear culture; ...and affects how people think about the subject".

He points out that it did not transpire overnight as some type of "Orwellian grammarian rewriting the English language in the Ministry of Truth" but evolved over time to accommodate those concerned with the development of these weapons. For example, we have a new variety of word-groups such as 'Limited Nuclear War' translated by Aubrey (1982) as 'Much of Europe annihilated', or 'Partial test ban Treaty' translating as 'tests conducted under rather than above ground' and so on.

Essentially a language is composed of many groupings of private codes, where interlocutors use words relative to the function of that group, peculiar to the members. A system of mutual knowledege develops between communicants where the terms used conceptually represent what best conveys their intended meaning. On a small scale we can see this operating between twins. Zazzo (1960, 1984) describes twins developing "Criptophasia" and "Secret Language" as their way of communicating, which is mutually shared by them alone. Thus within and between different language groups, specific interest areas produce terms to express their function. They are all attempting to communicate some idea as precisely as possible.

Each population appears to form their own conventions relative to their specific environment and needs. Thus in certain populations only time, coupled with interaction between the members, will allow comprehension and a mutual understanding of the expressions used. For these reasons, Cherry (1971) sceptically questioned the efficiency of space communication, which involves one way communication links with others who have no knowledge of our language system. Without mutual interaction and feedback occurring he argued mutual understanding may never be achieved, and pointed out:

"What can be assumed to exist in common between Earth and the planet that can serve as signs and rules, for a start, to build up a common language?"

These observations raise issues of how the child can enter into a system of shared conventional meanings within society since they must develop the ability to use terms in a shared and mutually satisfactory way. The terms learnt by the child will presumably indicate the most relevant functions of the society, and may be acquired by conventional learning. These issues will be discussed fully in Chapter 2.

The next section will discuss what is involved in a mutually shared system of meaning and the role of shared and mutual knowledge for communication.

4. THE IMPORTANCE OF COMMON KNOWLEDGE IN COMMUNICATION

We have considered language as a socially derived phenomenon with humans establishing a variety of languages, dialects, codes, and meanings, to accomodate their environment and needs. This implies that using a language requires more than just learning certain responses. For a language to succeed we require knowledge of that language, knowledge of the world involved, and knowledge of how to use the language in a shared and mutually satisfactory way. The meaning of expressions depend upon social-pragmatic factors, such as the relationship between the listener and speaker, their joint knowledge, and the wider social context of the exchange. This joint knowledge appears central to all aspects of communication, for meaning, conventions, reference, and so forth.

It is argued that there are two types of joint knowledge used in communication - shared and mutual, which are independent of each other. Shared knowledge refers to the portion of information that we have in common with others, and which is actually shared within members of the community. For example, certain world wide and contemporary facts, historical and geographical information, and knowledge that is taught through a basic school education, is shared in the community. To meet another British person may lead us to assume that they similarly know our political system and Prime Minister, the currency we use, our television system, and so on. However, this is different from actually knowing certain facts are mutually known within the community. For example, you may assume person X knows who the British prime minister is, and that you may share this knowledge, however you do not know for sure. This knowledge becomes mutual after interacting with person X reveals that they are aware of the British Prime Minister and aware that you know that they know this information. So now you both know that you both know who the British PM is.

Shared knowledge then, refers to an abstract concept of what is actually shared with others, which is independent from knowledge that is clearly known to be shared. While mutual knowledge is information that we are aware of sharing, and includes mutual belief, and common knowledge, between conversants. In this way, it would be possible for two people to have total shared knowledge where they know exactly the same information, although they have no mutual base. On the other hand, to mutually know some information X, then:

A would know X

B would know X

A would know that B knows X

B would know that A knows X

A would know that B knows that A knows X

B would know that A knows that B knows X

and so on ad infinitum (Defined by Schiffer, 1960).

Mutual knowledge in this form is basically a formal specification, which has generally been left to philosophers to define, since it is debatable whether we require such knowledge prior to an interaction, and how this knowledge develops and is assessed. This problem will be addressed later.

Lewis (1969) referred to the concept as common knowledge, while Schiffer (1972) preferred the term mutual knowledge, and both independently identified conditions which determined what situations may elicit this knowledge.

Yet the extent to which mutual understanding occurs is all a matter of degree, and must depend on the communicants shared knowledge and ability to take the role of the other.

Kreckal (1981) suggests that no two people will have exactly the same concepts, although communication aids the development of independent shared knowledge into a mutual perspective. And once one part of mutual knowledge is discovered between communicants, much more may be derivable through inference. In this way, conversants play an active role in converting individual knowledge into shared knowledge for communication to succeed. Thus knowledge acquired separately may be at best a type of shared knowledge, however, knowledge acquired through mutual interaction may lead to communicators developing similar concepts.

5. CONCLUSION

This section emphasised the importance of social-pragmatic factors in communication, and proposed that the meaning of natural language expressions is inherently dynamic. It was argued that conversants co-ordinate on the meaning of expressions depending on social-pragmatic factors, such as the social context of the exchange, the interactors, and the knowledge that they mutually share.

However, one general problem involves how people co-ordinate their knowledge to ensure they have a mutual base to discuss some issue. The suggestions offered to infer such mutual knowledge are theoretical, abstract specifications, and hypothesize how mutual knowledge may develop prior to, or during an interaction. Of particular interest in this thesis, is how co-ordination of language occurs during an interaction, where communicators arrive at the same interpretation of expressions within a particular context. The next section will investigate this issue further.

B. GENERAL CO-ORDINATION IN NATURAL DIALOGUE

Successful communication requires the co-ordination of various knowledge and decision-making procedures between speakers and listeners. This section considers how this process occurs in a more general sense between populations, while section C. investigates particular cases of semantic co-ordination between two speakers, such as in definite reference.

Co-ordination of meaning involves the relationship between what the speaker means by a certain expression and how the listener interpretes it. Indeed co-ordination is fundamental to all aspects of communication, and as Clark (1985) stressed:

"is needed whenever two or more people do things that impinge on the actions of one another and is inherent to almost all social activities."

Grice (1957) argued that four principles guide conversational interaction which depend on tacit conventions. These can be thought regulative rules of conversation. They concern: the quantity of information given, which should be adequately informative; the truthfulness or quality of the information; the relevance and validity in the current context; and its presentation in an orderly and audible manner. Although communication does depend on these to a certain extent, they are somewhat idealized since it is unclear to what extent they are actually used in communication. For example, politeness usually competes with truthfulness where people often prefer to act politely and cover up their true opinions, rather than expressing exactly how they feel. Thus Grice's principles may not be as universal as once thought, since the specific context of the exchange, the individual's culture, and the co-ordinated use of a shared language are equally as important.

However, these underlying tacit conventions appear early in life since children as young as 2 years old expect co-operation from their listeners, and by 6 years old demonstrate definite expectations of communicative patterns (Shatz, 1978c).

This thesis investigates how speakers and listeners co-ordinate on the meaning of natural language expressions, and how they utilise shared and mutual knowledge in the process. The following theories are directed at the more general problem of co-ordination where populations come to share certain meaning through conventions of use. This may be useful in determining how people locally converge on the interpretation of an expression discussed in section C.

1. GENERAL CO-ORDINATION PROBLEMS

Language has often been viewed as a type of joint problem where conversants have to converge on the meaning of natural language expressions. Schelling (1960) refers to these situations as "co-ordination problems", or "games of strategy", where the best course of action for each person depends on the actions of the others involved. For example, with deterrence a potential enemy is prevented from following some course of action by way of a threat, where the interdependence and expectations of each party are essential. Similarly, bargaining involves each party calculating what they expect the others to accept, with both sides aware that some solution is better than none.

Schelling investigated classic co-ordination problems such as obvious joint tasks, and how they may be solved. When communication is available, he proposed the problem may be solved by explicit agreement, generally based on fair and sensible factors. For example, two parachutists may arrange to meet at the village church if they should get separated while landing on a small island. However, if they were separated without having any previous plans then they depend on tacit knowledge, such as expectations and certain heuristics. In fact, often when communication is available, as Garrod and Anderson (1987) discovered, tacit bargaining may still come into effect.

In this type of interdependent situation, Schelling proposed that the co-ordination problem is solved by each person independently calculating what action they expect the other to take, taking into account what the other expects them to do, and so on. This occurs through higher-order expectations in a reflexive way. Furthermore, participants must co-ordinate or else neither will benefit, since any conflict over a preferred solution is overwhelmed by the need to solve the problem.

Schelling offered four heuristics which generally influence the decision to co-ordinate. These are salience, precedence, familiarity, and uniqueness. With recourse to the parachute problem, familiarity refers to choosing the most well known spot on the island, while uniqueness involves choosing the most unusual or outstanding spot. The salience heuristic involves uniting in some obvious, prominent spot on the island, such as the only house, since this appears the most natural choice for both to choose. Precedence involves following any previous solutions, since if the situation had occurred before and you had united at the small harbour, then this reinforces the repetition of this action.

Thus Schelling gave an account of co-ordination problems and discussed several solutions. Lewis (1969) adopted this scheme to account for the origins and maintenance of conventions in language.

Lewis viewed language as a type of co-ordination problem, and offered a general account of how the communication problem may be solved through conventions of meaning. Co-ordination problems were described by Schelling (1960) as interdependent situations where the best course of action depends on the joint decision of those involved. According to Lewis these recurrent co-ordination problems were predominantly solved through conventions of behaviour or belief. He described a convention as:

"a general sense of common interest, a regularity in behaviour all the members of the society express to one another, and which induces them to regulate their conduct by certain rules, mutually expressed and known to both."

In other words, it is an agreement, inherited from one generation to the next where its origins are often lost, such that it becomes common knowledge in a community that:
everyone generally conforms to X, everyone expects everyone else to conform to X, and everyone prefers to conform to X on the condition that the others do.

Thus, members of the community develop a system of mutual knowledge where they share some convention and expect the others to conform to it. Generally, conventions should be beneficial to the community they serve, and depend on truth. Almost every aspect of our behaviour and beliefs is governed by conventions, although we are usually unaware of this and prefer to think of ourselves as free thinking individuals. Most people conform to conventions of dress, time, health, and so on, without even questioning such platitudes, and non-compliers are often referred to as eccentrics.

The origins of most conventions used in society are generally lost, perhaps dating back to the whims of royalty, some government agreement, or some once logical solution to a recurrent co-ordination problem. For instance the convention of driving on the left-hand side of the road in Britain. This example clarifies Lewis's proposal of co-ordination problems being solved through conventions of behaviour or belief.

According to the R.A.C. the convention of driving on the left-hand side of the road in Britain, evolved from the days of the Highwayman. Swords were generally worn on the left, so logic suggested keeping horses to the left-hand side of the track, since if attacked, the rider was ready to fight - sword in right hand, and left flank protected by the wall or hedge. Similarly waggoners and coachmen generally sat on the right to whip freely, thus pulled into the left naturally to avoid vehicles and view the clearances between the coaches. The logic concerning why Continentals and others drive "a la droite" is also quite straight forward. For example, in coaching days postillions were more common in America and Europe, where drivers sat on the left, astride the rear horse, since this was the best way to control the team. Thus it was most advantageous to pull into the right-hand side of the road in order to judge passing distances.

In this way, some population find themselves with a recurring co-ordination problem, where each has to interdependently decide the best course of action to take. Each person tries to assess what action they expect the other to take, and aware that co-operation is essential for success.

The most logical solution to the problem is generally followed, and through time and the recurrence of the situation, this solution is repeated until the origins become lost. When this happens the solution becomes a convention, since those involved are relying on precedence to guide their behaviour.

The rational and theoretical basis for conventions are thus expectations and mutual knowledge. These are primarily higher-order expectations where one person calculates a causal chain of expectations regarding another person. For example, one of two people thinking "I expect that you expect that I will move to the left-hand side of the road", and so on, reasoning in this reflexive manner. This is not an interactive process but involves each person establishing their own set of beliefs and a certain degree of mutual knowledge through the convention. Apparently each believes their view is correct and shared by both (Vennemann, 1975).

Lewis argued that the general principles of natural languages may be based on conventions, where languages evolve to solve certain co-ordination problems of meaning. He proposed that all that is required are basic principles. For example, conventions of rules in a conversation, such as those of phonology, morphology, syntax, semantics and pragmatics, such that there exists a precedence of rules, and not that specific sentences represent specific meanings.

He stressed that conventions are most important for solving co-ordination problems, as well as discussing several other solutions. For example, explicit agreement involved a predefined solution such that if a problem arises, then this course of action is mutually expected. Salience concerns choosing an obvious solution such that you mutually expect each other to take this course of action. Precedence relies on the success of a previous solution such that if the problem recurs this solution is repeated. Lewis believes that communicants would be predisposed to use the previous solution, and thus it becomes the most salient option to choose. Indeed there is evidence to suggest that exposure to one type of functionally appropriate solution leads those involved to model the example for future use (Nelson, 1985).

Lewis believes that convention evolves from the precedence heuristic, where a certain course of action has been followed so regularly that it is mutually expected when the problem arises. This in turn adds the idea that the precedence solution is taken to justify the conventional choice. For example, the solution is followed because everyone else does so and has done in the past, and the fact that you were doing it, justifies this course of action. Thus precedence leads to the notion of justification. Lewis suggests that many other conventions may have evolved in this way, where everyone concerned mutually knows the convention exists, and conforms to it.

Schiffer (1972) used a similar framework to explain how communicants co-ordinate on the meaning of expressions. His principles of mutual knowledge resemble Lewis's concept of common knowledge.

His example concerns how the noise 'grrr' may have developed conventionally to imply 'I am angry', outlining the importance precedence plays. Through a lengthy process of person X uttering 'grrr' and being angry, Y eventually learns that X means 'I am angry' when they utter 'grrr'. This is reinforced by X only uttering 'grrr' to refer to this, and not in any other situation. Schiffer similarly arrived at a definition of conventions through the theory of games, where each person acts relative to what action they expects the others to take, although he does not consider it gives a complete account of conventions.

Despite the fact that conventions of meaning are essential to communication these theories understress the non-conventional side of language. As Clark (1985) commented:

"Conventions, however, are only one of the co-ordination devices people use in communication, a point that has been lost in most research on language and language use."

Grice (1982) similarly emphasised the point that meaning is not necessarily connected to conventions, and is simply one way that word meaning may be fixed. It is by no means the only one.

Although conventions identify systems rather than arbitrary mappings between a word and its meaning, word meaning may also be fixed by definition which is less common. For example, once dictionaries fix meaning, the words become non-conventional since there is no easy option for adapting their meaning. Thus once a rule is imposed on a system it is not a convention.

2. CONCLUSION

These theories treat language as a co-ordination problem and consider how word meaning may develop through conventions of use. They increase awareness of social-pragmatic factors for the development of meaning, and emphasise the way that interactors assess each others intentions, and attempt to synchronize their actions and thoughts.

However, whether this determines how meaning develops in the child is not apparent and will be investigated in Chapter 2. One should be extremely cautious when comparing the general origins of language with individual language development and everyday communication. Despite the fact that Lewis plausibly illustrates how conventions work in a signalling system, a full blown natural language would be far more ambiguous and complicated.

Furthermore, some researchers stress that language and communication should be investigated as separate issues, since it is difficult to discover just what amount of the child's development is dependent on communicative pressure (Bierwisch, 1981). For example, some children can communicate well yet demonstrate many linguistic problems, while others produce adequate language even though exposed to a poor communicative environment. In addition, linguistic competence does not necessarily imply successful interactive ability. For example, linguistic competence has been judged adequate for grammatical purposes by the age of 3 to 4 years old, and almost fully developed by 7 or 8, apart from vocabulary expansion or structural forms (McNeil, 1966), yet the child's communicative competence indicates many deficiencies. Thus links between language and communication should be made with extreme caution.

The next section investigates how these general accounts of language explain semantic co-ordination in natural language. Definite reference will be investigated which involves particular meaning where communicators generally choose expressions for specific recipients. This takes into account both the speaker and listener, their mutual knowledge, and the social context of the exchange. However, definite reference is only one of a number of co-ordination problems we may have looked at.

C. SPECIFIC CO-ORDINATION PROBLEMS: THE CO-ORDINATION OF DEFINITE REFERENCE

This section deals with specific meaning and how speakers and listeners co-ordinate on a particular meaning of an expression. For example, where two people co-ordinate on something in the actual world, such as reference which involves the real, solid world. This objective measure of co-ordination hopefully reflects their mental world. This is opposed to mental representations where two people, for example, may co-ordinate on a certain idea or belief in their mental world which cannot be objectively measured.

While section B. dealt with semantic co-ordination in a more general sense, such as in communities, and considered communication as a co-ordination problem solved through conventions of meaning, this section investigates particular meaning between communicants. This comparison may clarify the extent to which the general account of meaning conventions determines particular meaning. Garrod and Anderson (1987) believe that a general account of meaning is not in itself sufficient to explain semantic co-ordination, and that something else must be involved for particular cases.

In this section it is argued that referring expressions are influenced by the conversants themselves, using their mutual knowledge. It seems apparent that speakers and listeners generally co-ordinate on the choice of referring expressions, and choose definite references felicitiously. For instance, it is most unlikely that a person would simply use an ambiguous term without having first decided on the listener's knowledge and their interpretation of the term. This suggests that additional social-pragmatic factors are also required for successful communication.

1. THE CHOICE OF REFERENT

According to Lewis (1979) various expressions require some type of preceeding introduction and cannot be simply slipped into the conversation. Apparently this occurs in a rule-governed way during the on-going conversation, where one of the interlocutors exercises control over the other. Lewis noted that a definite control structure was evident during conversations, which was predominantly asymmetrical, where one party exerts influence over the other. He compared a well run conversation to a baseball game, in that it is an organised event with a definite control structure. For example, the "master" marks out the boundaries of what is to be discussed, adapting this to fit their knowledge, with the "slave" conforming to these tacit demands. This process appears to occur automatically and unintentionally, with the interlocutors generally unaware of conforming to such structure.

Similarly Brown and Yule (1983) observed that what people say in a conversation is restricted by the preceeding speaker and existing framework. They refer to this as "speaking topically", where interlocutors "pick up" elements from the previous speaker.

Conversational speech had often been viewed as unstructured, with few rules, perhaps due to the fact that writing and reading skills are taught in school whereas conversational rules are not. However, contrary to this view, Grice and others have demonstrated that this is not the case and that conversational speech is rule governed.

In general, speakers attempt to use specific terms to elicit the correct interpretation from the listener. This requires some type of mutual knowledge and a shared language in order to co-ordinate with the listener's knowledge base. The problem then concerns what type of knowledge communicants require for successful interaction. This question has produced much controversy among researchers over what kind of knowledge is utilised in natural dialogue, and how it is assessed and may develop during the course of the dialogue.

The research reviewed here explores mutual knowledge in relation to formulating definite reference which is only one of many issues which may have been considered.

2. THE ROLE OF MUTUAL KNOWLEDGE IN COMMUNICATION

For successful communication Clark and Marshall (1981) argue that speakers and listeners co-ordinate their knowledge in the formation of definite references. They propose that this requires something more that general global conventions of meaning. They suggest that local principles of interaction are required where speakers formulate their utterances for particular listeners, relying on the knowledge that they mutually share. At the same time, listeners deduce the meaning of expressions based on this tacit reasoning and both locally converge on the meaning of the expression. Clark (1985) states that:

"By the very nature of coordination the speaker and addressees both recognize that the speaker intends them to infer what she means on the basis of their common ground and nothing more. That is all that could be relevant and including anything else may even lead to error."

This implies that a certain degree of mutual knowledge has to be established prior to the interaction.

According to Clark and Marshall, people must ensure they have the same grounds in order to make a definite reference about a topic and discuss it. This implies that they must each refer to a huge section of knowledge to assess their common ground and choose an appropriate definite reference. Yet the reference is normally selected in a finite time space. They refer to this as the "mutual knowledge paradox", and argue that this is solved through the use of three heuristics. These enable interlocutors to infer their common ground quickly and efficiently choosing an appropriate definite reference for the listener.

Triple copresence is the first heuristic, where the speaker, the listener, and the object referred to, are physically present together. Each assumes the other has similarly observed the object, and that they may confidently refer to it, believing the other to share this knowledge. With the second heuristic, linguistic copresence, the speaker introduces the object into the conversation, where they can now assume the listener to be aware of it. Community membership is the third heuristic. A great deal of knowledge is presumed to be shared between the members of the same community, thus one may make a definite reference particular to the community, confident that the listener understands. Combinations of these can exist to infer mutual knowledge.

These heuristics require a memory organized by diary entries which contain specific encounters with people, and an encyclopedic section of general information. These encompass speaker and listener models, and once formed are constantly revised to incorporate fresh information. For example, a person's specific model concerning a close friend may store such information as their previous encounters, common interests, beliefs, and so on. In general, people usually prepare themselves for a conversational encounter, referring to their specific models and assessing their mutual knowledge store. Clark and Marshall propose that these models are formed through formal introductions and acquired information, and constantly updated as appropriate. Introductions often begin cautiously by attempting to discover occupations, status, political beliefs and so on, to enable some type of model to be constructed. Once some type of mutual knowlege is established, such as their political beliefs or interests, then one may confidently refer to this area. Almost all encounters involve assessing what knowledge we may share with our conversant.

Clark and Marshall disagree with general conventions of meaning such as those illustrated by Lewis and Schelling, arguing that they are insufficient in themselves to explain semantic co-ordination in everyday interactions. They also believe that mutual knowledge is essential prior to an interaction, yet fail to clarify the cognitive functioning of their copresence heuristics used to assess this knowledge, and assume a great deal of knowledge and processes. Furthermore, they treat mutual knowledge as an isolated problem, however, there is little evidence to suggest that such problems exist in everyday communication, or that we require such mechanisms to deal with them.

Garnham and Perner (1986) agree that mutual knowledge is necessary for communication and that it is computed in a finite decision procedure, although they disagree with the heuristics put forward by Clark and Marshall. They attack the ambiguity of the triple copresence heuristic. For example, we can have mutual knowledge of the stars being out, without having any physical proximity or eye contact with someone (ie. talking on the telephone). Similarly, eye contact would not be required in order to elliptically refer to a flash of lightning which occured in a friend's presence, with a reference such as "Did you see _that_".

This evidence suggests that the copresence heuristics may not be sufficient or necessary to compute mutual knowledge. Clark and Marshall believe that establishing mutual knowledge is some type of conscious deliberate process, and that we are rational human beings. However, adults as well as children are egocentric, and not quite as rational as Clark and Marshall would have us believe. Indeed evidence to define so nebulous a concept as mutual knowledge has been difficult to find as the following research illustrates.

A process was offered by Clark and Wilkes-Gibbs (1985) of how definite references may develop into mutual knowledge. They replicated Krauss and Glucksberg's (1966) communication task, outlined on page 74 of this thesis, to discover that definite references were negotiated in an iterative way. This acceptance process involved one of the conversants presenting a noun phrase into the conversation, and if appropriate for both communicants, then the next contribution was made towards the conversation.

However, if the phrase was unsuitable, then the participants proceeded to repair, expand, or replace, the phrase continually, until a mutually agreeable version was reached. Thus any portion of the dialogue could be changed and updated in an on-going reciprocal way. In this collaborative process mutual understanding was established to the appropriate level. For example, the references used should be sufficient to convey the intended meaning, rather than assuming that it is precisely mutual. Explaining something to a novice, naive to the terminology, would typically require less detail than explaining it to a connoisseur of the field.

Clark and Wilkes-Gibbs found a 'trade-off' in effort between suggesting a definite reference and refashioning it. For instance, the more time and effort spent in choosing an appropriate definite reference for the listener, would presumably lead to less modifications. Thus, interlocutors should attempt to choose utterances suitable for the recipient. Yet the spontaneity and dynamic nature of natural language gives us little time to plan ahead, coupled to the fact that we are often unaware of the specifications that would suit the listener. Thus Clark and Wilkes-Gibbs suggest that we may simply offer suitably sufficient phrases to start the acceptance cycle. Once underway the flow would modify itself. In this way, they offered some indication of how a mutually appropriate reference may be derived.

On the whole it appears that speakers and listeners must share certain ideas and knowledge for communication to succeed. Clark and Carlson (1982) investigated certain instances where shared beliefs among people were more pronounced. These involved 'joint acts' where two or more people were in interdependent situations, requiring co-ordination of actions for success. For instance, the playing of duets by musicians, where they argued that mutual belief is essential for the commencement of even the first note.

Clark and Carlson acknowledge the scepticism levelled at mutual knowledge processing because of its infinity of conditions. However, they argue that it is wrong to automatically assume some type of infinite series of steps in the mind. For example, as Schiffer, Lewis, and others have demonstrated, just one piece of the right information may be sufficient to assume mutual knowledge. So one action or expression may indicate that communicants have mutual knowledge on an issue without recourse to a list of inferences and heuristics. This implies that certain conditions may indicate mutual knowledge. These conditions themselves are finite, yet may be used to assess the infinity of conditions which mutual knowledge requires.

They argue that Clark and Marshall's (1981) mutual knowledge belief induction schema is all that is required to assess mutual knowledge. That is:

a and b mutually know that p if and only if some state of affairs G holds such that:

1) a and b have reason to believe that G holds.

2) G indicates to a and b that each has reason to believe that G holds.

3) G indicates to a and b that p.

For example, an agreement where two people believe some knowledge holds, without having to work out the logic why, and indicates the next gesture is for real. They believe that total mutual knowledge is not required for everyday conversation. Something less is probably sufficient, since mutual knowledge can vary in degree.

In everyday interaction, it remains debatable whether mutual knowledge is a pre-requisite for success. One aim of this thesis is to investigate what type of common knowledge may be required for language use, and how it may develop. While the above theories assume that mutual knowledge is required prior to the interaction, there seems little evidence to suggest that young children infer this knowledge. Rather, it may develop later. Furthermore, how is this knowledge utilised and assessed, and do children assess mutual knowledge the way Clark and Wilkes-Gibbs and others have outlined?

Johnson-Laird (1982) remains sceptical on this issue, and proposes that mutual knowledge is not a pre-requisite for successful communication. He attacks the question of infinity of conditions and refutes Clark and Carlson's belief in a mental primitive. For example, where mutual knowledge is devised through inference rules and certain evidence. While focusing on the mechanisms used to infer mutual knowledge he noted much ambiguity, since there was no elaboration of how the three copresence heuristics may achieve mutual knowledge. In addition, he questions how this inference rule develops, how children acquire it, whether it is innate, and why it evolved. Finally, he points out that if a person knows some information, it is not clear that they are aware of knowing they know the information, since speakers are not generally aware of employing such complex processes in the way that Clark and Marshall argued.

Johnson-Laird illustrates that mutual knowledge may not be required prior to communication, using an example of acquiring a theatre ticket for Macbeth. He states that one would presumably ask for a ticket for the performance without firstly establishing whether the ticket-vendor similarly knew this performance was playing. Thus formally establishing mutual knowledge seems to be necessary for guaranteeing communication, yet futile for everyday use. For instance, we do not normally require such formal rules to communicate, nor can we be confident of having mutual knowledge with our interlocutor.

As an alternative, Johnson-Laird points out that communicative success implies the existence of shared knowledge and understanding. This indicates that mutual ignorance may be an incentive to communicate, since one may use a definite reference in order to discover whether the listener has knowledge in this field. As Johnson-Laird (1982) notes:

"But if they start with completely mutual knowledge there might not be much point in communicating: they might be stating the obvious. As in the old drive-reduction theories of psychology, mutual ignorance is a drive that is a spur to conversation which in turn, reduces it; sometimes completely."

This suggests that communication can succeed without prior establishment of mutual knowledge, since alternative strategies may be used to infer mutual knowledge where necessary. For example, the use of feedback and questions during the conversation. Indeed language systems must be designed to overcome problems in everyday conversations, and thus avoid the complicated process of establishing mutual knowledge.

Similarly, others have argued that the best evidence for mutual knowledge is not physical copresence but comprehension. Sperber and Wilson (1982) discuss how understanding is evidence that mutual knowledge exists between interlocutors.

Their evidence is of three types. Firstly they point out that although identifying mutual knowledge is a complex process, problems are not so apparent in comprehension. Thus mutual knowledge must be a simple, unanalysable concept, which does not involve complex calculations as Clark and Marshall proposed. Alternatively if misunderstanding occurs, one would request clarification, or simply misunderstand, discovering the incongruence through feedback, and so on.

Secondly they argue that mutual knowledge is not a sufficient condition for belonging to a certain context, since it is generally a small specific context that is referred to and searched - far smaller than the interlocutors common ground. Thus something more than just belonging to common ground must be involved to determine the actual context searched. It must be accessible and manageable, and involve a mechanism by which a specific incident can be located. Clark and Marshall's process does not do this.

Thirdly, they noted that mutual knowledge is not a necessary condition for understanding to occur, that is, understanding may still occur although certain things are in the context and are not mutually known.

Similarly Vennemann (1975) regarded interaction as a basic source for establishing mutual knowledge between speakers and listeners evolving during the conversation in the form of a "presupposition pool" containing information:

"constituted from general knowledge, from the situative context of the discourse, and from the completed part of the discourse itself."

General knowledge refers to knowledge that conversants presume they share with each other, such as various world-wide and important political events and history. The situative context of the discourse refers to present facts observed in the immediate context, such as the weather. Knowledge concerning the completed part of the discourse is simply information which has previously been mentioned in the conversation. According to Vennemann mutual knowledge is derived from these three sources and thereafter presumed to be known to both communicants.

In addition conversants assume they share a joint "presupposition pool", which contains these three types of knowledge, with each believing only one exists (their own), which is constantly updated as the conversation proceeds.

The evidence appears to indicate that mutual knowledge may be unnecessary for everyday communication. It may be required in more formal situations such as with legal documents, Acts of Parliament, or statutory rules, where the message has to mean exactly what was intended. In these cases information has to be unambiguous and accurate, such that it may not be misinterpreted in any way. On the other hand, everyday interactions do not require such stringent co-ordination of meaning, and are generally deficient in the necessary conditions to guarantee mutual knowledge, yet reasonable understanding is evident. Thus Sperber and Wilson propose that rather than mutual knowledge, Grice's (1957) relevance principle may be more appropriate for successful communication. This states that communicants expect co-operation where utterances are relevant to the listener's knowledge and current context and:

"The speaker tries to express the proposition which is the most relevant one possible to the hearer."

In this way, speakers and listeners believe that each conforms to this principle, and so the listener abstracts the most relevant meaning from their set of possible alternatives that the speaker could have meant.

Yet Gazdar and Good (1982) noted that this account involves relevance, and paradoxically suggests a type of mutual knowledge in itself. The mutual knowledge of relevance calculations presumes that the speaker calculates what the listener will take as most relevant from the expression, and similarly the listener assesses what the speaker meant the expression to refer to, and so on.

Statistics to interpret so nebulous a concept are difficult to find, and since suggestions are not liable to empirical testing there is no reliable way of establishing relevance, as Moore (1982) appropriately noted. In this respect, researchers only have a partial understanding of the factors involved in communication. However, mutual knowledge and co-operation appear essential for success.

Interlocutors appear to seek out their common ground in order to communicate effectively and understand each other. Grosz (1981) argued that the implicit goal of conversation concerns establishing commonality, or mutual knowledge, and considered the role of focusing. She defined focusing as:

"the active process, engaged in by the participants in a dialogue, of concentrating attention on, or highlighting, a subset of their shared reality."

She noted that the speaker and listener's focus affects their interpretation, and what they say affects what is focused on. The experiment involved an expert instructing their apprentice on the co-operative task of dis-assembling an air compressor. While doing so participants worked towards a shared perspective of the object and constantly checked that they had a common focus. The speaker chose appropriate definite references using redundancy, and shared knowledge.

In general communicants focused on only a small degree of shared knowledge at any one time, thus constraining the search area with greater chance of success. The speaker and listener both assumed a common focus and problems only appeared when a discrepancy in understanding occurred. Similarly, Venneman (1975) proposed that each interlocutor assumed a joint presupposition pool throughout the interaction. This evidence appears to reinforce the assumption that mutual knowledge is not required prior to communication, rather it is assumed until communication fails.

Goodman (1986) used a similar task where an expert instructed an apprentice on the assembly of a toy water pump. Analysing the extent of miscommunications, he noted that a reference was either imprecise, confused, ambiguous, or over specific, and that the listener was considered to the relevant degree. Furthermore, he noted that listeners often found the correct referent although the instructions were fairly ambiguous, and explained this due to "negotiation". This takes into account all the language and knowledge that they mutually share. This could either be "explicit negotiation" between conversants where they generally discuss the referent, or "self-negotiation" where the listener examines the reference in more detail.

Goodman was attempting to construct an efficient natural language communication system which could cope with miscommunication. When problems in communication occurred, he considered several ways of repairing the breakdowns. For example, the listener may make assumptions unconsciously in a natural and automatic way. Alternatively they may actively replace the speaker's information until a suitable alternative is reached, or simply ask for clarification. More importantly they may be solved by using social conventions, and world and conversational knowledge. That is, linguistic, perceptual, discourse, hierarchical, and trial and error knowledge. For instance, in trial and error knowledge successful performance of the action is the best evidence of being correct.

The evidence seems to suggest that some type of mutual knowledge is required for successful communication, although exactly what type and how it may be enacted, processed, or develops, remain controversial. The contradiction appears to be whether mutual knowledge is assessed prior to communication through various heuristics, or whether communication itself evidences mutual knowledge.

Perhaps investigating how young children communicate may shed some light on this debate. In general there appears to be some disparity between how Clark and Marshall (1981) think children should communicate, and what they actually do. It seems fairly complex for a child to be computing various strategies to assess mutual knowledge. Rather, they may simply be conversing without taking into account the listener's perspective. This would contradict proposals that mutual knowledge is a pre-requisite for communication.

The mutual knowledge process may even develop later in children, promoted by our society, which places great value on identification with others and the role of shared knowledge. Indeed children who have a great overlap in shared knowledge may not encounter critical communication problems, and this may be the reason why they prefer similar others. This is not only apparent in children. Adults prefer conversing with similar others with whom they share some common bond, whether it be similar political beliefs, intelligence, interests, or background.

In accordance with the above hypothesis, Ladd and Emerson (1984) found that children are attracted to similar others. They investigated shared knowledge in children's friendships as a function of age, and the type of friendship maintained, and suggested that shared knowledge is a determining factor in the development of mutual attraction and close friendship.

According to Duck et al (1980), friends appear to develop shared knowledge by collecting evidence from mutual exchanges and shared activities. They use this to form a reciprocal awareness of each other in terms of similarities and differences. In this way, children who discover a high degree of similarities between themselves, may be mutually attracted, leading to close friendship. Alternatively they may become mutually aware of their differences.

Selman (1980) discovered that children in the age range 4 to 9 years old, use the self as a reliable scale to judge others against. Positive characteristics were evaluated as those similar to the self, and negative ones as those different from their own. A fundamental difference with older children from around 6 to 12 years old, was their appreciation of characteristics which were different from their own.

Shared knowledge (common or overlapping knowledge) thus appears to be a determining factor in the formation of children's friendships, although with development they were able to appreciate differences.

Ladd and Emerson reinforced this claim with evidence that greater shared knowledge exists between mutual friends as opposed to unilateral ones who, as expected, did have a lesser degree of shared knowledge. Using 48 pairs of children, they assessed shared knowledge by using a picture-sort procedure where:

"Friends selected items that were most descriptive of themselves and their friend. Shared knowledge was indexed by summing the number of items that were chosen by both partners as a) descriptive of themselves and their friend, and b) descriptive of themselves but not their friend."

Results were in accordance with Selman - of a decrease in partner similarity with increasing age - and were consistent with that of Duck et al. Thus shared knowledge was related to close friendships in children, and mutual friends knew more about each other.

This appears perfectly rational, since those children with increased similarities may communicate without having to assess mutual knowledge. For instance, their definite references should be understood without recourse to mutual knowledge. On the other hand, those children from different cultures or background, may encounter communication problems, since they may use terms their partner does not understand. When misunderstanding occurs, they may drop the subject completely, or simply leave the situation, failing to elicit the correct adult social response.

These observations appear to reinforce the assumption that children communicate prior to establishing mutual knowledge. The computation of mutual knowledge requires such complexities that it seems remarkable that young children are using it in communication. Yet it has been suggested that mutual knowledge processing may be innate, since the child similarly learns language, which is also a highly complex process. Alternatively, they may not be establishing mutual knowledge, but communicating successfully with others who share similar knowledge, such as parents, siblings, and close friends. In this way, discrepancies may not be noticed, since mutual knowledge is already established in many areas. The process may even occur later though pressure from parents and society to take the role of the other.

Shatz (1978) noted that children have many problems in discovering what is mutual knowledge for a listener, and what should be communicated. With exophoric reference they have been found to check that the listener has also viewed the object, as Clark and Marshall proposed (Flavell, 1978a). However, many problems are encountered with endophoric reference where the task is considerably more complex and involves memory, discourse inferences, and inferences concerning the listener's knowledge. As Shatz pointed out:

"Thus although children may be able to take account of listener characteristics that are readily observable, taking account of more covert characteristics may prove too difficult."

Perhaps they infer mutual knowledge by conventions, since these have proved extremely useful in language, and give a default type of rule when the child's knowledge is lacking. Furthermore, society determines most of these conventions, which we acquire through experience and direct intuition from parents.

Indeed Schieffelin (1979) discovered that this occurred overtly in some cultures, where the mother gives explicit examples in the teaching of the social rituals to the child. Similarly, the Japanese education curriculum includes social studies and moral education, instructing children on such things as moral dilemnas, cultural values and non-verbal communication (Lynn, 1988).

Grief and Gleason (1980) discovered that prompting by parents, greatly increased 2- to 5-year-olds use and appreciation of social conventions, such as greetings, leave-takings, thanks, goodbye, and so on. They noted that children used 'hi' and 'goodbye' only about one fourth of the time it was required, and 'thanks' around 7% of the time they should, although their parents use of the terms were much higher. However, these rates increased when they were prompted by their parents. This evidence suggests that children are learning the appropriate conventions for their culture, since they often fail to respond on certain occasions. This may be the case with mutual knowledge where children gradually learn conventions and social rules through experience.

D. CHAPTER CONCLUSION

This chapter investigated the development of communication skills as they relate to language. In particular, how speakers and listeners co-ordinate on the meaning of natural language expressions, and how shared and mutual knowledge are utilized in the process. Social-pragmatic aspects of natural dialogue were discussed, such as the users of the language and their mutual knowledge. It was argued that communicators use the interaction to infer the meaning of expressions in this dynamic way. This interactionist approach takes into account the speaker and listener, their common knowledge, and the wider social context of the exchange. The literature review then explored this approach in more depth, as well as covering the traditional approach to meaning.

The interactional approach relates meaning to the users of the language both at a general and local level. For example, at a local level groups tacitly devise the meaning of the expressions they are using relative to their specific environment and needs.

This leads onto the problem of what type of knowledge is required for successful communication, and how speakers and listeners co-ordinate on the meaning of natural language expressions during the interaction. Semantic co-ordination was considered at a general level in relation to populations, where some such as Schelling (1960), and Lewis (1969), argued that word meaning may develop through conventions of use. Specific meaning was then investigated and how speakers and listeners correspond on the particular meaning of expressions, such as in definite reference. According to Clark and Marshall (1981), and others, this co-ordination problem is not simply solved by general meaning conventions as discussed by Schelling and Lewis. For successful interaction Clark and Marshall argue that mutual knowledge is required prior to the interaction since communicators must ensure they have the same grounds to discuss some issue. They argued that it is inferred by certain heuristics. However these were thereafter shown to be inadequate by other researchers. On the other hand, Johnson-Laird (1982) argued that communicative success in itself implies shared and mutual knowledge between communicators, and therefore this knowledge is not required prior to the interaction. In fact he stated that mutual ignorance is actually an incentive to communicate to discover what knowledge we have in common with others. As well as this he pointed out the inadequacies of the mechanisms put forward by researchers to infer mutual knowledge.

This thesis is concerned with the type of knowledge required for language use and how it may develop. To solve semantic co-ordination in particular cases it would appear that communicants require some type of shared knowledge and ideas, and rely on co-ordination, memory, conventions, knowledge assessments, and inference, which all develop with communicative experience. Co-ordination and mutual knowledge appear fundamental to communication, although whether mutual knowledge is required prior to or during an interaction remains debatable. Total mutual knowledge may not be necessary for everyday communication, and probably an impossibility, however, it appears that communicants require some degree of common ground to communicate. Yet the processes to infer this remain inconclusive.

Regarding development, the enigma involves whether children use mutual knowledge in communication, and how it may develop. Young children communicate most successfully with their parents, siblings or close friends, where there is already a great deal of shared knowledge, thus the assessment of mutual knowledge may not be required. It may develop later due to pressures of society to identify with others.

Chapter 2 will discuss some of these issues further and concentrate on the development of communication skills in young children.

CHAPTER 2

THE DEVELOPMENT OF INTERACTIVE COMMUNICATION SKILLS

A. INTRODUCTION

This thesis explores the development of communication skills as they relate to language, and discusses the role of social-pragmatic aspects of dialogue for this development. Some of the relevant background issues concerned with the development of communication skills will be reviewed in this section. The first part will outline what is involved in communication, before considering how the child develops and acquires these abilities. For example, the child must learn the vocabulary of the society in order to comprehend and produce the language, and utilise various coping strategies for deducing meaning. This chapter explores how the child learns to use terms in a shared and mutually effective way.

1. COMMUNICATION

In order to communicate effectively the child has to calculate how to map their ideas into words. They have to discover the sound system, the relevant semantic and syntactic rules of the linguistic community, thematic rules, speech acts, rules for sentences, along with the appropriate rules of conversation. Most importantly they have to acquire a shared system of meaning to comprehend and produce terms. This concerns such areas as language, social behaviour, and development.

Efficient communication requires the speaker to account for the listener's capacity to understand, and direct their message at the listener's knowledge state. Rommetveit (1983) proposed that understanding a message suggests some compatibility between the communicants internal knowledge representations, whereas misunderstanding illustrates some degree of incompatibility. In this way, communication involves co-ordinating mental representations, where the listener's recognition should merge with the speaker's intended meaning. Sharing a mutually accepted code is a requisite for this. Nelson (1985) describes a highly conventionalized system of meaning as:

"an internalized system of knowledge representations - semantic and conceptual - that correspond to those of the cultural group."

As we have established in Chapter 1, communicants depend on conventional communicative systems which rely on signs, to express information to one another. According to Grice (1967) there are two main types of signs used for communication, natural and conventional ones.

Natural signs have self-explanatory, obvious forms of meaning which are almost universal, such as certain facial expressions (for example,crying or smiling (Ekman, 1971)). Conventional signs, on the other hand, are based on culturally determined sets of rules which have to be learnt by the child. These are the most common type of sign used everywhere in society, and include any term whose meaning cannot be intuitively deduced. Yet natural signs may also be used conventionally such as in sarcastic smiling and so on, in order to convey some other message.

This implies that an arbitrary relation exists between most words and their meaning, arising by accident or convention rather than anything else. Nelson (1985) noted that for successful communication, children have to learn and mutually accept a system of shared meanings used in the community, where the terms used create a similar conceptual representation in the listener.

The following sections outline various other aspects of language which are central for successful communication. This illustrates some of the complex skills the child has to acquire and develop.

2. COMPREHENSION AND PRODUCTION

Two essential skills for communicating language are comprehension and production. As Clark and Clark (1977) explained:

"Comprehension requires that listeners take in an utterance, analyse it, construct an interpretation, and utilize what they have understood in the way the speaker intended."

While production concerns planning and organizing the message for the listener. Unfortunately there is no straight forward relationship between the two, and generally the child uses a word as soon as they become familiar with it (Bloom, 1974). This often suggests a deceptively more complex level of language development than actually obtained. For example, young children can often repeat songs and stories from picture books with complete accuracy, yet not properly understand what they have produced. To add to the problem the child is clearly able to comprehend far more than it can produce, and often may understand a parent when only able to produce a few one word utterances themselves. Similarly, adults can comprehend many terms they have never used themselves, although they seldom produce terms they do not understand.

3. VOCABULARY EXPANSION

Communication requires the acquisition of a language system with many highly conventionalised components. Communicants must be able to both comprehend and produce terms while learning a vocabulary, and as noted above these involve different processes.

The first few words generally appear in a child's production vocabulary between the age of 12 to 18 months, based on familiar and close objects. For example, food, toys, and animals, expanding to bodyparts, household items, clothing and people by the age of two years old (Nelson,1973). This is followed by a rapid proliferation, so that around the age of 3 years onwards, parents have difficulty knowing exactly what words their child understands (Miller, 1986). This is complicated by the fact that the child appears to understand more than it can produce. Yet to use or respond to a word does not necessarily evidence knowledge of the intended adult interpretation, since the child's first appreciation of a word vary greatly from the adults.

Templin (1957) carried out extensive cross-sectional studies on the growth of the child's vocabulary to conclude that a 6-year-old child of average intelligence knows some 13 000 words, and an 8-year-old some 28 300 words, and so in this period the child learns an average of 21 words per day. However the words are not learnt in an arbitrary and unrelated fashion. They are learnt through conceptually related patterns.

Miller (1986) discussed the importance of context and the use of conceptual patterns to integrate new words, whose meaning gradually develops. He defines a vocabulary as "a coherent, integrated system of concepts" where most words are learnt in context and not nearly as ambiguous as dictionaries would lead us to believe. Printed dictionaries are lexical databases where words and their meaning are arranged and deduced through alphabetical order and retrieval, and defined by other words that describe their meaning. In contrast, our subjective dictionary can be accessed via the sound, or meaning of a term, phonologically and semantically, into semantic fields. Related concepts are learnt together and not as arbitrary lists of facts.

4. THE IMPORTANCE OF CONTEXT FOR DEDUCING MEANING

In relation to vocabulary expansion the main interest is how children acquire new words and learn their meaning. For both children and adults alike, the process is two-fold. Firstly they must recognise they have a word, and secondly they must recognise it is a word with a certain meaning. Since adults do not explicitly teach children word meaning then the only way it can be achieved is through contextual inference.

It appears that young children are extremely inventive and active when computing word meaning and communicating information. They combine context and language in an extremely effective way to understand the meaning of terms, and make the most of their limited linguistic resources by utilizing various coping strategies. For instance, they often devise their own means prior to the appropriate conventional skills developing, such as repetition, pointing, grasping or reaching methods, and multiple meaning one-word-utterances (Carter, 1975). They rely on non-linguistic evidence, such as gestures, gaze-direction, and context, to interpret what adults say, and use guesswork to abstract the most plausible alternative from the context (Clark and Clark, 1977).

Clark and Clark (1977) believe that when the child first acquires a word, they enter the meaning into their mental lexicon. This gradually develops until the meaning of new words eventually coincides with the adult version through prior experience and contextual cues. They point out:

"In forming their initial hypothesis, they select a possible meaning from their encyclopedic knowledge and from that derive a strategy for using the word."

Thus children use their prior knowledge and the immediate situation to deduce meaning. This gradually adjusts to merge with the adult version, while their existing vocabulary is utilised to the full.

Shatz (1978) carried out several experiments with children under 4 years and proposed that they comprehend in terms of an "action-based strategy". In one experiment children were presented with sentences which could be interpreted as a request for more information, or for the action to be demonstrated. For example, the sentence "Can you talk on the telephone?", would be presented in two different contexts, biased toward each of these results. That is, either spoken in as neutral a context as possible, or presented in contexts of action and informative gestures.

She found evidence that children adjusted their behaviour to the linguistic context of the sentence. However, they all preferred to act rather than give more information, regardless of the context. Shatz thus suggested that the child's communicative response may depend more on primitive response strategies than on any complex discourse inferences or the propositional content of the utterance. This implies that children act according to a default action response strategy, whose importance appears to decrease as the child gathers more information on language and context to indicate which response is required. Thus children's response and evaluation strategies should not automatically be assumed to be similar to the adult interpretation of the expression.

Nelson (1973) considered this issue further, where children may focus on the function of objects and form concepts through an action based strategy. She discussed how word meaning may be derived from experience with the word, interaction with the others in their linguistic community, and through the context of the exchange. For example, changes in context or question format greatly affect the child's interpretation.

5. CATEGORICAL DEVELOPMENT

This vocabulary system, along with word meaning, is not just composed of arbitrary relations, but is organised in a very sophisticated manner, grouping terms into various categories. Learning a system does not just involve arbitrary relations. For instance, with colour vocabulary it is not sufficient to determine what red means in isolation since the addition of further colours, such as orange, may modify the definition.

Categorization involves the organization of the acquired lexicon, and as this expands then the child's awareness of communication grows accordingly. Some of the issues in categorization involve taxonomy, while others involve thematic categories. Taxonomy concerns organizing words according to their label - that is, grouping things in terms of semantics. Thematic categories concern grouping things in terms of the context in which they are used. Thus categorical development is important from a semantic point of view, and different from thematic relationships. Evidence suggests a developmental preference, where children prefer thematic notions of meaning, and then taxonomic relationships.

Markman and Hutchinson (1984) found that before 6 years of age, children generally used thematic relations between objects rather than the appropriate taxonomic category. For example, to associate dog with bone, or toys with play. Yet, when the child believed they were learning a new word, they often used categorical organization, and after 6 years of age generally used categorical relations when appropriate.

Since young children find thematic relationships most salient, Markman and Hutchinson investigated how categorical relationships may develop. In one experiment they gave pre-school children a target word, such as dog, and then presented them with a thematic association, such as bone, and a taxonomic one, such as cat. The child had to choose the one most similar to the target object. The younger age groups of 2/3- and 4/5-years old, preferred a word with a thematic relationship rather than the appropriate taxonomic category. However, when the target word was unknown, they attempted to choose taxonomic associations. They appeared to search for links to tie this new word in with categories they already have, or attempted to form a new category to accommodate the word.

Children of around 7 years of age, however, were effective in solving the task, and capable of segregating a mixture of fruit and vehicles into appropriate categories, whereas the younger age groups generally arranged the objects into patterns.

From their analysis, Markman and Hutchinson concluded that rather than anything else, the child's attention to categorical relations changes most with development. This may be partly due to experience in early language, and partly innate. For example, while the youngest children used few categorical restraints on word meaning, the 4/5-year-olds set some restraints, and the older children set increasingly appropriate ones. Children focused on the context and gestures of the speaker to deduce the meaning of expressions, and attempted to assign new words into already existing categories where possible. With younger children thematic associations were most salient which progressed to the appropriate taxonomic categories with development. This shift from thematic to taxonomic categories involves a progress from non-linguistic organisation based on events occurring in a world, to a linguistic system where language is used to discuss the world.

Thus young children appear effective in segregating words into semantic categories and distinguishing between them. When Carey and Bartlett (1978) requested 3-year-olds to assign novel words to a category, they discovered that children were well adapted to this task. A single exposure to a new word was sufficient to start a re-organization of the specific category. Carey (1974) suggested that this requires a two-step process. Firstly they attempt to assign it to a semantic category, and secondly they learn the difference between words they have assigned to the same category.

6. CONCLUSION

This section concerned the development of communication in relation to language, and explained several main aspects of communication. To communicate effectively the child must acquire a mutually accepted conventional meaning system based on the vocabulary of the community, along with the ability to deduce word meaning, and produce and comprehend terms.

Hence the question is how the child readily acquires these skills and a highly conventionalised meaning system in what would appear an extremely short period of time. This development may appear intuitive to the layman, yet has proved an enigma to psychologists, linguists and philosophers for years. Some of these issues will be discussed in next, especially the development of this representational capacity and whether the roots are innate or lie in the infants early, pre-linguistic experiences.

B. THE DEVELOPMENT OF COMMUNICATION SKILLS

1. INTRODUCTION

This section outlines some theoretical issues on the development of communication skills, such as how the child develops a shared meaning system, and the necessary interactional skills to cope with communication in dialogue. Some of the theories assume that the child has a specific disposition to learn a language, while others regard environmental factors and parental encouragement as most important. This contrasts the individual with an innate ability to acquire a language on the one hand, with environmental factors on the other. However, this distinction alone is far too abstract, since many varied and complex factors influence language under each section which are often taken for granted. For instance, the individuals culture is often stated as a main environmental influence yet to define what this entails is rather more complex. One should investigate the opportunities for the child to grasp a language, where interacting with those representative of the culture play an important role, as well as many other more obscure factors.

These open empirical questions of human understanding do not clearly serve to identify the physical mechanisms involved in communication, however they have led to an increasing awareness and better understanding of the inner mechanisms of the mind.

2. AN HISTORICAL REVIEW

Language and communication have proved elusive issues throughout history, when attempting to understand the essence of a language and how that may develop. Since Plato's doctrine (427-347 BC) that learning is recollection, dependent upon the existence of innate ideas, the view that language may be pre-determined has held its ground. Plato believed that knowledge is part of the essential nature of the soul, and that we are born knowing things. Thus to learn something is simply to recover from your mind, knowledge that you had before you were born.

This belief in innate capacities directly opposes that of empiricism - the view that our minds, wholly empty at birth, obtain all knowledge from post-natal experience.

In modern times Rene Descartes (1596-1650) may be viewed as starting the first cognitive psychological revolution. He was concerned with the idea that there was no certain way of acquiring knowledge and considered how human beings could get to know anything for certain, and how. This involved self-inquiry and introspection to deduce "what can I know". Whereas Descartes discussed the theory of knowledge, researchers today are more concerned with logistics and linguistics, investigating the theory of language rather than the theory of knowledge.

One of the first attempts to give a detailed account of human language and understanding was made by the English philosopher John Locke. His "Essay Concerning Human Understanding" (1690) gave a critical assessment of the origins, nature, and limits of human reason in an empiricist way. The central proposal was that words only indicate an idea in the mind of those that use them, and his main principles paved the way for other empirical philosophers to base their thought, such as Berkeley, and Hume.

John Stuart Mill (1806-73) considered a different view of language and meaning, and proposed that 'names name things' and not the idea in our mind. For example, he stated:

"There seems good reason for adhering to the common usage, and calling the word sun the name of the sun and not the name of our idea of the sun. For names are not intended only to make the hearer conceive what we conceive, but also to inform him what we believe."

Mill empasised the common usage of words and language. Cherry (1971) clarified this when he pointed out that the word communication evolves from the Latin word 'communico', which means to share, and is indeed a shared social process of mutually accepting signs and co-operating to use them in a common way.

Many of these beliefs in innateness remain popular today. Chomsky (1957) argued that languages have underlying structural similarities, that they are extremely complicated and universal, and that we are born with knowledge of this 'universal grammar'. According to Chomsky this would explain how children readily produce and understand new utterances on the basis of an acquaintance with only a few. In 1957 he stated:

"that the whole framework of grammar may be innate, and language learning may simply involve calibration to the local conventions and the acquisition of a vocabulary."

Chomsky argued there is only one core grammar, which is innate, plus a number of variations, where external factors tune into this. In addition, he believed that children would learn a fundamental linguistic structure by the same age period, regardless of the language learning environment. He described languages as an internal infinite number of procedures and to know a language involves acquiring and mastering this code of generative procedures.

Chomsky's studies revolutionised the scientific study of language, with his belief that in learning a language we acquire tacit rules concerning its syntax and semantics.

More recently Chomsky (1988) argues that languages must be innate, since if we were to design a language we would presumably make it easy to acquire and use. On the other hand, he argues that languages are not designed for ease of use. For example, sentences are not easily parsed and language design makes it difficult to say what we mean and express our intentions correctly. Furthermore, we have many unusable expressions and only practice the usable ones, and it has proved difficult to learn a second language. Regarding the theory of evolution, he argues that it is not obvious how the brain could have produced such a system. Languages go beyond the survival level, and are not always functional. However, this stance directly opposes the biology of language since contemporary biologists argue that relationships between function and structure are very complex and obscure, and one should not expect a simple relationship. For example, Chomsky believes the function of language and its structure should be clear.

However, Chomsky concludes that he will continue to argue that language learning is innate, until it is proven that languages evolve through experience, or otherwise.

More recently Gould and Gould (1986) have applied some of Chomsky's ideas in relation to areas outside language. They suggest that difficult tasks are more likely to be innate, since they require much more time to solve, yet certain species perform complex tasks quite naturally and without much training. For example, they argue that language may result from a type of innate, instinctive learning, since children:

"unattentive, distractable, and often, as adults, very slow in other ways - learn language effortlessly, without the need for formal instruction or reward."

They discuss how many animals and birds are born with innate prewired programs of how to carry out tasks which are important for their survival and existence. For example, robins start to build their nests with sticks and mud finishing with grass, whereas other species use lichen backed with cobwebs. Commonsense assumes they observe their birth environment and somewhat improve on it. However, Gould and Gould argue that they are born with a pre-wired behavioural program which determines what they learn.

They compare this with learning other tasks which prove impossible for many species. For example, they consider the laborious teaching effort and feedback required, when teaching children arithmetic at school since the child is not innately pre-wired to acquire maths.

Yet Gould and Gould may be simplifying the issue slightly, since mathematics or calculus may be regarded as a language in a technical sense, where the child similarly has to learn the symbols and rules. And if a society was based on a mathematical language code, then this would presumably be learnt easily. Or perhaps we have to learn a natural language first before we can put numeracy into perspective.

Although, it may appear that children 'learn language effortlessly', one must consider the strenuous effort parents take while teaching the child a language, which Schaffer and others have stressed. For example, adults modify their speech for the child, use short sentences, repeat themselves, and use attention holders such as high pitched voices and gestures (Clark and Clark, 1977). They encourage the child to take communicative turns, providing what Clark and Clark refer to as: "language lessons in miniature" on such things as words, sentences, and conversations. In their opinion the child is not born with a mental lexicon but has to acquire it by attaching meaning to words.

Yet while Chomsky argued that language on the whole is innate, Schaffer (1979) proposed that the innateness may be in the interaction. Schaffer argued that it is the capacity to interact in the communicative process that is innate, which goes beyond language.

He proposed that the child is born with some innate capacity to interact, which is encouraged and developed through parents, elders, and schooling. For example, elders modify their speech to suit the child, talk in the 'hear-and-now', and use slow and simplified terms. In this way the infant is viewed as an interactive organism looking for social exchanges with support from the parent through reciprocal patterns. Schaffer comments:

"If babies had no pre-adaptation for interacting with others, social development could not take place as quickly as it does."

He discussed how the co-operational turn-taking behaviour of communication is enforced by the child's pattern of behavioural on/off cycles which regulates their breathing, digestive, and other systems. For example, the infant may go into a burst of sucking behaviour where the parent remains quiet. Then the infant may pause, where the parent takes the opportunity to stimulate the baby by stroking or chatting. In this way, communication is already established, through mainly gestural channels, before the child can use the language.

Video recordings have illustrated this co-ordinated timing. Schaffer, Collis, and Parsons (1977) observed how the parent would monitor the direction of the infant's gaze and elaborate on the focused object by stating its name, colour, and other relevant details. They maintain the behavioural interactions based on good timing and mutual integration, to ensure knowledge overlap, adapt to the infant's time cycles and stimulate them in relation to these. This co-operative turn-taking behaviour may thus set the structure for alternating conversational patterns of dialogue. Dialogue patterns appears to set in at a very early age since they have been found when 2-year-olds interacted with 1-year-olds (Schaffer,1979).

Furthermore, if communicants are not mutually aligned then this may affect communication ability. Michaels and Collins (1982) noted that ethnic children in particular, were not developing adequate literacy skills of basic adult competency. They proposed that this was due to differences in oral discourse style associated with the teacher's expectations. For example, many ethnic children would be misunderstood or interrupted at the wrong point, thus deprived of the benefits of synchronized collaboration.

Nelson (1985) proposed that the infant does not begin life endowed with such a system of communicative skills but has to learn how to use that language. She believes that the child's language system begins as a two-person idiosyncratic code and gradually progresses into a complex multi-contexted conventional language system. This develops through years of accumulating knowledge of such things as syntax, semantics, phonetics, and world knowledge, and is not simply innate as others have argued.

Nelson also proposed that the child requires three types of meaning for successful communication. That is subjective meaning, which develops inside the individual's meaning system, shared meaning which develops among two or more interactants within some given context, and objective meaning, which comes from the individual's culture. According to Nelson, a theory of meaning development must consider the child's cognitive system, the communicative context, as well as their linguistic, and social development.

She discusses how the child's language is influenced by several main environmental factors, such as the objective, cultural, and social contexts of the child. For example, whether they grew up in a rural village or city suburb, whether their culture is that of the city street with its computers and filofaxes or village life with tractors and harvest implements, and the structure and learning environment of the family. There are many factors that influence the child's language development and vocabulary, however, Nelson proposed that these are the main areas in which the child interacts and develops a common language system.

According to Nelson the child learns conventionalised community meanings through context and interaction with the members of their society whose language system is gradually transferred to the child. Especially since most meanings are conventional and cannot simply be deduced from the situation or word itself. Languages are thus inextricably linked to societies and cultures as a whole, where the meaning of terms used will denote the necessary functions of that society. Thus the child must not only acquire a certain language but also a sound understanding of their culture and its particular requirements for successful communication.

On a more extreme level Channel Four recently showed a programme called 'Hot House People' (1988), which insinuated that any child, given intensive early parental training has the opportunity to become extremely gifted and highly intelligent. Yet this directly contradicts the well established notion that intelligence and talent depend primarily on mental abilities governed by hereditary factors.

Thus although parental encouragement and early education can reap exceptional benefits (Bloom, 1985), Lynn (1988) points out that this recipe will not automatically produce a genius.

Lynn states that the child's early background with parental ecouragement provides a positive foundation for learning, and if consistent can be extremely beneficial. Indeed most exceptionally gifted adults were generally encouraged early on from one or more adults. Thus, early training can produce long-term gains of which many can be major. Certainly with language development, parental encouragement produces substantial gains (Fowler, 1983). As Lynn (1988) points out, parents who chat to their babies from birth onwards, often learn to communicate much earlier than infants who were not exposed to this environment.

Finally, he points out that parents should give this very complex issue much thought, since early pressures to succeed may often be detrimental to many other social skills equally as important for success, such as self-direction, self-confidence, and patient persistence. The high rates of child suicides in Japan point to the worst extremes of child pressures to succeed in the educational sphere, however, they have also produced extremely high educational standards (Lynn, 1988).

This evidence appears to suggest that parents play an important role in guiding and shaping the child's development, which take place within communicative experiences in the cultural environment. However, one cannot simply rule out the underlying hereditary influence which plays a more obscure role in the child's development.

3. CONCLUSION

The research concludes that the child acquires a language through parental encouragement, certain innate co-operative behaviours, and exposure to the communicative environment. It also indicates the continuing debate between innate abilities and environmental factors, since both are, and will continue to be important in their own right. However apart form the work by Schaffer and a few others, the debate tends to overlook the importance of interactional abilities, which is a very central component in language use and communication. The debate tends to focus on learning the language and grammar and not on the development of interactional skills.

Section C. will attempt to fill this gap by investigating issues which relate to interaction. For example, the child's ability to communicate a message to a listener, the listener's ability to comprehend utterances, the use of questions and interrupts, and the ability to jointly negotiate reference.

C. COMMUNICATION PROBLEMS

This section concentrates on the development of interactional skills for communication in dialogue. The debate on the importance of innate versus environmental factors for language development illustrated how interactional skills have been under-rated on either side. These skills were largely ignored at the expense of studying the development of meaning, syntax, morphology, phonology, and so on.

The studies reported next are all based on interactional aspects of dialogue and those developmental processes which reflect the interaction between communicators.

This section will investigate some of these issues such as the interactional skills the child possesses and how others may develop, the reasons for communication failure, what measures may improve performance, and the child's evaluation of messages and ability to monitor content.

1. REASONS FOR COMMUNICATION FAILURE

Young children have demonstrated many problems while interacting, although their performance does improve over age (Krauss and Glucksberg, 1969). Various reasons have been offered for their poor interactive ability.

However, one of the earliest and most influential was that of Piaget's egocentrism principle where the communication failure was attributed to the child's inability to adopt a listener's perspective.

1.1 THE EGOCENTRIC CHILD

Piaget (1926,55) argued that pre-school children already have their concepts and picture of the world and their problem concerns how to communicate. According to this egocentrism argument, children are poor interactors because their early speech is essentially private, and fails to take the addressee into account. Piaget (1955) produced evidence that around 50% of pre-schoolers speech (of age around 18 months to 7 years old) was neither adapted nor addressed to a listener's requirements. While some of their speech was addressed to a specific listener, a fair percentage was addressed to anyone in the receiving area, and gave no indication of listener awareness.

Comparing structural differences in communicative behaviour between adults and children, he noted that children repeated words that served no useful social purpose and often talked to themselves in monologues. Furthermore, they generally continued to do so even when aware of a listener's presence. Piaget concluded that the child's speech was generally private and egocentric, without any social consideration. He hypothesized that this reflected cognitive limitations on the child's part and explained their poor communicative ability.

Piaget believed that the child's early speech directly reflected their thought processes, which only later developed into private speech. On the other hand, Vygotsky (1962) argued that language precedes thought and not the other way around. Vygotsky noted that egocentric speech increased with the difficulty of tasks as a type of "thinking aloud". Hence he proposed that egocentric speech was a precursor to verbal thought and with development went "underground", as thoughts to plan and guide our verbal thinking. In this way the timing of private speech changes, such that it precedes the child's actions rather than accompanying them.

Although both researchers emphasized the significance of egocentric speech, Piaget believed it to be a hindrance for the child, eventually developing into social speech, while Vygotsky suggested it may actually have a self-regulatory function, and simply become silent rather than developing into anything else.

Other researchers have observed that private speech co-occurs with difficulty in cognitive tasks. Beggs and Howarth (1985) for example, suggest that it parallels reading aloud with expression, and found a critical period it develops. They proposed that children generally acquire inner speech around 8 to 11 years, and both slow and fast readers demonstrate similar acquisition patterns. Apparently the main function allows the reader to build prosodically sound utterances, internally, which adds meaning to incoming information. Prosodic cues, such as intonation, have been found to assist the listener with the acquisition of new information (Lieberman, 1967).

1.2 REFERENTIAL COMMUNICATION

Piaget was essentially investigating how children use words in general and carried out several experiments on egocentrism outside of language. He explored egocentric speech in a number of cognitive activities and believed it to be a plausible explanation for the child's poor communication ability. This was endorsed by future studies which concentrated on particular skills to provide a more specific test of egocentrism. For example, Glucksberg, Krauss, and Weisberg (1966) devised a task to study the child's awareness of message adequacy and concluded that children displayed many egocentric qualities. Their basic referential communication task has since been used widely, which involves subjects describing some visible external referent. In this case communicating reference basically involves:

"an action by which one person tries to focus the attention of another person on a certain part of the environment".

Referential communication involves utilizing shared knowledge to identify referents in terms of their locations, or other characteristics ameniable to the listener (Asher, 1979).

The task developed by Glucksberg et al involved two subjects positioned at opposite ends of a table with a screen between them to prevent any visual contact. One child has a dispensor and received one of six novel forms to be described in such a way that their partner can choose the object from a comparable set and stack it on a rod. The novel forms were a collection of building blocks, each displaying a certain picture, and the aim of the task was for dyads to finish with the same order of blocks on their rods. The main focus fell on the ability of the describer to provide sufficiently informative messages for the listener. To be informative it was proposed that the speaker should compare the referent with the nonreferents, perceive the listener's needs, and evaluate the contents of their message.

Results indicated that this process, often automatic and unconcious to adults, posed great problems for the developing child. For example, on the first trials with the novel pictures all children in the age range 4 to 10 years performed poorly. However, the older children improved markedly with practice, while the younger age groups continued to make errors. These younger children, in the age range 33 to 63 months, generally gave uninformative messages, consistently preventing the listener from choosing the correct block. Furthermore, earlier pre-tests had indicated that all the children were able to solve this type of task, since success was high when the blocks displayed pictures of animals.

On further analysis, Glucksberg at al discovered that the younger age groups often used references which had private meanings rather than public or conventional ones. For example, they described a novel form with expressions such as "Mummy's hat".

In their second experiment, they reversed the role for the describer, so that the child was presented with their own initial description (eg. "Mummy's hat"), and asked to choose the correct block. Consistently the child knew which block to choose. Thus the descriptions were sufficient for their own discrimination, yet ineffective for the listener. This confirmed the hypothesis that children were displaying egocentric qualities, and using language in a private and egocentric way. One explanation may be that the child believes the information to be mutually known to the listener (egocentrism), and thus what the child has to learn is to distinguish mutually shared information from the rest (Perner and Garnham, 1986).

However, this phenomenon did not persist for long. For instance, Glucksberg et al discovered that if the example such as "Mummy's hat" was presented to its author two weeks later, it failed to produce the correct reference in that child. This would suggest that memory cannot accomodate private speech for any great length of time. Thus young children often produced messages that were ultimately uninformative even for themselves.

Using the same task, Krauss and Weinheimer (1964, 1966) noted that adults used more complex, specific descriptions on their original encounters with the novel forms, such as:

"It's an upside down cup. It's got two triangles, one on top of the other",

leading to more economy when the referent had been successfully located, producing for example:
"an upside down cup", and then simply "the cup". Communicants appeared to be negotiating and developing private two-person idiosyncratic codes where they alone shared the specific meaning of the references.

Such a progressive reduction is consistent with Zipf's (1935, 1949) observation that the most frequently used English words have only one syllable, and that frequency and length are inversely correlated. For example, as a word becomes more frequent, perhaps due to technical or cultural changes, it tends to be shortened (eg. 'moving picture' to movie, 'television' to TV, 'telephone' to phone, and so on). In this more general sense, the population as a whole adapts vocabulary to suit the function.

Regarding the negotiation of definite reference, Krauss and Weinheimer suggested that children may be incapable of establishing a suitable joint nomenclature in a short space of time, since their descriptions predominantly had private rather than public meaning. Children may not have developed the necessary skills to co-operate with one another and produce joint descriptive codes, where they adapt to the listener's contribution and accomodate their views.

This suggests a plausible alternative explanation for poor referential communication, to the effect that children may attempt reasonable descriptions but fail due to their lack of appropriate cognitive skills. For example, they may not have the necessary vocabulary or expertise to respond appropriately.

1.3 IGNORING THE REFERENT

A further explanation for the child's poor referential communicative ability may be the fact that they are ignoring the nonreferents and simply focusing on the referent in isolation (Asher and Oden, 1976). If this was the case then subjects might attempt to describe the referent, at the expense of the nonreferents, and so produce ambiguous descriptions in that context.

Olson (1970) argued that successful reference depends on contextual differentiation, and that our language relies on the listener's knowledge and experience. Thus according to Olson words do not specifically refer to objects, but provide information relative to the set of alternatives. In this way, the context of the referent determines how it is described, and as Olson states:

"semantic decisions are not determined by either syntactic or semantic selection restrictions but by the speaker's knowledge of the intended referent."

Olson (1970) reports a number of studies to support this view. In his main experiment a gold star was placed under a white wooden block, and one subject had to describe to the other where it was placed. On each trial the star remained under the same white wooden block, however, the number and types of other blocks present were manipulated. This greatly affected the descriptions generated. As the number of alternatives changed in colour and shape, then the gold star block was described differently in order to differentiate it from the other shapes present.

Thus it is possible that young children produce poor descriptions because they overlook the nonreferents and simply concentrate on the referent in isolation.

To investigate this further, Asher and Oden (1976) used the standard referential communication task, where pairs of children were divided by a screen. Each child was presented with two words such as OCEAN-RIVER, with the speaker having one word underlined. The task was to communicate the underlined word in a one-word-message, using a different word from that underlined. The paired words were deliberately similar in meaning, such that successful differentiation depended on the subject taking the nonreferent into account, and giving clear descriptions.

In this case perhaps 'waves', 'ships', or 'Atlantic', would differentiate ocean from river, however, children appeared to simply focus on the referent, describing it by 'boats', or 'fish'. This failed to specifically differentiate it from river. Yet when the target word was paired with a dissimilar word, such as OCEAN-HOUSE, their partner had little difficulty solving the task and choosing the correct word.

There could be at least two reasons for this poor communication of reference. Firstly, that children were ignoring the nonreferent and concentrating solely on the referent, and secondly that they were using egocentric forms of comparison with private rather than public differentiation. To clarify this, Asher and Oden gave subjects their original inadequate description, in order to determine if the message differentiated the two words for themselves. For example, they might give the subject 'boats' or 'fish' to discover if this uniquely identified OCEAN.

The results suggested that this was not the case. So they concluded that the child's problem may indeed be one of failing to compare the referent with the set of alternatives which, as Olson pointed out, is crucial to the specific identification of the referent. Thus children were not necessarily displaying egocentic qualities but rather attempting to describe the referent at the expense of the nonreferents.

1.4 CONCLUSION

In the main, studies of this sort produced evidence that pre-school children were poor communicators of reference but this gradually improved over the school years. The reasons for their poor communication fell into several main categories. One, that they provided private messages, two, that they failed to take account of alternative possibilities, and three, that they were incapable of the joint negotiation of schemes. It is possible that young children have not yet developed a whole system of communicative skills to distinguish between good and poor messages, and determine such things as word choice, and informativeness of various expressions over others. The next section will discuss the skills the child uses effectively to communicate with others.

2. THE SKILLS THE CHILD POSSESSES

The studies described above illustrate how communication failure has often been attributed to Piaget's egocentrism explanation. This assumes that the child is ignoring the listener's perspective and failing to provide sufficient audience related information. For several years Piaget's view has dominated research in this area.

More recently, however, a growing number of studies have found evidence for a somewhat different explanation. These studies generate evidence of two sorts (1) that children as young as 2 or 3 years old are capable of taking another's perspective, and (2) that young children can successfully communicate referentially with a listener under certain special circumstances. That is with simple tasks, and when they are aware of the skills to use. Thus poor communication ability should not simply imply egocentrism. The next section will investigate this evidence in more detail and highlight the skills that the child does possess.

2.1 COMPLEXITY OF TASKS

Whitehurst and Sonnenschein (1981) suggested that children may be capable of producing adequate descriptions but lack the appropriate vocabulary and language skills to do so. They carried out a similar comparison study as Asher and Oden (1976) but in addition administered pre-tests to ensure that the children possessed the necessary lexicon to express their intentions. They then investigated whether children were comparing and contrasting the referent with the nonreferents.

The trials could range in complexity, from using two triangles which could differ in terms of colour, size, or pattern. In the simpler conditions (eg. where the triangles differed by colour alone) it was found that children could produce informative messages, sucessfully comparing the referent and nonreferent, but this was not the case for more complex material (eg. where the triangles differed in all three aspects).

Thus the results indicated that children as young as 4 to 5 years old were capable of comparing stimuli and producing informative messages, provided that the task was simple in terms of vocabulary and cognitive demand. Although this does not necessarily imply an ability to take the listener into account, it does indicate that children may not have the appropriate vocabulary to carry out certain more complex tasks.

2.2 TASK AWARENESS

This demonstrates that children often perform well with simple tasks, however they could only succeed if they were aware of the skills to use. Thus task content in itself is insufficient to produce successful performance.

The results of these experiments implied that the child's initial descriptive deficits may not be due to communicative restraints, since they could respond correctly at other times, especially when prompted. Thus the problem may lie with the child's ability to detect the task's requirements, such as the unique identification of a specific referent. The child may already possess these necessary skills, but be uncertain about when to apply them. So young children may not possess the experience to infer what is required in certain tasks, especially in the expected adult way.

Further studies support this conclusion. For instance Ackerman (1981a) found evidence that 5-year-olds could detect referential ambiguity, although success was lower on more difficult tasks, and Whitehurst and Sonnenschein (1981) noted that once the task was clearly defined, the child often demonstrated the appropriate skills. This would tend to suggest that children have not learnt a new skill but how to apply an existing one. So with simple tasks and a clear grasp of what is required, successful communication was often elicited from the child.

These various alternative explanations for the child's poor communicative ability demonstrate the problems attributing cause to effect. Thus, rather than the child simply displaying egocentric speech, they may fail to judge the correct amount of information required to specifically identify some referent. Alternatively, they may be unaware of the nature of the task, or limited by their cognitive processing capacity. They may not yet possess the appropriate skills to identify specific referents, or the younger listeners may be unattentive, the describers non co-operative, or perhaps older children are just more garrulous with a larger vocabulary. These are just some of the reasons for possible communication failure. Thus inability to solve a task should not simply be attributed to communicative ignorance or inefficiency, since many alternative explanations may hold.

Analysing the volume of communication studies carried out, Dickson (1981) suggested that various basic communication skills could be taught to children to assist them with communication and language development. For instance, the importance of comparing the referent to the nonreferent for unique identification, to ask specific questions when they fail to understand a message, that communicative failure may be due to the speaker as well as the listener, and so on.

Although it may be beneficial to educate the child in this way, Whitehurst and Sonnenschein (1981) comment:

"the distinction between knowing <u>how</u> to do something and knowing <u>when</u> to do it, is subtle but important."

2.3 ROLE-TAKING IN CHILDREN'S DIALOGUE

Role-taking concerns the child's ability to take the point of view of the other, for example, for the speaker to note any knowledge discrepencies between themselves and the listener and so improve the message. The speaker should be able to recognise the listener's task and thus provide appropriate information. Role-reversal presumes that adopting the role of the speaker once one has been the listener for example, should make one more aware of a listener's needs, and become more sensitive to the demands of each role. This investigates a more specific version of egocentrism where speaker and listener should be aware of each others role and the different tasks they have to carry out. This section discusses whether children are effective at role-taking and able to take the view of the other, rather than being classed as egocentric.

There are a number of studies which indicate that young children adjust their speech while talking to listeners of a younger age. These studies consider the extent to which the child is able to take into account the listener's perspective.

These experiments concentrate on more natural forms of speech production in less structured settings, such as in playschools, compared to the more rigidly controlled tasks investigating specific skills in the laboratory.

Evidence indicates that young children are aware of their conversational responsibilities. For example, they talk louder to a person who is hard of hearing, or limit their speech to topics a listener understands (Shatz and Gelman, 1977). Even by the age of 19 months they make attempts to maintain discourse, and by the age of two years generally attempt to respond when required. This illustrates a sensitivity to their role in a conversation (Bloom, 1976).

Shatz and Gelman (1973, 1977) in particular, found substantial evidence that 4-year-olds could adapt their language to 2-year-olds, as compared to adults. While explaining the workings of a toy to a younger child, they were found to use a fewer number of sentences, which were shorter and syntactically simpler, as well as more prosodic cues such as stress and intonation, and more explicit requests and attention holders. This was not evident in their speech to the adult subjects, or their peers, and occurred whether they had a younger sibling or not. The results indicated an awareness to adjust to listeners of different ages, which is inconsistent with Piaget's notion of egocentrism.

One criticism levelled at this explanation is that the child may simply be imitating the way their parents communicate with them. Tomasello and Mannle (1985) investigated 3- to 5-year-old's ability to adjust structural characteristics of their speech for younger listeners. They discovered that children did not adjust the length and complexity of their utterance over time, whereas their mothers did. This suggested that the young child's apparently social speech may stem from imitating their parents, as well as being encouraged by the younger conversational partner. Yet even at this superficial level these children were attempting to modify their speech to take the listener into consideration.

Further studies indicated that children adjust their speech to the age of a listener, and talk more to adults than their peers. Camaioni (1979) noted a developmental change in the child's behaviour from around 2 to 4 years old, where the child changed from a parallel play to a more co-operative one. In addition, the child displayed a similar pedagogical relationship towards a younger child, as an adult would.

Garvey and Hogan (1973) found children to be "sociocentric", and capable of "genuinely social behaviour and interpersonal understanding", since when socially engaged they generally adapt to others. Their evidence stemmed from videotaping 18 dyads of children, aged 3.5 to 5 years old, in 15-minute play sessions. Although private speech was evident, Garvey and Hogan emphasised the point that social behaviour was also predominant in young children.

Evidence of social communicative skills in young children have been replicated elsewhere. For example, Mueller (1972) videotaped 24 pairs of children, in the age range 3.5 to 5 years old, to discover that social behaviour was generally the rule and not the exception. 62% of all utterances were successfully reciprocated by the child, where they responded in some definite way, compared to 23% intermediate responses, and only 15% classed as failures where the child did not respond. Mueller discussed how the success of the interaction may be dependent on other social variables. For example, their social response may depend on their physical distance from the speaker, or the listener's visual attention at the beginning of the utterance, or the technique used to catch their attention, such as "Look" or "Listen", and so on.

These studies demonstrate that children are able to adjust their speech when communicating with younger children of lesser linguistic competence, as opposed to their speech being egocentric. This questions the importance of egocentrism in general and inability to take roles in particular, to account for the young child's poor performance.

Dickson analysed studies on referential communication to conclude that:

"the pattern of results gave little support to the view that referential communication performance is influenced to any great extent by egocentrism or role-taking".

2.4 CONCLUSION

The studies reviewed in this section produced evidence that young children are able to take another's perspective, and that referential communication is possible under certain conditions. For example, with simple tasks and a clear awareness of what is requested from them, children were able to contrast referents with nonreferents to produce informative messages. Thus errors may not be caused by egocentrism but rather the fact that they lack the appropriate vocabulary and language skills to complete certain referential communication tasks.

3. BENEFITS OF SOCIAL INTERACTION

The above evidence from referential communication studies, illustrates that young children have difficulty providing adequate messages. While investigating this issue Deutsch and Pechman (1982) noted that social interaction could alleviate many of the initial deficits and improve performance. In connection with this they asked 3- 6- and 9-year-olds, to choose a gift from eight alternatives, and offered feedback whenever necessary. Results were then compared to a group of adults choosing a gift.

In accordance with previous results, children, as opposed to adults, produced equivocal descriptions of the gift. Yet the messages improved markedly with interaction. For example, if the speaker gave an ambiguous description, and the experimenter repeated it in question format, the adults, and the 6- and 9-year-olds, then described the referent correctly. Even with the 3-year-olds, interaction led to 89% adusting their descriptions.

Further studies in this field have produced similar evidence where children (although generally over 4 years old) respond favourably when given structured advice for more effective communication (Cosgrove and Patterson, 1978). Increased interaction proved beneficial where the listener would point out ambiguities, and request more information when required. This also decreases processing demands on the part of the speaker, who is now aware of the listener's active participation to query them at any point and highlight any misunderstanding.

This type of situation mirrors real life interaction where feedback is the rule and not the exception. On the other hand, traditional referential communication tasks often involved communicators having fairly well defined speaker and listener roles devoid of visual contact. Although these are often necessary for certain descriptive tasks they neglect the benefits of natural feedback and visual information.

4. THE ABILITY TO EVALUATE MESSAGES AND MONITOR CONTENT

There appear to be clear age divisions in children's ability to evaluate and monitor the contents of information (Markman, 1976), which depend on the child's developmental stage. Thus the child's interpretation of certain situations may be very different from that of adults.

Markman (1976, 1981) noted specific age divisions in children's appraisal of information. In one experiment, she gave children essays to evaluate, which were composed of glaring inconsistencies, such as the following, and asked them if they made sense:

"Fish must have light in order to see. There is absolutely no light at the bottom of the ocean. It is pitch black down there. When it is that dark the fish cannot see anything. They cannot even see colours. Some fish that live at the bottom of the ocean can see the colour of their food."

These were often judged comprehensible by children, who failed to notice the errors of consistency. Markman concluded that children are often unaware of whether they have understood something correctly. Not only children, but adults also overlook inconsistencies in texts. Sanford (1981) found that adults failed to draw the correct conclusions when presented with certain riddles and examples. It is thought that when texts contain sound structure then people fail to process the information further and draw deep conclusions. In addition people generally view texts as authoritative and thus are less likely to re-question certain parts, perhaps believing it was an oversight on their own part.

Yet, this lack of understanding may not be the only explanation for the child's poor comprehension monitoring. For example, children may not have read the passage carefully enough and overlooked a crucial line, or they may lack the confidence or assertion to protest and question the experimenter's authority. Children, as well as adults, are sensitive to the experimenter's demands and are often influenced by non-linguistic devices which indicate the desired experimental outcome, rather than using their own intuition and grammatical rules. Thus researchers should work with great sensitivity when attributing meaning to the child's actions.

Even though alternative explanations for Markman's results are highly plausible, other studies have indicated the child's apparent insensitivity to the quality of a message and their dependence on cues from the experimenter. For example, Finn (1976) noted that children were significantly influenced by paralinguistic cues. He asked 5- to 8-year-old children strange questions in order to investigate their ability to monitor the incoming information and note inconsistencies.

They were presented with questions out of context, such as: "Are there more Wugs or more Glugs?"

and generally replied normally such as:

"There are more Wugs".

When asked to defend their answers, they would often justify this with answers such as:

"Because they're taller".

Finn then asked the children if these were "good or silly" questions, with most children believing them to be "good" questions. Paralinguistic cues were very important to their decision, since results depended whether the experimenter asked the question in a serious or humorous way. For example, with an 8-year-old:

Adult (laughing):	Have you seen many talking cars?
Child:	No.
Adult:	Is that a good or silly question?
Child:	Silly.
Adult:	Why?
Child:	'cause.
Adult (normal voice):	Have you seen many talking buses?
Child:	No.
Adult:	Is that a good or silly question?
Child:	Good.

Once again the importance of context and the speakers gestures play a crucial role in the child's deduction of meaning.

In an extensively cited number of studies the Robinsons (1976,77,81,85) investigated the child's ability to monitor the contents of information and their awareness of message inadequacy. They proposed that successful communication requires the appreciation of how effective a message is, in terms of potential ambiguity and informativeness.

In their basic experiment, the Robinsons used two sets of cards with single pictures on them, giving one set to the subject (the listener) and one to the experimenter (the speaker). The speaker then chose a card and described it in such a way as to enable the listener to choose the same one from a comparable set. However, on certain trials the experimenter would engineer a communication breakdown and then ask the child who was to blame. The child could then choose the listener, the speaker, or both, as responsible.

The Robinsons found major age-related differences in children's perception of who was to blame. For example, children around 5 years generally blamed the listener suggesting that they should 'listen harder', whereas around 7 years, 'speaker blamers' were more common, and all the 11-year-olds consistently blamed the speaker when appropriate.

There are several possible reasons for this. It may be that young children believe they are responsible for the failure, since they may be familiar with their parents instructing them to concentrate and pay more attention (Pratt and Nesdale, 1984). In addition, young children often use the age of the speaker rather than the message itself to evaluate the contents (Sonnenschein, 1986). They regard adults as good models of communicative ability, and are more ready to accept their messages. On the other hand, older children may focus more on the quality of the message itself, with less emphasis on the speaker.

The child could choose the speaker, listener, or both, as responsible for the failure yet consistently chose the listener. This suggests that the younger 'listener blamers' fail to appreciate that inadequate messages are responsible for communication breakdowns. They are unaware of the essentials of a good message, and when their messages failed as speakers, they required substantial prompting before improving the contents. Deutsch and Pechman (1982) similarly noted that their 3-year-olds were generally oblivious to the adequacy of their descriptions, and often blamed the listener for the communication failure and not the speaker. The older age groups, on the other hand, produced references that were more successful, using greater redundancy. Yet the 3-year-olds did supplement their message with feedback and prompting from the experimenter.

This unawareness has been replicated elsewhere, along with failure to supplement their message when the experimenter stated they did not understand. Cosgrove and Patterson (1977) report that even when the problem was highlighted, the child often failed to improve their message. However, when the appropriate action was indicated, such as the need to ask questions, an increase in content appreciation was evident for children over 4 years of age (Cosgrove and Patterson, 1978, Robinson, 1981). This implies that the child may be aware of communication failures, however, not know how to cope with them. This illustrates the contrast between the identification of a problem and how to deal with it.

In a further study the Robinsons noted the response of mothers after their children described some referent inadequately. They then investigated the same children on their sixth birthdays. Those children who had assistance on the inadequacy of their message, by explicit discussion, now had some definite awareness of message inadequacy, with greater content appreciation and interactive improvement. However, one problem concerns whether the skill would generalise to another study such as the one carried out on their sixth birthdays. And if the same study was used, then perhaps the child has just learnt how to act in this specific situation.

One reason for poor communication monitoring may be the child's inability to differentiate between speaker and sentence meaning. Robinson, Goelman and Olson (1983) argued that children fail to appreciate the message because they confuse what was meant with what was said. They found that children as young as 4 years, could differentiate between good and poor messages. Yet failed to do so when the meaning of two sentences were similar but worded differently.

Thus it appears that young children either fail to monitor messages adequately, or monitor them but fail to note any inadequacies, or note inadequacies but fail to act upon them unless prompted by an adult. These skills have been found to develop anywhere between 4 to 8 years, at around the same period that conventional definitions begin to appear.

5. COMMUNICATIVE STRATEGIES IN TASK-ORIENTED GAMES

Perhaps a comparison between successful and unsuccessful communicants would indicate what poor communicators fail to do, or are doing wrong. Brown (1986) investigated the listening comprehension of over 700 pairs of same aged 13- to 16-year-olds, and compared the strategies of successful and unsuccessful subjects. She similarly noted that poor communicators generally had difficulty identifying inadequate messages and giving appropriate feedback. Furthermore, many of these problems were caused by the conceptual content of the material rather than anything else.

In her experiment, two subjects sat at either side of a screened table, and each had a similar map in front of them. These maps were composed of familiar named features such as a waterfall, church, house and so on. One subject had a route through the map to instruct their partner how to replicate it on their map. Subjects were told that the maps were slightly different.

Communication ability was measured by calculating response times during certain sections of the game, and the number of utterances generated in certain problem conditions. In this way, areas which give rise to problems could be highlighted and compared over different pairs of subjects.

Brown noted various differences emerging between good and poor problem solvers. For example, successful listeners appeared to recognise when a definite problem existed and what it was. As Brown explains:

"A good listener is not simply a passive recipient but is actively seeking to construct a coherent self-consistent mental representation and is actively seeking to eliminate inconsistencies."

Successful communicators were less prepared to accept their partner's more ambiguous directions, and would directly request more information and elaboration. Unsuccessful ones on the other hand, often detoured off the route completely, without the slightest hesitation, in order to reach some point their partner had mentioned, even though this was inconsistent with previous descriptions.

Thus Brown concluded that there appeared to be fundamental differences between good and poor communicators. For example, good communicators actively evaluate incoming information, monitoring any inconsistencies between their comprehension and the message content, and promptly gave relevant feedback. Whereas less successful ones generally fail to ask appropriate questions when the message is inadequate.

Using a similar type of task, Lloyd (1985) compared the development of communication skills in same age pairs of 7- and 10-year-olds, and adults, while giving route directions by telephone. Subjects were placed in separate rooms and given identical maps of a community with familiar features marked on such as churches, houses, and garages, where each feature could be uniquely identified by colour or pattern (see page 123, Figure 3.6). One player's map was covered by a perspex overlay with a route drawn on, which they had to communicate to the other, to enable them to mark this route onto their map. The speaker and listener roles would then be reversed on the following game.

Lloyd found that 7-year-olds produced significantly less adequate descriptions than the two older groups, with equally poor performance as listeners and speakers. The 10-year-old group, on the other hand, made twice as many errors when they were listeners compared to speakers. In comparison, adults were far more efficient in terms of precision and uniqueness and produced more economic descriptions.

Lloyd used a turn to measure the amount of conversation for each move, which was the amount of speech bounded by the other player's contribution. He discovered that 7-year-olds take the fewest turns with an average of 4.4 turns per move, compared to the 10-year-olds with an average of 8.3 turns, and the adults with 6.1 turns. It is intuitive that amount of speech should correlate with success, however since adults produced less speech than the 1o-year-olds, he concluded that the youngest group were not giving enough information, while the middle group have much redundancy, and the adults produced more efficient and economic descriptions.

In addition he discovered that subjects used various descriptive strategies to give route descriptions, and that different age groups preferred different strategies to describe points on the map (see page 124 for a full discussion of these descriptive types).

A.H. Anderson (1988) carried out a similar type of shared task to investigate conditions which may produce more active and successful communication between dyads. Pairs of 14- to 15-year-old native English speakers were positioned across a partitioned table to avoid visual contact, and each given a map marked with several familiar features as shown in Figure 2.1. In the first condition one subject had a route marked to describe to the other who had to replicate the route on an identical map. While in the second condition one subject had two parts of the route on their map and their partner had the other two. This joint problem involved communicating each section to establish a complete route. These two conditions were repeated using maps which were slightly different.

To establish communication efficiency Anderson calculated the number of words each subject produced in certain areas of the map, as well as the number of conversational turns. Results indicated that more difficult map conditions generated the most communication. For example, when the maps differed the subject with the complete route produced the greatest amount of speech, compared to when the maps were similar. This increased further when both subjects had parts of the route on their map, and again in this condition when the two maps were incongruent.

To investigate the speaker's performance in more detail, Anderson devised map protocols. These documented which features the speaker should mention and the direction of the route in relation to these, to allow an accurate representation of the route. This provided an objective record of the speaker's instructions. Results indicated

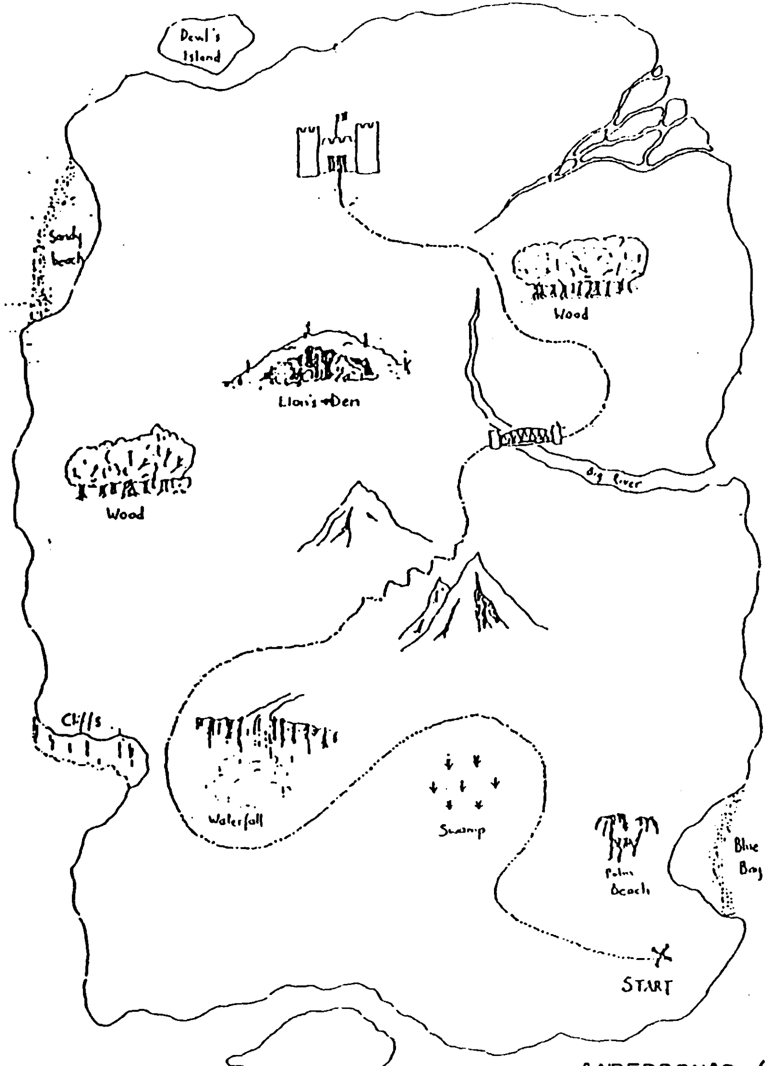


FIGURE 2.1

ANDERSON'S (1988) MAP TASK - EXAMPLES OF TWO MAPS

SPEAKER'S MAP

LISTENER'S MAP

that incongruent features generally produced more effective descriptions. Yet on some occasions where more dialogue was evident for incongruent features, this did not necessarily imply more effective instructions since subjects were simply repeating information.

This research is useful in illustrating what conditions may produce more active behaviour in joint communication tasks. As Anderson concluded:

"It seems that the most difficult tasks produce the most talk from 'listeners', and if we want to encourage their participation, we should increase not decrease the demands the tasks make of them."

In contrast to previous research these task-oriented games stress the interaction between pairs of subjects while solving a joint problem. They highlight what is involved in successful communication and identify good and poor communicators due to their interaction. Furthermore, the studies illustrate how both the speaker and listener have an active role to play in successful interaction. And Anderson discovered certain conditions which increased communication and participation from both speakers and listeners.

D. CHAPTER CONCLUSION

This chapter investigated the development of communication skills in relation to language. The first section gave a brief account of what communication in language involves, and then considered how the child may develop and acquire the necessary skills. The main influences focused on the debate between innate or environmental factors in the development of communication skills. However, it was argued that this debate under stresses the importance of interactional skills for this development. The sections that followed then discussed the development of communication skills in dialogue and how the child performs in interactional situations.

Young children have demonstrated many problems with the development of meaning and interactive skills, especially their ability to communicate information to a listener. However, these skills improve over the school years. The studies indicate that young children are deficient in several main communication skills, such as the ability to provide effective messages, to evaluate the contents of information, the awareness and detection of communication failures, and the ability to respond appropriately to information.

Many explanations have been given for their poor communicative ability, however, the earliest and most dominant one was that of Piaget's egocentrism principle. This attributes the failure to the child's inability to adopt a listener's perspective.

Past research commonly attributed the child's communicative failure to Piaget's egocentrism principle, although the research outlined here has shown the limitations of this approach. As Shatz pointed out, communication is far more complex than the earlier Piagetian theories assumed. Yet this work has been exceptional in stimulating research on language development for several decades.

Some of the studies concentrated on the child's ability to communicate a reference to another, heralded by Glucksberg et al's referential communication paradigm. Their study indicated that young children were indeed exhibiting egocentric qualities, since they generated private one-person descriptions. Yet, future studies indicated that this was not the case. For example, Asher and Oden (1976) demonstrated that children often produced messages that were even inadequate for themselves, thus they could hardly be labelled egocentric.

Reasons for the child's poor referential ability were then attributed to many other complex and varied sources. For example the complexities of the task itself, and the limitations of the child's cognitive and attentional capacities on such things as vocabulary, expertise, and comprehension. As well as this, it was noted that communication draws on many sources of information, which may be governed by the limitations of the individual's processing system.

Other possibilities were the fact that young children may not possess the necessary specific language skills to develop joint two-person codes for describing reference with a partner (Krauss and Weinheimer, 1964, 1966). In addition, several studies indicated that children apppeared to be describing the referent, while ignoring the nonreferents, and thus producing poor identification relative to the set of alternatives (Asher and Oden, 1976). This reflects a general failure to attend firstly to the totality of a situation, such as the context of reference, and secondly to take the listener's view of the context into account. These two explanations, however, are not totally inconsistent with egocentric speech.

Yet later research demonstrated that young children could indeed compare the referent with the nonreferents, producing informative descriptions, providing the comparison task was simple in vocabulary and cognitive demand (Whitehurst and Sonnenschein, 1981). In less complex conditions 4- to 5-year-olds were capable of producing informative messages, comparing the referent with the nonreferents. Indeed they were often successful at comparison activities providing the experimenter clearly outlined the task. This implies that the child is unaware of the experimental demands, since with feedback and prompting (as would be natural in real life situations), communication skills improved. Thus many communication skills were available but not enacted.

The research that followed clearly demonstrated that children were able to communicate information to a partner. This indicated the inadequacy of simply attributing any communication problems to egocentrism, but rather to other aspects of communication.

A second major attack on the egocentrism principle were a range of experiments which demonstrated that far from giving isolated soliloquies the young child was able to adapt their speech to their listener's needs appropriately taking the other's perspective. Video recordings illustrated 4-year-olds adapting their speech to 2-year-olds, as compared to chatting with adults (Shatz and Gelman, 1973,77), and children as young as 3 years were shown to be capable of social interactions and mutual understanding (Mueller, 1972, Garvey and Hogan, 1973). Social behaviour was indeed the rule and not the exception. Furthermore, a number of studies indicated that as early as 2 years old, children show some idea of conversational responsibility, where they attempted to respond when required (Bloom, 1976).

Thus Piaget's theoretical framework for communication appears outdated, and no longer sufficient to explain the child's communication development, since it overlooks many other important language issues. In addition, it holds constraints on the development of conventions and communication on the whole, since language is a social phenomenon, learnt through interactions. The speaker and listener are part of the whole interactional unit, and not independent, isolated entities, as the concept of egocentrism requires.

Thus when children fail to perform as expected, it does not necessarily demonstrate an absolute inability to solve the task. They may indeed possess the necessary skills but misunderstand what is required of them. Furthermore, when children do succeed on other tasks, it should not be assumed that they have done so in the same way as adults. Children's performance varies in different tasks, and in some appropriate contexts they have performed extremely well.

The task itself and the measures employed may often determine if a skill exists. One criticism levelled at this task-specific approach is that perhaps the skills used by the child are unique to that task, and not generalizable to other situations where they use natural language.

The bulk of research carried out has demonstrated further complexities and problems with the investigation of language development, although the more knowledge that accrues should eventually lead to some general language development framework. However, it appears that the acquisition of meaning and communication skills develop with the growing body of knowledge in a variety of different areas, especially the cognitive, social, and linguistic ones. Furthermore, with the expanding number of cross-cultural studies on more primitive societies, and non-Western cultures, the definition of any broad, general communicative abilities should become clear.

More recently communicative competence is viewed as uniting a variety of subskills, each of which is necessary for successful communication. Thus lack of one of these skills in the child's knowledge base, leads to inadequate communicative ability. Although seemingly plausible, objective proof of this explanation is not readily accessible.

Alternatively, something between structural change and processing demands may be more adequate to assess the child's communicative competence.

As for the development of the child's communicative abilities and meaning structure, several things have become clear. Firstly that the parents play an important role in guiding and shaping the child's development, and secondly that these developments take place within communicative experiences in the cultural environment.

These earlier studies appear to view language development and communication as a 'one-shot' activity at describing some referent. For example, where the speaker produces some single utterance that is judged as either effective or not. In contrast, later research places more emphasis on the interactional possibilities of the exchange where both speaker and listener negotiate certain solutions, and the reference may be distributed over a whole series of interactional turns. Thus speaker and listener use the interaction to clarify messages and so produce greater understanding. These later studies consider whether children are able to use the interaction to their advantage, since studies on referential communication indicate that young children have difficulty providing adequate messages. Deutsch and Pechman (1982) found evidence that young children were capable of this. They demonstrated that children of 3, 6, and 9 years improved their messages with feedback and prompting from the experimenter. This implies that any initial deficits could not be due to linguistic constraints, since children responded favourably with assistance.

Studies conducted independently by Anderson, Brown, and Lloyd, investigated interaction while pairs of children attempted to solve some joint problem. Although subjects are restricted by the task itself, they are left to discuss the problem as they wish and in how much depth and detail. To encourage free interaction the tasks are generally fairly long, and involve interaction with a peer. This allows an investigation of the interactional process and such things as the distribution of information over turns, the involvement of both speaker and listener, the number of interrupts, queries, and feedback occurring, and so on. These tasks allow an objective measure of communication through a standardized task and involve more naturally occurring dialogue.

Studies concerned with the development of communication skills generally investigate children from 6 to 13 years old since this is where interactional skills appear to develop and consolidate. Thus although children are capable of communication and demonstrate conversational responsibilities from an early age such as 2 and 3 years old, their ability to perform successfully in communication experiments does not appear to develop until much later. For example, younger children generally give a relatively poor communicative performance, improving steadily over a long age range. However, although they are not always totally successful in these experiments, it is still clear that they can communicate, since in many situations they perform well. For example, with their parents who generally use the interaction to motivate the child, and maintain the conversation.

The work carried out in this thesis is concerned with the development of interactive communication skills, and the next chapter outlines the computer maze-game task used on 7 to 13 year old school children who communicate with a same-aged partner. In this respect the task is more realistic in terms of everyday communicative situations than previous studies conducted by those such as Piaget, or the Robinsons, where the subjects had a specific problem to solve with the experimenter present throughout. A task based game has the advantage of promoting natural and extended dialogue yet within a very restricted reference domain. Typically subjects become involved in solving the task and thus less aware of the dialogue they produce. This contrasts with earlier communication tasks where subjects were explicitly instructed of the task requirements, such as with the referential communication tasks of Glucksberg et al, Asher and Oden, Krauss and Weinheimer, and so on, where subjects would be more aware of the dialogue produced. The computer maze-game enables an exploration of how children deal with extended conversation within the wider and more natural interactional framework of a game. The game is so devised to produce location descriptions from the children, yet 'how' and 'when' is totally dependent on the subjects themselves. In this respect the task provides a more sponataneous and dynamic situation compared to recent task-based experiments of say Lloyd or Brown, where one subject was predominantly the speaker while the other predominantly the listener throughout the task.

The rich data base produced from the computer maze-game allows one to explore many aspects of communication, in particular how subjects co-ordinate their interpretations of maze locations and develop restricted interpretations for the language they are using. The maze-game is basically a co-operative one which raises questions concerning mutual knowledge and semantic negotiation, with an added advantage of investigating referential communication in a wider and more extended interactional setting than earlier research experiments allowed.

CHAPTER 3

REVIEW OF SIMILAR EXPERIMENTAL RESEARCH

The experimental studies reported in this thesis explore the processes of semantic co-ordination in natural dialogue and how they develop in school-age children, using a specially designed computer maze-game. The advantage of the maze-game over the other experimental tasks which we have discussed, is that it enables an exploration of extended interaction within the framework of a wider communicative setting. Children are involved in a co-operative game with a same-aged partner, where either subject may describe points as they choose, rather than instructed to describe a series of reference. Furthermore, children are not restricted by role or specific task requirement, nor was the experimenter present throughout. Several main developmental issues, which were discussed earlier, may be investigated from the game, such as the ability to provide adequate information and describe locations on a maze spatial array, the listener's ability to monitor the information and provide appropriate feedback, subjects' joint ability to develop and negotiate restricted interpretations for describing maze locations, the type of descriptions and schemes used to describe positions, and so on. Section A. will briefly explain the experimental computer maze-game in more detail, while the following sections will review similar experimental research.

A. OVERVIEW OF THE COMPUTER MAZE TASK

The computer maze-game, which is used in the main study, was developed by Garrod and Anderson, and programmed by Mullin, Glasgow University. It involves pairs of subjects attempting to solve a joint co-ordination problem, by spontaneously describing positions on a maze.

Subjects are seated in separate sound-proofed computer booths, in front of a VDU, and communicate through headphones and microphone. An identical maze-shape appears on each player's screen, as shown in Figure 3.1, and the game involves manoeuvring the X through the maze to the *. Each subject's X and * are in different locations from their partner's, and they are unaware of each others position on the maze unless verbal descriptions are given. In addition a number of barriers block the paths, (small vertical or horizontal lines across paths), and a number of switch nodes (small s) are distributed on both mazes in different positions. Players can only see their own configuration of these. Players move alternately from one node to another along the paths and have to get to their * as quickly as possible, incurring few penalty points.

Subjects should proceed towards their goal until they encounter a barrier. If they attempt to pass it they rebound back to their initial position and two penalties are incurred against their joint penalty score. In addition there is a joint move score shown on each screen. To overcome the barrier, the player must locate their partner's position on the maze, and direct them into one of the troubled players s nodes. When they move into this designated node the troubled player's gate state reverses. That is, all their previous gated paths are now open, and all previous open paths are now gated. In this way, the blocked player may now proceed towards their goal, along this specific path, until another barrier is encountered and the whole process repeated. Players may also move into a node where one of their partner's switches lie and so unintentionally reverse the others barrier configuration.

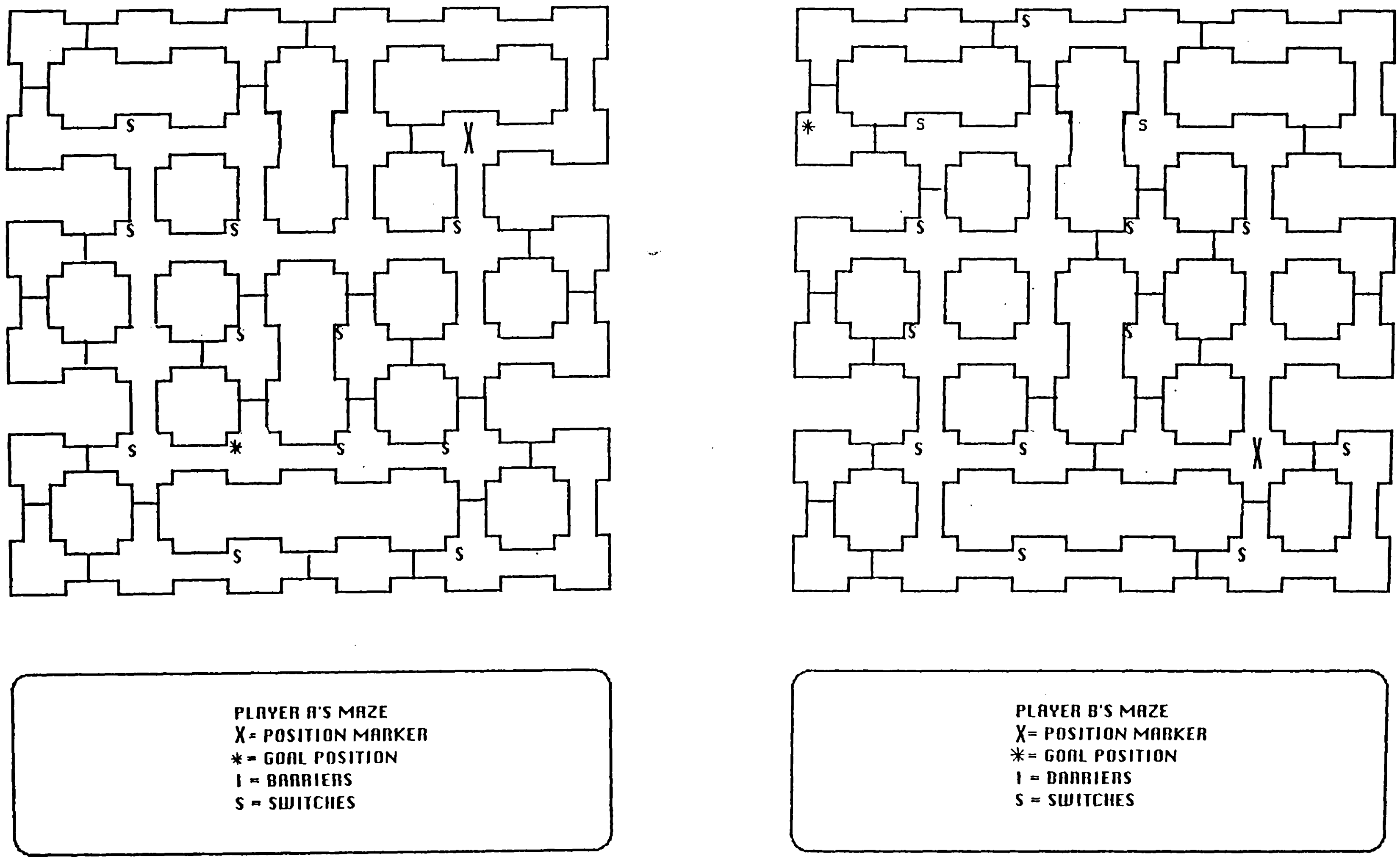


FIGURE 3.1
EXAMPLES OF THE TWO MAZES FOR PLAYERS A AND B AT THE BEGINNING OF A GAME

Thus players are not instructed how to describe points or indeed that they have to, such descriptions occur spontaneously as a direct consequence of the task itself. Each game generally generates several maze location descriptions and this allows for an analysis of the dynamic development of description schemes within dialogue pairs.

B. HISTORY OF THE TASK BASED APPROACH

Several tasks have been developed which share certain features with the maze-game. They involve either co-operative games, explicit description from spatial arrays, or just constrain the topic of discourse in some other way. Each will be examined in turn to highlight certain aspects of the experimental maze-game.

1. INTERDEPENDENT DECISION-MAKING AND CO-OPERATION

Co-operative tasks depend on the individual's cognitive skills and their ability and readiness to communicate and take the view of the other. Some studies have indicated that co-operation is more effective than individual efforts, and that co-operative groups do better than competitive ones. Yet group performance is often less than that of the best individuals (Georgas, 1985, 1986). Evidence suggests that co-operative ability develops with age, evolving from the individual's competence to reflect upon the nature of knowledge, and decentralise that knowledge (Reith, 1988). As with egocentrism, problems are not confined to childhood and are also apparent throughout adult communication.

Schelling (1960) investigated problems of co-ordination, where subjects were in interdependent decision making situations. This involves situations where the best course of action for each person depends on the expectations and decisions of the others involved. For example, deterrence concerns the prevention of an action occuring by way of a threat which is believed to hold, or as Schell pointed out with failed deterrence:

"He, thinking I was about to kill him in self-defence, was about to kill me in self-defence. So I killed him in self-defence."

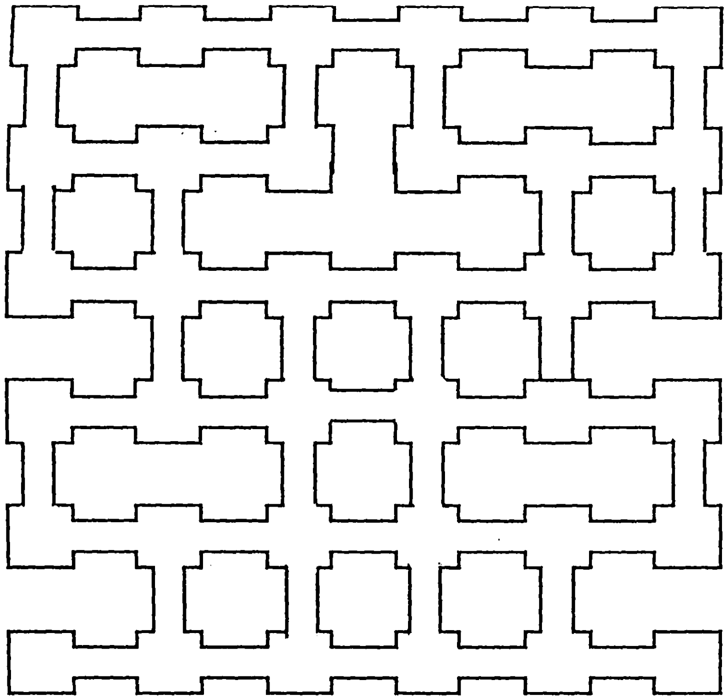
Schelling discussed how people reach agreement when communication was not available. For example, two parachutists landing on an island without arranging a meeting place, or two nations with conflicting views, deciding what action to take once communication has broken down, and wishing to produce some agreement.

In these situations, Schelling proposed that a decision is generally reached by tacit bargaining. This relies on mutual belief and certain heuristics which influence their choice of action. For example, each person calculates what action they expect the other to take, taking into account what the other expects them to do, and so on, ad infinitum. This process is not interactively formulated, but calculated individually via higher order expectations, in a reflexive manner.

According to Schelling, the heuristics which influence the decision are salience, familiarity, uniqueness, and precedence. The salience heuristic involves choosing the most obvious and natural solution to the problem, whereas uniqueness involves the most prominent solution. While precedence involves following any previous solution. As we have already seen in Chapter 1, this may develop into a convention where it becomes common knowledge between those involved that this is the best course of action. Familiarity is similar to this heuristic where the solution which is most well known is followed. Furthermore, any conflict over what solution one would prefer is overwhelmed by the need to reach a common solution.

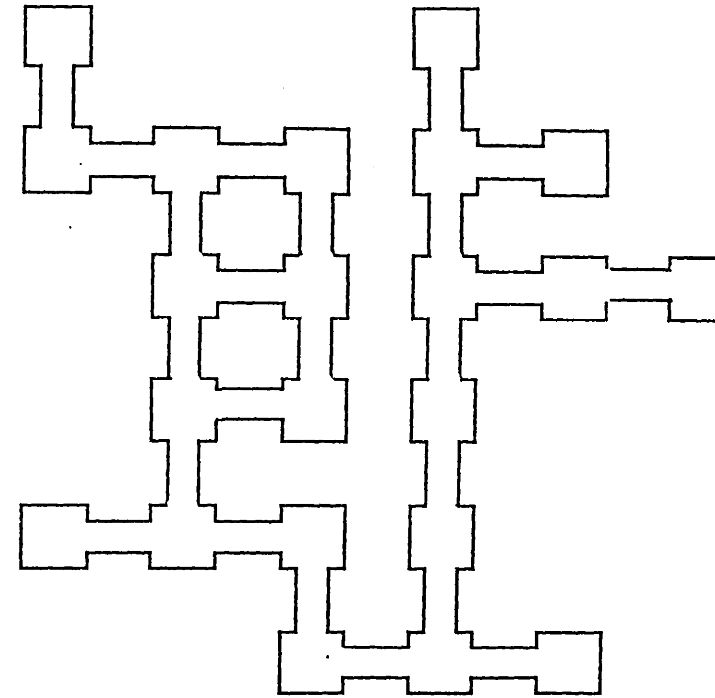
The computer maze-game used in this thesis involves a co-ordination problem, where players are in an interdependent situation, although communication is constantly available. The game allows an investigation into co-ordination problems and how they may be solved. For example, the use or preference of certain heuristics may be examined, and whether the solution evolves explicitly or tacitly. There are a variety of different mazes shapes used in the game, and if one is predominantly row based where lines are the most salient feature as in Figure 3.2, we may investigate whether subjects are influenced by this (salience). And if they are, then will they continue to use this strategy in the second game as a precedent, or if the maze is now most salient in terms of figures as in Figure 3.3, would they change their descriptive strategy to accomodate the figural shape? These are just some of the issues which may be investigated with the computer maze-game.

Schelling's account provided a general explanation of co-ordination problems and how they may be solved in a theoretical way. The



HORIZONTAL ROW TYPE

FIGURE 3.2



FIGURAL TYPE

FIGURE 3.3

experiment reported next provides an early example of interdependent decision-making.

Deutsch and Krauss (1960,1962) investigated bargaining agreements, co-operation, and conflict, between individuals, where interdependent decisions had to be made. This produced interesting results for world-wide communication, since they were essentially interested in the effects of communication on bargaining, and the role of threat in influencing people to make decisions. Similar to the computer maze-game, players were in an interdependent state where co-operation was necessary to solve their problem, however in the above experiment there was also a degree of conflict present.

The task took the form of a 'trucking game' where two players were assigned the names Acme or Bolt, and had to organise a trucking company where goods were driven from location A to B via a set-up illustrated in Figure 3.4. Players could deliver the goods via the short route, which was a one-lane stretch of road, or via a route which was 56% longer and thus less lucrative in terms of delivery costs. For example, one delivery gave a subject 60 cents, however, operating expenses were deducted from this figure at one cent per second, thus shorter routes were most lucrative.

Subjects were seated in separate rooms and could view the development of each game on a panel, and instructed to gain as many cents as possible. All money, however, was imaginary.

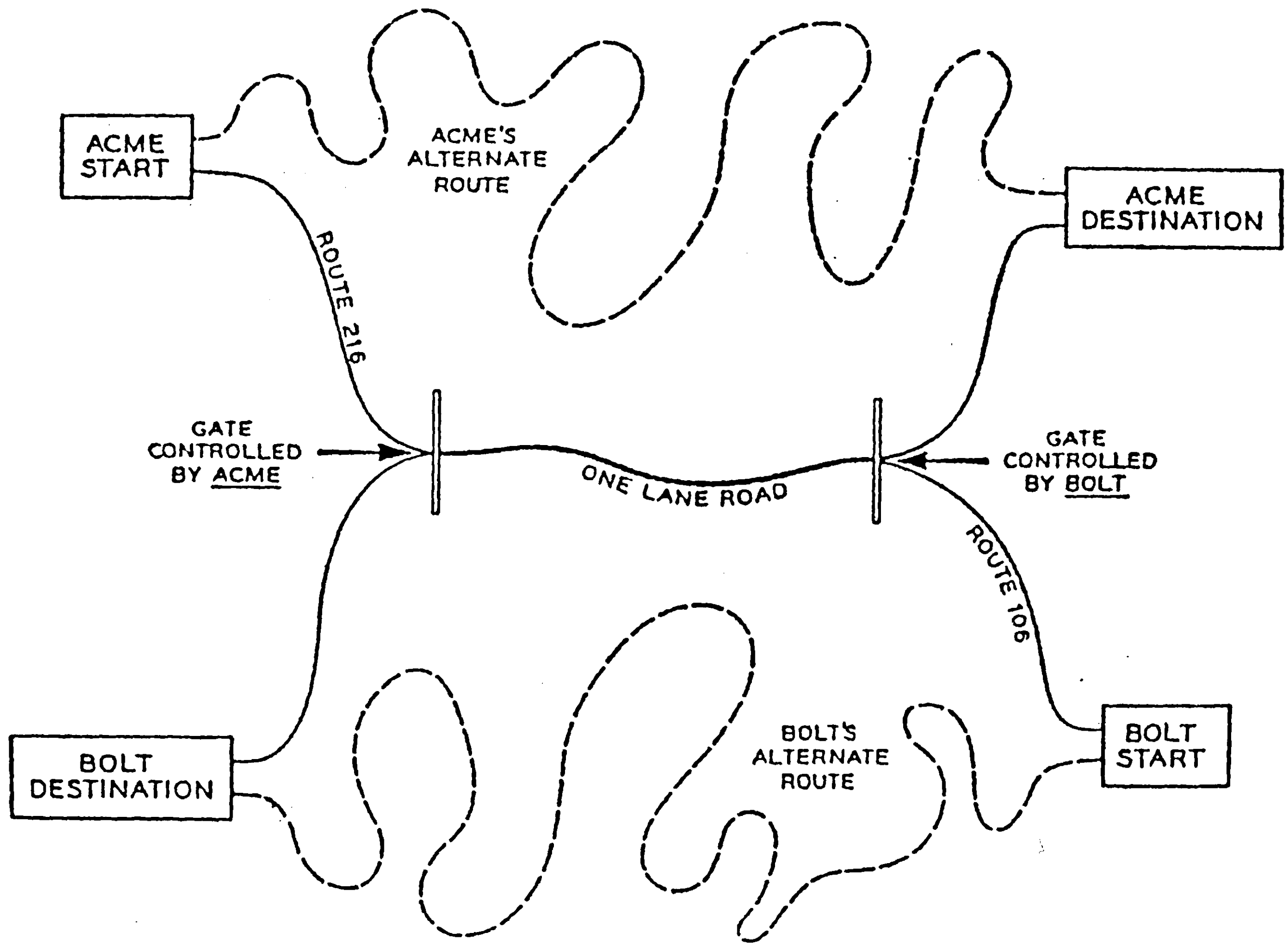


FIGURE 3.4 SUBJECT'S ROAD MAP
FROM DEUTSCH AND KRAUSS (1960)

To induce elements of threat two opposing trucks could not pass each other on the one lane stretch of road, thus producing competition to travel on this stretch. Furthermore routes could only be changed at their starting points - such that if they are on the one lane stretch and have to change route, they have to reverse to the starting square and then change. In effect, the players must overcome this competition, and co-operate to solve each game.

Deutsch and Krauss were interested in discovering the role of communication and threat in alleviating conflict and so manipulated these two variables, and examined the effect on bargaining agreements.

With the communication variable, each game could have: no communication; optional communication where subjects may interact if they wish; or instructed to talk on every trial in the compulsory communication condition.

In the threat condition Deutsch and Krauss manipulated the use and control of two gates. These could only be closed on the one lane stretch yet opened wherever they were on the route. There could be: no threat during a game where the gates were not used; bilateral threat where both subjects control their gates; and unilateral threat where one subject controls their gate while the other did not. The dependent variable was their joint payoff.

Deutsch and Krauss found convincing evidence that levels of threat affected agreement since agreement between the players was most likely in the "no threat" condition, where there were no gates available to the subjects. It was more difficult to reach in the unilateral threat condition, since if conflict arose threat would be used, and most difficult to accomplish in the bilateral condition.

Communication was then introduced to determine its influence on reaching an agreement. In the optional communication condition very little interaction actually occurred. Compulsory communication was most effective in influencing subjects to reach an agreement, where joint payoffs increased significantly in the unilateral threat condition, but not the bilateral one.

Thus, when both subjects could use threat, compulsory communication did little to alleviate conflict, since competition was already high between them. Compulsory communication only helped subjects reach a decision when one could use threat over the other. In the no threat condition, communication had no effect. Players who could use threat generally did better than those who could not, since if a conflict occurred threat would be used where possible, where the threatened party generally felt hostile to this.

Deutsch and Krauss were primarily interested in bargaining and threat, and so their dialogues were not coded further. They noted that communication was functional and generated for a purpose, such as co-ordinating plans, developing agreements, and issuing threats.

In connection with the computer maze-game both tasks involve interdependent situations where players should co-operate to solve their problem. In the trucking game an element of competition was present through individual money tallies, and threat and communication were manipulated. While in the maze-game task, competition is not present and subjects have a joint total number of penalties and move score. They are instructed to co-operate with one another to reach their goal positions. External threat is available in the form of the "monster", however this threatens both players and often produces greater unity to help overcome it. Thus although both tasks share certain similarities they are essentially investigating different aspects of communication.

2. DESCRIBING POINTS IN SPATIAL ARRAYS

Another aspect of the computer maze-game is that it involves subjects describing points from spatial arrays in order to progress to their goal. Other researchers have investigated this issue and considered how subjects describe spatial arrays and points within them.

For example, Linde and Labov (1975) requested residents of New York City to describe the spatial layout of their apartment. In this way, speech is constrained to that of apartment layouts, and descriptions can be more reliably quantified and compared.

They discovered that this monologue condition generated well-formed speech acts, since subjects described their apartments in two main ways. The "tour" was the most popular category as:

"a speech act which provides a minimal set of paths by which each room could be entered."

97% of the descriptions generated fell into this class of imaginary tours where spatial layouts were transformed into organized, linear descriptions. For example, one subject gave the following tour type analysis:

"You walked in the front door. There was a narrow hallway. To the left, the first door you came to was a tiny bedroom. Then there was a kitchen, and then bathroom, and then the main room was in the back, living room, I guess."

In addition, they noticed that within this tour descriptive category were sub-sections. For example, people generally began describing their apartment from the front door, and when they reached a fork they described one branch first, and then jumped back (in one step) to the fork and described the next branch.

They named the second description type the "map", which constituted 3% of all the layouts. This concerned a global description of the apartment, which was further analysed into more detailed local descriptions by top down processing. For example:

"I'd say it's laid out in a huge square pattern, broken down into 4 units... Now on the ends -uh- in the two boxes facing out in the street you have the living room and a bedroom."

From this evidence, they concluded that people basically use fairly consistent patterns to assist them in describing spatial arrays based on rules of social interaction, social conventions, and abstract discourse processes. This implies that information is not simply stored in a totally confused manner, rather that we align facts in a consistently ordered way.

In a similar type of constrained speech production task, Levelt (1982) asked subjects to describe simple two-dimensional networks to their partner. He was primarily interested in linearization, the way in which incoming spatial information may be organized sequentially. Previous work indicated that subjects use consistent strategies in linearization, such as Linde and Labov's tour-type strategy where material is organized in a well structured linear way.

The task involved changing a two dimensional input into a linear description - organising the information in a step by step categorical way. Starting from the arrow on the diagram in Figure 3.5, subjects had to describe the structure, to enable a listener to draw the network when presented with the description on audio tape.

Levelt proposed that the linearization process occurred in two main ways for generating descriptions, one being predominantly 'speaker-oriented' (which Linde and Labov had discovered), and the latter predominantly 'listener oriented.'

In the 'speaker-oriented' model, subjects described points by following a tour of the array, where each point was closely connected and followed accurately. Where forks occurred in the diagram, subjects would describe one fork first, and then go back to the other point in one step. The difference with the 'listener-oriented

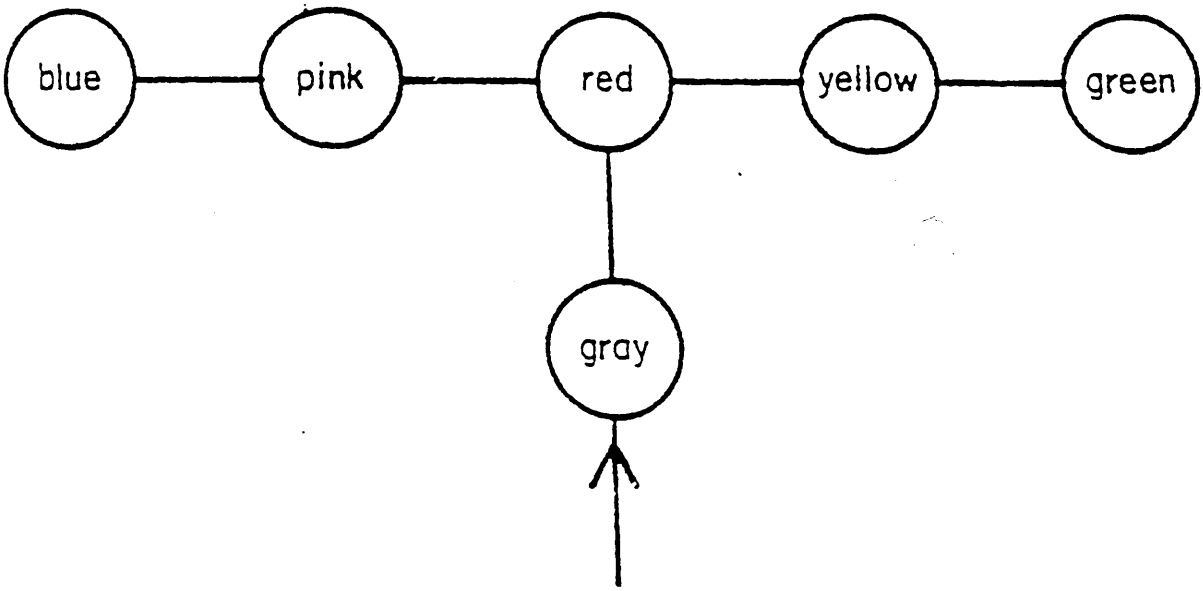


FIGURE 3.5
LEVELT'S NETWORK OF COLOURED
NODES AND BLACK ARCS FOR SUBJECTS
TO DESCRIBE (1982)

model' is here, subjects did not simply jump back to the unfinished point, but meticulously retraced their steps, step by step, thus lengthening the description by anything up to 50%.

Regarding subjects' descriptions at these choice points, Levelt noted that there were either global or local constraints on descriptions, where subjects could relate to the whole network, or simply describe the immediate area.

Levelt's experiment clarified the two main linearization models, and established that there were distinct linearization types, since 33 out of 53 subjects exclusively jumped back to the unfinished choice points, while 16 out of 53 exclusively moved back step by step.

In comparison with the computer maze-game both investigate descriptions generated from spatial arrays. Furthermore, they take place within restricted reference domains, and in Levelt's case the figure itself is composed of nodes connected by paths, similar to the maze structure. These experiments concluded that subjects generally describe positions in consistent ways. As well as this, Linde and Labov's tour type descriptive strategy shares similarities with Anderson's (1983) path type category referred to on page 137 and Table 3.2, where descriptions start at a predetermined point, and move through the structure on a detailed tour, to the point in question. However, in the computer maze-game Anderson found four main ways of describing points on the maze. As well as this, the computer maze-game takes place in an interactive communicative environment, whereas the above tasks involve monologue conditions, devoid of natural interaction and feedback.

3. REFERENTIAL COMMUNICATION TASKS

A further aspect of the computer maze-game is that it is a task based approach. Brown, A.H. Anderson, Shillcock, and Yule (1984) have used similar communication tasks in educational settings to assess language and communication ability. They believe that communication skills (especially the ability to transfer information), should be taught to children at school in a similar way that reading and writing skills are. They stressed the importance of effective communication and discussed a number of common interactional problems.

Brown et al noted that teachers often investigate language ability by requesting each child to discuss some topic such as a hobby. They point out the pitfalls of this assessment since the free talk situation often proves surprisingly difficult in terms of cognitive demands. For example, in such situations the child has to structure and organise a previously unstructured event and it may be unclear what knowledge the class shares on any topic. Furthermore, the teacher cannot reliably compare language ability across children if the topic of discourse is not constrained.

In order to constrain the topic of speech they used co-operative tasks where two subjects have some joint problem to solve. For example, where one has a simple diagram, and should communicate some information to the other, in order to replicate the diagram. A pre-determined set of instructions would be available, outlining the main information to be transmitted from the speaker, for the listener to successfully replicate the information. This scoring protocol would allow communication skills to be reliably assessed and qualified such that problem areas could be identified in a more meaningful way.

In addition, Brown discussed how tasks could vary in difficulty and type, and how within each task there could be a graded scale. For example, simple tasks would involve describing objects with static relationships between them, while more difficult ones would concern dynamic objects, and abstract ideas.

One main advantage of these tasks is that thay can be employed over a wide range and type of subject group and reliably compared.

For example, Blakar (1973) used a similar referential task to examine normal and pathological dyadic communication. In his experiment subjects participated in pairs, seated at a table with a low screen between them to allow eye contact. One subject was requested to communicate a route through a city to another, who had to reproduce this route.

In one condition the maps were identical, while in the other they were slightly different, such that only a street or two differed on the listener's map. This difference should be identified in order to resolve the conflict and solve the task. Pairs of subjects, who were acquainted with each other, were given 40 minutes to solve the task. Failing this time limit, the game was terminated.

Blakar discovered that there was a great variation in the time taken to complete the task. Furthermore, subjects used various contracts to organize communication, which developed and changed over time.

This task has also been used to examine sex and communication (Pedersen,1980), clinical psychological aspects, and social psychology, among other things. For instance Solvberg and Blakar (1975) investigated communication skills in parents of schizophrenics compared to a control group with non pathological off-spring, using the task. They discovered that on 4 out of 5 times, the parents of schizophrenics failed to solve the task in the 40 minute time limit, whereas all of the control group did.

Both Brown et al (1984), Lloyd (1985), and A.H. Anderson (1988), have used similar co-operative tasks to investigate many aspects of communication. For example, how instructions are conveyed, the ability to detect incompatible information, the use of feedback and interruptions, and how subjects co-operate towards some joint solution.

In one experiment Brown et al (1984) used the task based approach to investigate listening comprehension of native English speakers, listening to their own language. While comparing successful and unsuccessful communicants they hoped to highlight differing communicative strategies.

In the experiment two subjects were given similar maps of familiar features and told that there may be some differences between the maps. One had a route marked on it to be described such that a listener could replicate it on their map.

Using over 700 pairs of subjects of age 13 to 16 years old, Brown assessed communication by measuring such things as response times and amount of utterances generated in certain conditions. This enabled an investigation of communication in problem areas.

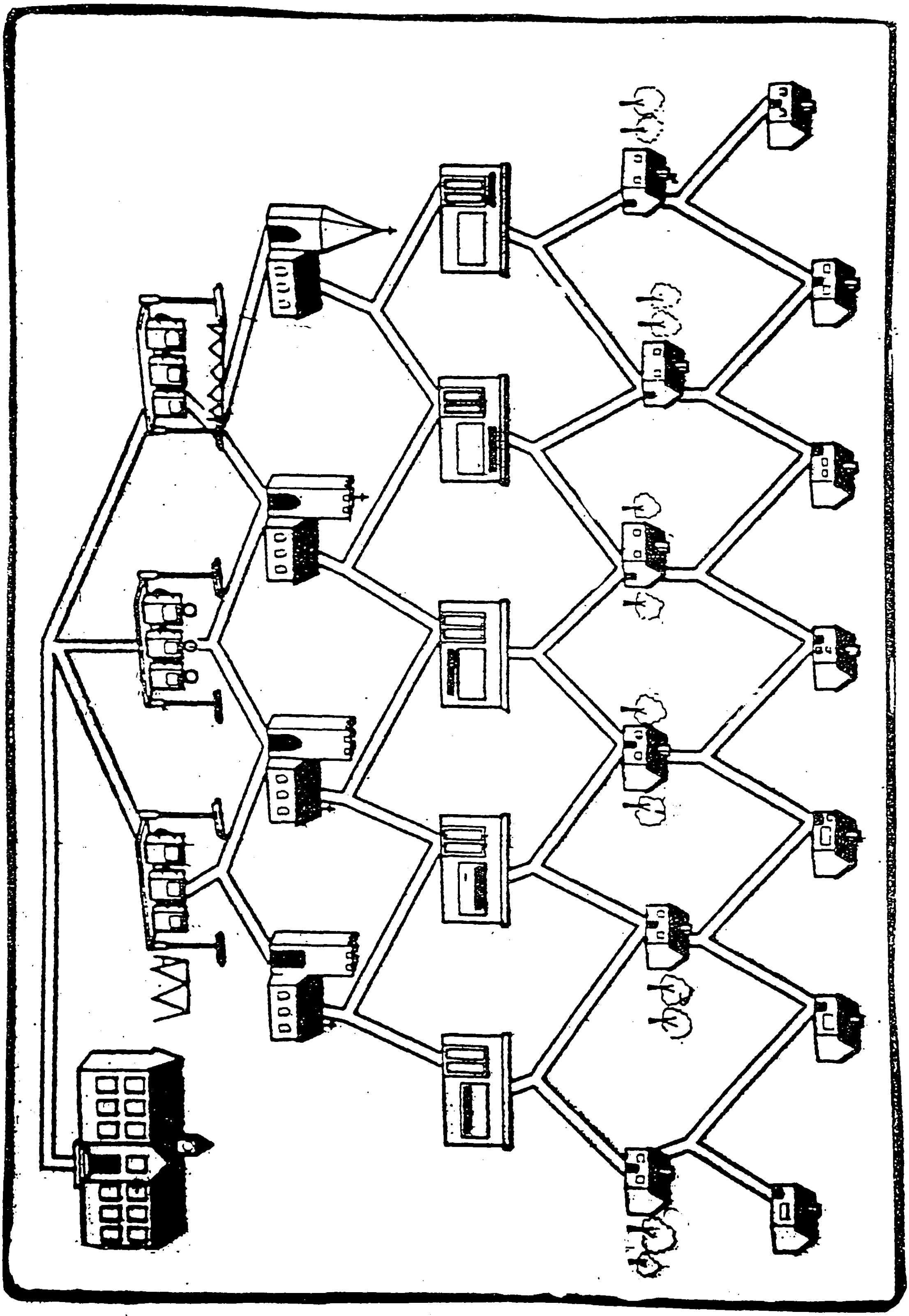
Brown noted that successful listeners appeared to recognize a problem existed and regard it positively by clarifying their uncertainties. They were less likely to accept ambiguous descriptions and requested more information when necessary. On the other hand, unsuccessful students were more passive, and often accepted highly ambiguous descriptions, even when inconsistent with previous ones. From this Brown concluded that there were fundamental differences between good and poor communicators in identifying inadequate messages and giving appropriate feedback.

Lloyd (1985) investigated children's ability to produce and comprehend verbal messages using a similar task. He used pairs of 7- and 10-year-olds, compared to 12 adults, where same aged subjects had to communicate information to each other.

Two subjects were placed in separate rooms and given identical maps of a community, where each familair feature could be uniquely identified and described by colour or pattern (see Figure 3.6). One player had a route drawn through their map to communicate to the other, to enable them to mark this onto their map. The roles would then be reversed. The communication took part via telephone, and Lloyd video- and audio-taped the games, and made full verbal transcripts of the dialogues.

FIGURE 3.6

LLOYD'S (1985) ROUTE FINDING TASK



Results indicated that the 7-year-olds offered significantly less adequate descriptions than the two older groups, producing an even performance as listeners and speakers. While children of 10 years made twice as many errors when they were listeners compared to speakers, and the adults produced far more efficient and precise descriptions.

Concerning the amount of discussion, the 7-year-olds said the least, compared to the 10-year-olds who produced more speech that the adults. Lloyd concluded that the youngest group failed to provide sufficient information, while the middle group demonstrated much redundancy, and the adults produced more economic descriptions.

While investigating the way subjects described the route Lloyd noted four main strategies emerging. Other strategies were used, however, they were far less frequent and only accounted for less than 3% of all the descriptions.

These strategies were primarily descriptive ones, and not conceptually differentiated in terms of underlying categories. Yet they indicate differing ways that subjects' chose to describe points on the map, and furthermore the age of subjects appeared to influence their choice of description.

The minimal strategy (M) involved the speaker simply referring to various parts of the map, without concentrating on specific locations. They considered the area in question, but not how to move there through the map. For example:

A Right you're at school

B Mm hmm

A Go all the way to the garage

B Yeah

A Up to the church

B Yeah

When additional information was given it was generally limited and ambiguous.

The numerical strategy (N) basically concerned counting out the various moves. For example:

A From the first garage you go up, you go up and then
you turn to the third church

B The third church?

A You go up to the fourth house.

A common error with this strategy involved the describer failing to give their initial counting spot.

The components strategy (C) gave more consideration to the listener's needs, with a more detailed account of the route, while pointing out alternative routes. In addition, information was given in workable units while waiting for confirmation at each part. For example:

A Right, then is a house, two houses, right?

B Yeah

A On each side, now there's, there's one with a, er, aerial in't there?

B Right, where?

A On the chimney

B Yeah

The directional strategy (D) discussed straight forward directions, without reference to distance or features on the map. For example, 'left', 'up', 'straight down', and so on.

Lloyd found that the 7-year-olds preferred the M strategy, and used C and N strategies as well, but rarely D. The majority of their descriptions were inadequate where they displayed lack of co-ordination between pairs, lexical errors, attentional lapses, and provided inadequate listener feedback.

The 10-year-olds used mainly the C strategy, where the listener's needs were now taken into consideration. They provided more successful descriptions, with little difference from the adult group, yet they were similar to the youngest group in terms of the mean number of strategies used.

Adults, on the other hand, preferred the D strategy, as well as the C and N strategy. On the whole they used multiple descriptive strategies, such as D+C or D+N. In comparison the children were more rigid and usually used one descriptive strategy at a time. For example, only two children used multiple descriptive strategies. Thus adults appear to be more flexible, choosing the most efficient strategy to describe the route, which was generally dual ones. Lloyd suggests that the younger children may be incapable of this due to the processing demands on providing such information as speakers or interpreting it as listeners.

These tasks share certain similarities with the computer maze-game, since they are co-operative tasks, and speech is constrained to the domain of the task itself. However, all three involve asymmetrical role assignment since in each condition one subject is predominantly the speaker, and the other the listener. Thus although communication is constantly available to both subjects, their role as speaker and listener are pre-defined, and speech is often uni-directional. On the other hand, the maze-game allows subjects to communicate and describe points when and as they wish, thus their roles, as well as the objectives of the experiment, are fairly ambiguous.

Nevertheless, these tasks have provided very interesting results for communication ability and illustrate the advantages of a task based approach for comparing a large number of subjects from different groups and varying age.

4. CONCLUSION

The tasks reviewed here share certain features with the computer maze-game used in this thesis. For example, they either are set in a restricted reference domain; involve describing points from spatial arrays; or investigate interdependent decision making. However, the computer maze-game cultivates multiple aspects and combines elements from each area to produce an effective task to investigate natural dialogue. The review was intended to give a brief history of the progression of communication tasks to illustrate the advantages of the maze-game in view of previous communication research.

The maze-game involves an interdependent decision making situation where pairs of subjects attempt to solve a co-ordination problem. Schelling (1960) discussed co-ordination problems in interdependent situations, although he was primarily concerned with how they were solved when communication was not available. For instance through mutual beliefs and the use of certain heuristics. An early example of co-ordination problems was that of Deutsch and Krauss (1960,1962) who used a co-operative game to investigate the effects of communication and threat on reaching agreement in conflicts. In this interdependent situation, subjects were competing against each other, and not together as in the computer maze-game, and Deutsch and Krauss were not interested in coding the actual dialogues generated. They found that agreement between two aggressors was most accessible where neither could use threat over the other, and most difficult when both parties had the ability to use threat. Compulsive communication was most effective in the unilateral threat condition, but not in the bilateral threat condition.

Another aspect of the computer maze-game task involves spatial descriptions. Linde and Labov (1975), and Levelt (1982), investigated how subjects describe points from spatial arrays, using a content analysis on the descriptions generated. However, both were monologue conditions, and subjects were specifically instructed to describe points in the array. These studies concluded that subjects describe in a consistent and organised linear way, since several main ways of describing structures evolved from the analysis.

More recently communication has been investigated via referential tasks, where subjects communicate pre-determined information to each other. In this way, dialogue is restricted to a specific reference domain, and subjects are instructed what is required of them but not how to do it. Blakar (1973), Brown et al (1984), Lloyd (1985), and A.H. Anderson (1988), have all used such tasks to investigate communication ability.

A.H. Anderson et al argued for the superiority of the task based approach within a restricted reference domain, since a series of tasks may be devised with a pre-determined scoring protocol in order to assess communication ability.

This referential communication paradigm, first devised by Glucksberg, Krauss, and Weisberg (1966) and explained on page 74, has been used widely to investigate communication ability. The experiments generally involve pre-determined situations where subjects are instructed what is required of them with the experimenter present throughout. However, one should be wary of extrapolating from certain task specific situations since this may only tap the child's ability to solve a specific task. The strategies employed may be unique to the experimental situation, and not generalizable to natural language use and communication on the whole.

We should attempt to study real life communication in natural situations. Yet it may prove difficult to quantify unconstrained speech in a reliable and consistent way. For example, if we study general conversation, how can we compare and contrast different dialogues? A controlled experiment on the other hand, involves excluding irrelevant variables and precisely studying others, which often involves concocting a situation unlike the real world. Thus an experimental task is required where dialogue is constrained, yet in as natural a way as possible. In addition, the basis of the task should be disguised and incorporated into a broader interactional framework, to obscure the communication task as such and make participants less aware of themselves as the object of linguistic analysis.

The computer maze-game attempts to fill this gap with a task where pairs of subjects have to co-operate to solve a joint problem. A task-oriented experiment has the advantages of promoting natural and spontaneous dialogue, while some aspects of the artificiality of the situation are removed. For example, most subjects typically become involved in solving the task to the extent they are unaware of themselves as the focus of interest. Thus dialogue is unrehearsed so that _what_ subjects discuss is pre-determined but not _how_ they discuss it. Thus the maze-game is not a descriptive task as such since it goes beyond context, and subjects may choose whether to describe locations or not. And when points are described speech is constrained to the restricted reference setting of the maze domain. In this way, the dialogue may be reliably quantified and assessed across any subject in the experiment and a large number of subjects may now be compared.

Furthermore, the maze-game gives a record for each game, coding the maze shape, gate reversal states, each move and time from a zero baseline, time taken to solve the task, number of moves, and number of penalties incurred. The record can be directly correlated with the dialogue itself since at each move a tone is put on the tape. This gives an independent source of data to the dialogues recorded.

One further advantage of the maze-game is the fact that the experimenter does not need to be directly present throughout the task, thus keeping the experimenter effect to a minimum. For example, subjects are instructed on the rules of the game, and then placed in separate computer booths and left to communicate with their partner. Since the experimenter can follow the games in a separate computer booth, their presence is minimal, only appearing when problems arise, or when requested. This may be evidenced by the freedom of the dialogue and acute change when the experimenter entered one of the subject booths. To this extent, the dialogues generated remain as natural as possible in this type of laboratory setting.

The experiments reviewed in this section were presented in order to give the computer maze-game a historical background, by way of illustrating similar research areas. The review is by no means exhaustive, nor was it intended to be, and simply serves to highlight several main features of the task. For example the aspects of interdependent decision making, restricted reference domains, and spatial descriptions.

The next section investigates work by Anderson (1983), and Garrod and Anderson (1987), who used the computer maze-game on adult subjects. It provides a useful background to this thesis since many of their assessment procedures have been followed. Furthermore, it illustrates the flexibility of the task to be used over a wide age range of subject groups, to produce a rich corpus of data which can be reliably compared.

C. CO-ORDINATION OF MEANING IN ADULT DIALOGUES

1. INTRODUCTION

Anderson (1983), and Garrod and Anderson (1987), used the restricted context of the computer maze-game to investigate the extent to which adults negotiate a common semantic system during the course of a dialogue. They argued that the meaning of expressions in everyday use are often tacitly negotiated by the dialogue partners themselves. Thus, although conventional meanings underpin all communication, they found evidence that speakers engaged in any extended dialogue develop restricted interpretations for the expressions they are using. Typically these are related to their particular function in that interaction, and are dependent on the social context. This suggests that the semantics of natural dialogue may be more flexible and subject to the local interaction between speakers than has generally been assumed. Indeed they conclude that their research:

"certainly suggests that general conventions of meaning serve only as starting points for interpretation, perhaps giving default meaning which may be overwritten by more local and transient conventions set up during the course of the dialogue."

Anderson (1983) used the computer maze-game to analyse the semantic and social-pragmatic nature of meaning in natural language expressions. He focused on the descriptions generated during the game, in order to determine the effect of pragmatic factors on the development of meaning in expressions.

The main findings and conclusions from this research have been summarised in Garrod and Anderson (1987) (see also Anderson and

Garrod, 1987), and are reported in the next section of this chapter, however, there are other aspects of Anderson's (1983) thesis which are of interest and will be reported here.

2. PROBLEM SOLVING IN THE COMPUTER MAZE-GAME

Anderson analysed data from 28 pairs of same sex undergraduates from Glasgow University, who played two computer maze-games each, producing a total of 56 games. He had four main experimental conditions. The first was a baseline condition and involved pairs of subjects simply playing two computer maze-games on symmetrical mazes. He then compared earlier played games with later played games to investigate whether practice effects the players' efficiency in solving the task.

The second condition analysed the effect of a maze monster on subjects behaviour and generation of descriptions. The maze monster takes the form of a small 'M' on each subjects maze, and moves once for every three moves of the players. Its aim is to follow one of the players until it occupies the same node, where the game terminates and players have failed. Players succeed if they reach their respective goals before the maze monster reaches them. Thus players should avoid the monster at all costs to prevent termination of the game.

The third condition Anderson analysed was the effect of various maze shapes on subjects behaviour and dialogue. He devised specially constructed maze shapes, such as composed of predominantly columns or rows, or figural ones which had less paths and nodes to traverse. In this way Anderson could examine the effect of the various mazes on the generation of descriptions. For example, if a predominantly row based maze is used, one can ask whether subjects describe points in terms of rows, or continue using the descriptive scheme that they had used previously (ie. in the previous game).

The fourth condition was a reassignment manipulation where Anderson matched certain subjects depending on their previous descriptions. These subjects had already played two maze games and were reassigned depending on the descriptive strategies they used.

To compare the various conditions Anderson used four main measures. These were the number of moves by players to achieve a solution, the time taken to reach the solution, the rate of moving (that is the number of moves per minute), and the mean number of utterances by both players between successive moves (an utterance was a players contribution bounded by their partners). These measures were readily accessible since each maze-game produced a computer printout, giving details of the maze used, gate reversal states, move number, and time of each move from a zero baseline. (A similar analysis was carried out on the child sample used in this thesis, see Chapter 4, Section B.).

In the baseline condition, Anderson compared the first and second games in order to investigate whether any practice effect was occurring in solving the task. From the four measures taken, he concluded that a practice effect was evident, since players were becoming more efficient at solving the task from their first to second game. For example, later games required significantly fewer moves to reach the solution, implying increasing efficiency between subjects. With this control data at hand, Anderson could compare the other three conditions with this. The results of these four conditions are summarised in Table 3.1.

In the monster condition, he found a significant effect of slowing the subjects rate of moving, as well as producing a significant increase in utterances between moves. Anderson expected such results, since monster games were strategically more difficult, requiring increased planning and co-operation in order to defeat the monster and avoid its path. Thus one would expect fewer moves per minute and more utterances in order to plan ahead.

Similarly, Anderson found a significantly slower rate of moving on the specially constructed mazes. This again may have been expected since fewer path-ways on more difficult mazes would presumably lead to more planning and less moves. Yet he found a non-significant difference between the number of utterances between moves, although they were higher than the baseline condition.

With the final condition, Anderson discovered that changing partners did effect the dialogue generated. For example, the reassignment study showed a slower rate of moving than the baseline study, as well as a higher mean number of utterances. Both of these differences were significant, thus proving the importance of pragmatic factors in the generation of dialogue. Compared to the baseline study there was an immediate effect from the manipulation of subject variables. One

Efficiency Measure	Study 1 $\bar{X}$	Study 1 S.D.	Study 2 $\bar{X}$	Study 2 S.D.	Study 3 $\bar{X}$	Study 3 S.D.	Study 4 $\bar{X}$	Study 4 S.D.
1. Number of moves to game solution	36.57	8.25	42.0	11.07	34.7	12.64	31.16	5.8
	N = 7		N = 10		N = 10		N = 6	
2. Time taken to game solution	9.82	3.37	17.69	5.43	14.74	7.39	12.15	3.9
	N = 6		N = 9		N = 10		N = 6	
3. Rate of moving (No. of Moves/ Min).	3.68	0.4	2.40	0.57	2.45	0.63	2.63	0.6
	N = 6		N = 9		N = 10		N = 6	
4. Mean No. of Utterances between moves	6.81	1.21	10.49	10.24	10.27	4.55	9.42	2.16
	N = 7		N = 10		N = 10		N = 6	

TABLE 3.1 = SUMMARY STATISTICS OF GAMES SHOWING MEANS, STANDARD DEVIATIONS, AND NUMBER OF SUBJECTS IN STUDY 1 (BASELINE), STUDY 2 (MONSTER GAMES), STUDY 3 (MAZE SHAPE), AND STUDY 4 (RE-ASSIGNMENT) ON THE FOUR EFFICIENCY MEASURE FROM ANDERSON (1983)

might have expected less of a difference, since in effect subjects have had more experience on the maze-game. However, the manipulation of subject variables had such an effect as to significantly reduce their efficiency on the task.

3. SEMANTIC AND PRAGMATIC ANALYSIS OF THE DESCRIPTIONS

Anderson carried out a cluster analysis on the main semantic analysis of the 1356 descriptions generated. Four different basic schemes were found for describing points on the maze, which are illustrated in Table 3.2. In this classification scheme each descriptive type relies upon different conceptions or mental model of the maze onto which language may be interpreted. For example, path descriptions depend upon a path network model of the maze, whereas line and co-ordinate descriptions rely on a set of models in which collections of nodes are organised into horizontal, vertical or even diagonal vectors. On the other hand, figural descriptions require the identification of complex patterns of nodes such as "T-shapes" or "rectangles" or "right indicators". To this extent, the various descriptions are both conceptually and semantically distinct from each other (see Chapter 5, Section A. for a full discussion of the descriptive types).

Anderson suggested that the descriptions used may be determined by the various restricted models people have, and that once formed these models are used for reference. Thus interlocutors appear to agree on a spatial conception of the maze which they would then use for reference. As Garrod and Anderson (1987) state:

TABLE 3.2

EXAMPLES OF THE FOUR DESCRIPTIVE TYPES GIVEN BY GARROD AND ANDERSON (1987)

(1) ***Path network***

"See the bottom left, go along four and up one that's where I am"

(2) ***Co-ordinate***

"I'm on the third row and fifth column"
or
"I'm at D five"

(3) ***Line***

"I'm on the third level, second from the right"

(4) ***Figural***

"See the middle right indicator, well I'm on the left of it" "pairs of speakers are able to negotiate both the form of model underlying their descriptions and the way in which the language maps onto this model."

Furthermore, they noted that there was a strong social-pragmatic factor present within pairs of subjects where they often entrained each other, and ended up using the same terms to refer to the same concepts. Thus although a great variety of descriptions were used across pairs of speakers, within a given pair the descriptions were unusually similar. Thus speakers were conceptualizing the mazes in a similar way and converging onto idiosyncratic schemes depending upon special restricted codes.

Garrod and Anderson noted that on several occasions the players explicitly discussed what a term referred to, however, on the whole the mutually shared reference evolved tacitly. This process eliminated any ambiguity as to what certain terms referred to, and aided efficient comprehension. Thus dialogue partners were co-ordinating their language through tacit negotiation, to define mutually acceptable descriptive codes and their extensional semantics. That is, the things they can refer to. This appeared to be a product of the interaction itself, rather than the physical context of the situation.

In addition, Garrod and Anderson observed continuous improvement in co-ordination of descriptive types from game one to game two, which produced greater entrainment. For example, in game one, 10 out of the 21 dyads shared a predominant descriptive type, while in game two

19 out of the 21 dyads shared the same predominant type. And the descriptive type used in game one may not be the same as that adopted in game two, by the same pair of interlocutors. For example, there was a tendency for dyads to shift from perceptually salient schemes to more abstract ones, at the same time producing greater co-ordination. In this way, they often dropped path and figural descriptions in favour of co-ordinate or line type, as the dialogue proceeded.

4. SOLVING THE CO-ORDINATION PROBLEM

The computer maze-game involves a joint co-ordination problem, which basically requires the establishment of a mutual base of conception and language to refer to locations on the maze. As illustrated earlier, this co-ordination problem may be solved through explicit negotiation, where interlocutors openly discuss the type of scheme to use. Garrod and Anderson found this to be particularly evident with their co-ordinate descriptive scheme, where interlocutors often negotiated a particular code system to uniquely describe each point on the maze. However, this solution did not appear popular from their transcripts. Instead it occurred predominantly after some problem in communication cropped up, where there had been difficulty reaching a mutually suitable descriptive scheme. They discovered that when a scheme had been explicitly negotiated between communicants it was often abandoned thereafter, especially when problems developed. Therefore, they concluded that explicit negotiation did not play a great part in solving co-ordination problems.

Alternatively, Garrod and Anderson (1987) proposed that interlocutors solve the co-ordination problem in a more flexible and cost effective way. They proposed a simple language convergence control principle, termed output/input co-ordination which results in a joint referring expression in a relatively short period of time. Following this principle, speakers should always attempt to equilibrate processes of production with those of comprehension within any given exchange. Thus in the computer maze-game context, a speaker formulating any description should employ the same model and construal of the language against this model, as that which yielded a satisfactory interpretation of the last relevant utterance by his or her partner. If both participants do this, they will quickly converge on a mutually satisfactory description scheme without having to engage in any explicit semantic negotiation. Thus interlocutors establish a mutually shared meaning system, with the minimum of collaborative effort. Furthermore, both interlocutors are involved in generating the dialogue. As Clark and Wilkes-Gibbs (1985) and others have shown (see Chapter 1), this minimisation of collaborative effort appears to be crucial to theories of this type, since dialogue occurs spontaneously and dynamically in actual use.

Garrod, Anderson, and Sanford (1984), (see also Garrod (1987)) were able to simulate many adult description sequences with a computer model following this principle. However, they also discovered some of the limitations associated with the principle.

First, they discovered that rigid adherence to output/input co-ordination blocked the development of novel description schemes, since introducing any new schemes once co-ordination had been achieved, requires at least one participant to violate the principle. This implies that once a descriptive strategy is adopted it will be difficult to change. Hence, it did not account for the co-ordinated development of novel schemes within the strict constraints of output/input co-ordination. They noted, however, certain interactional strategies that speakers may adopt to overcome this limitation. One particular strategy required the pair to accept an implicit division of labour and epistemic control, whereby one speaker acts as arbiter over the scheme while the other agrees to accept arbitration.

Thus communicants allow a system of 'master and slave' (Lewis, 1978) to control the interaction, where the 'master' controls the descriptive strategy adopted, determining any changes, while the 'slave' accomodates to these requirements. As Garrod and Anderson state :

"In this way, one of the participants will adapt to the other, who is free to introduce any modifications in the scheme used by the pair."

Indeed they noted that among adults it was not uncommon to see dialogues where all new description schemes were only introduced by a single speaker and subsequently followed by their partner. Furthermore, they found that if the follower attempted to introduce any description which failed to match that used previously by the leader, this was queried in some way.

A second limitation of their principle concerned the way it searched out mutual knowledge of the scheme. They point out that in interpreting any description, a listener presumes that the speaker shares the same scheme just so long as the description is interpretable against their own one. In other words, output/input co-ordination only guarantees mutual knowledge in a falsification definite way. Thus, one may only be certain that their partner has a different scheme (ie. when interpretation fails) but never be certain that they have the same scheme. For instance, they point out that within a co-ordinate scheme the same location in the centre of five-by-five maze, can be given the same description (say C3) according to at least four different co-ordinate subschemes (starting at the top, bottom, left, or right). This means that output/input co-ordination is a poor mechanism for co-ordinating on the more abstract schemes, at least in the absence of strong circumstantial evidence.

5. CONCLUSIONS FROM THE ADULT RESULTS

Garrod and Anderson used the computer maze-game to demonstrate that local conventions can be built up during the course of a conversation. They found that adult pairs demonstrated strong evidence of co-ordinating their descriptive schemes. Thus within a particular dyad, interlocutors entrained each other such that they would end up using the same scheme.

Furthermore, this co-ordination increased across games, where subjects were using dialogue more like their partner as the interaction progressed. They formed particular idiosyncratic codes, synchronizing their intentions and thoughts, to produce increased co-ordination from the interaction itself.

Garrod and Anderson also discovered that adult speakers steadily moved from relatively concrete schemes, such as path or figural, toward more abstract ones, such as line or co-ordinate. For example, 50% of adult pairs used a different scheme predominantly in the second versus first game, and most adults who shift schemes did so as a pair. In other words, most speakers did not shift to a scheme used by the other member of the pair in game one, but rather shifted together to a new scheme. For example, 70% changed scheme as a pair.

This evidence demonstrates a general convergence on a similar description scheme across the dialogue, with progressively increasing co-ordination. This was linked to the steady development of more abstract and generally more efficient languages of description.

In conclusion they discovered that communicants generally do not explicitly discuss how to describe points on the maze, rather the descriptive code evolves tacitly. They offered a language convergence principle, pointing out both its advantages and limitations, which explains how a joint referring expression may be formulated in a short space of time.

The study reported in this thesis sets out to discover if young school children can co-ordinate their use of language and interpretation in a similar way. Semantic co-ordination is an essential process in learning to use any language, since the child has to enter into a system of shared conventional meanings while engaged in the primary task of conversing. This aspect is investigated while using some of the above measures used by Garrod and Anderson.

PART II

THE EMPIRICAL RESEARCH USING THE COMPUTER MAZE-GAME

CHAPTER 4

THE COMPUTER MAZE-GAME EXPERIMENT AND GENERAL FINDINGS

A. THE COMPUTER MAZE-GAME

This experimental study explores the development of semantic and conceptual co-ordination between speakers and listeners in the context of a specially designed computer maze-task. Pairs of same-aged school children were asked to solve the joint task, which elicits spontaneous dialogue yet within a very restricted domain. The dialogues typically contain a number of location descriptions which enables an investigation of semantic negotiation and the emergence of co-ordinated description schemes. This may provide some insight into how young children negotiate towards a mutual conception of the meaning of expressions and enter into a shared system of meaning.

This section discusses the procedure through which this development was investigated, while the following two sections document some of the more general findings from the research, such as subjects' efficiency at solving the task, and their basic language performance. This present section will begin by considering the experimental hypotheses behind the investigation.

1. HYPOTHESES

The study was directed at three main questions:

a) the general question of the degree to which the different age groups co-ordinate their language while engaged in solving the joint problem of the maze-game. If dialogue partners were co-ordinating their interpretation, each should predominantly be using the same language code as the other. This involves investigating descriptions generated within a given dialogue, and determining the extent to which communicants employ the same language to describe points on the maze, as compared with other members of their group.

It was hypothesized that older children may negotiate and fix onto a common descriptive scheme with less difficulty than younger children.

b) It was hypothesized that the dialogue co-ordination between players should increase over the games. Research by Garrod and Anderson (1987) has demonstrated that adult subjects produce a reliable increase in co-ordination during several interactional tasks.

c) The pattern of convergence and change of description schemes across games was investigated. It was hypothesized that younger children will demonstrate a more rigid appreciation of descriptive schemes, adhering to certain successful schemes and failing to adapt and improve their scheme over time. Garrod and Anderson (1987) observed that adult speakers tend to change their descriptions between the first two games, steadily moving from relatively concrete schemes (such as path or figural) toward more abstract ones (such as line and co-ordinate).

To investigate these hypotheses the following computer maze-game was used which will be explained in full detail below.

2. THE EXPERIMENTAL PROCEDURE

Two subjects were seated in separate sound-proofed computer booths, in front of a computer terminal, and each wore a set of headphones and microphone for communication. They were then instructed on the rules of the game indicating the specific features on the maze. The experimenter stressed that they were not competing against each other, but co-operating to solve a joint problem where they have a joint penalty and number of moves score. Subjects were asked to repeat parts of the rules to the experimenter to ensure adequate understanding.

If subjects appreciated the rules, they were then given three more computer maze-games. If not, they were either given further instructions, or their data was disgarded from the sample, after participating in the games.

An identical maze-shape appeared on each player's computer screen - the players' position indicated by the X on their maze, which they have to manoeuvre along the paths to their goal position, denoted by an asterisk * (see Figure 4.1). Each players X and * were in different positions and they could only see their own, thus they were naive to each other's position unless verbal descriptions were given.

They were instructed to move towards their goal as quickly as possible, incurring minimal penalty points, and that the game only

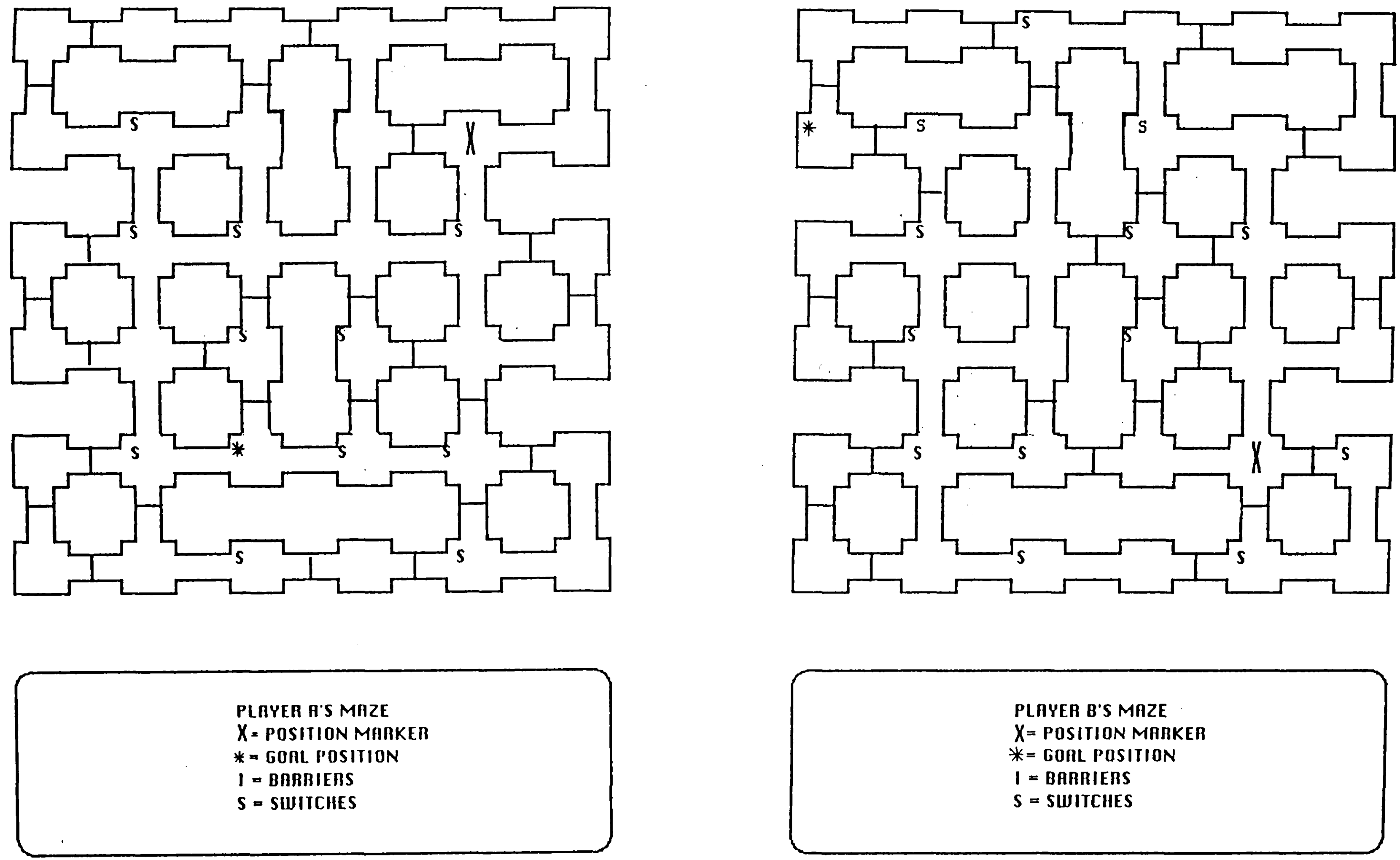


FIGURE 4.1
EXAMPLES OF THE TWO MAZES FOR PLAYERS A AND B AT THE BEGINNING OF A GAME

terminated when both were in their respective goals. Players moved alternately from one node to another, and could only do so when their X flashed and at no other time, nor could they forfeit their turn. Thus if one player reached their goal first, the two had to continue to take turns until their partner also entered the goal.

To complicate matters a number of obstructions were in the paths of subjects. For example, approximately half of their available pathways were blocked by small vertical or horizontal lines perpendicular to the direction of the pathways. These prevented the subject from traversing this path. To compensate, approximately one third of available nodes were switch nodes, represented by a small "s", which could be used to switch the gate configuration over. The operation of these "s" nodes are explained below. Players could only see their own configuration of barriers and "s" nodes.

If a player attempted to traverse a gated path they would rebound to their initial node and two penalty points would be awarded to their joint penalty score. This score was displayed at the bottom of each player's screen. In this way, players could use the barriers to remain in the same location. Players also had a joint total moves score which indicated the number of moves made by both players to that point in the game. It was expected that these joint scores might produce a measure of co-operation rather than competition.

As we have already indicated in Chapter 3 and section A, subjects would thus proceed towards their goal until they encountered a barrier. In order to overcome this barrier, they require the co-operation of their partner since the "s" nodes may only be operated this way. For example, if player A is blocked by a gate they must find player B's position on the maze, and then direct B into one of A's nearest "s" nodes. When B moves into this designated node with A's directions, then A's gate state reverses as indicated in Figure 4.2. That is, all previously gated paths are now open, and all previously open paths are now gated. In this way, the player may now proceed towards goal along this specific path until they encounter further gates, requiring the generation of further maze location descriptions. Each player sees their own configuration of "s" nodes and nothing results when they move into their own. However, if one of the players moves into a node where the other has an "s" then this would unintentionally reverse the barrier configuration for that player. Such accidental gate reversals were common.

After each game, subjects were given a quick "memory test" for the maze configuration. Their computer screens were dimmed to prevent them viewing the maze, and they were given a 6X6 photocopied maze shell, composed only of nodes (see Figure 4.3) and instructed to draw in the missing paths in the form of the maze just viewed. This was an attempt to gain insight into how they conceived the overall shape of the maze. For example, if they were using a horizontal line-type strategy to describe points on the maze (see page 212), then perhaps they would see the maze as a configuration of parallel, horizontal lines and so emphasise this in their drawing.

It is important to note that children were not instructed to describe points nor told how to describe them, rather this occurred

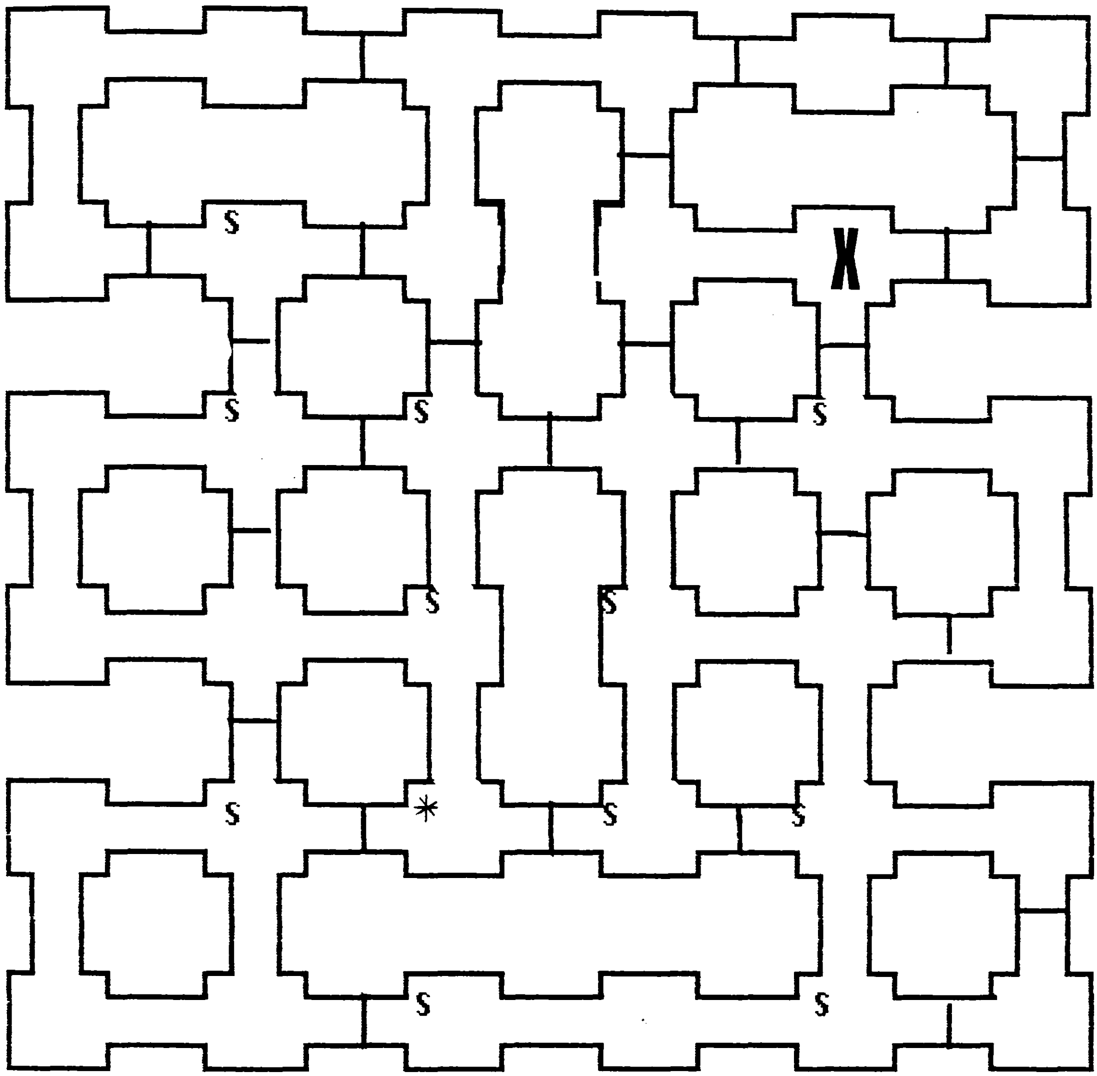


FIGURE 4.2

PLAYER A'S MAZE
X= POSITION MARKER
* = GOAL POSITION
I = BARRIERS
S = SWITCHES

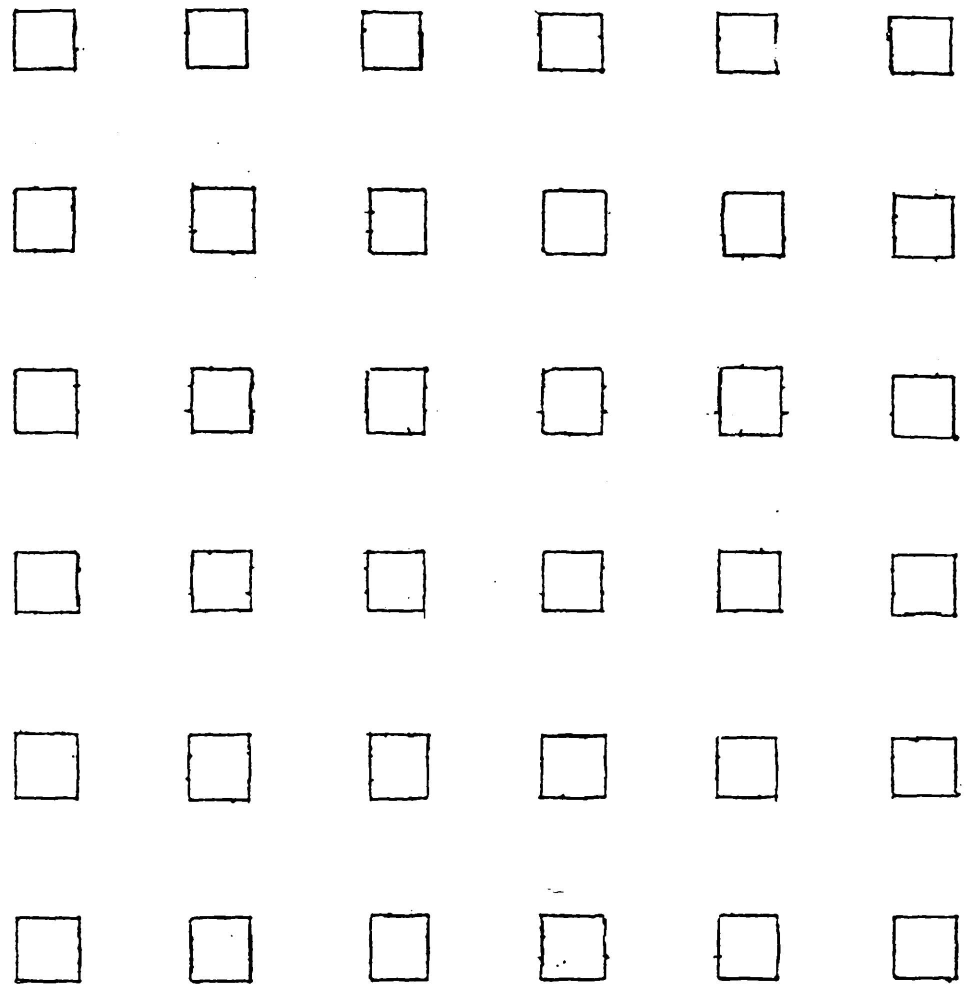


FIGURE 4.3
MEMORY TEST MAZE SHELL

spontaneously as a result of the task itself. Thus dialogue would typically consist of descriptions from the maze-game and success would depend, to a certain extent, on the formation of a co-ordinated description scheme between two players, where they co-ordinate their language to express positions in the maze.

SUBJECTS

14 pairs of 8-, 10-, and 12-year-old school children participated in the maze-game from Hillhead Primary and Secondary School, which have a local catchment area of Hillhead, Glasgow. Both schools have a substantial proportion of ethnic minorities with around half of the children being indigenous white. The children who played the maze-game had English as their first language, and were drawn from both populations. No attempt was made to control for the social and economic background or academic ability of the children, and both subject populations have a mixed spread of social class and income background. Children were randomly paired by their teacher, who worked through each class on the basis of those children who had returned their permission slips. This procedure exhausted the available subject population at the Primary school, but not the Secondary school where teachers randomly selected the pupils who would play the maze-game. There was an equal number of male, female, and mixed pairs throughout the three age groups of children.

APPARATUS

The computer maze-game task was developed by Garrod and Anderson and consisted of using three Apple11 computers and a four-track tape recorder. The maze programme was written by Mullin, from the Psychology Department, Glasgow University. Subjects sat at a terminal in separate sound-proofed computer booths, and all communication took place through headphones and microphone, which was connected to a TEAC A-3340 four-channel tape recorder. Two tracks of the tape-recorder were used for recording each subjects speech, and the other two for each subjects distinctive tone, which occurred every time they moved on the maze. All dialogue was recorded on EMI and BASF 6 inch reel tapes. In addition, the speech was recorded onto a portable Philips audio tape recorder, using 90 minute BASF tapes. The third Apple11 computer was in the experimenter's control room, along with the four-track tape-machine. On this master computer the experimenter could view the development of the game and monitor all speech.

To move their X through the maze, subjects used a four-way push-button box, where the four buttons corresponded to up, down, left and right.

A computer printout was available for each maze-game played, which documented: every move made by the players (and the monster when used), the time of each move relative to a zero baseline and total game time, the maze shape with "s" positions and gate states, total number of moves and penalties incurred by both players (see Appendix B). The printout thus indicated successive game states, and could be used to relate any verbal description to the point being described on the maze.

After each game, subjects were given a photo-copied maze-shell diagram and coloured markers, and asked to construct the shape of the current maze. They were then given school utensils for participating in the study.

DESIGN AND INDEPENDENT VARIABLES

There were a number of independent variables which could be manipulated in the maze-game. These were the shape of the maze used, the distance from start to goal, partner variables, and whether to include the maze-monster in the game. The monster was optional and represented by an "M" on both subjects mazes. The "M" moved once for every third move of both players, and followed one player at a time abiding by their maze configuration of barriers, and attempting to occupy the same node position. If it succeeded, then the game terminated and players had failed.

Subjects were introduced to the maze task by a simple practice game where they could view each others position on the maze, and which was not audio-taped. In this game their start and goal positions were located nearby so that they had only two or three barriers to overcome to reach their goal.

The first game was a baseline one played on a square type maze where subjects X and * were placed a reasonable distance apart, and the monster was not present. It was expected that later games might be solved more efficiently than earlier games due to a practice effect.

The second condition used the maze monster to investigate the effect of a threatening force on players behaviour, using more complex maze shapes. It was hypothesized that the monster should increase co-operation between the players and lead to more planning and discussion in order to avoid its path. Monster games were expected to take longer than baseline ones, except in the case where one of the players was defeated by the monster.

The third manipulation involved the effect of the maze shape on subjects descriptions. A variation of maze shapes were used in this study and Appendix A contains all mazes used in this study. These varied from the symmetrical square maze shape, to the more complex column or row based mazes, to the figural star type shapes.

The more difficult mazes had fewer paths to traverse, and were expected to lead to more problems, forcing subjects to depend more on their partner, rather than avoiding a barrier by taking an alternative route to their goal. Thus we may expect more time and detailed planning in order to succeed, with a slower rate of moving in these games.

Furthermore, the effects of the maze shape on subjects' descriptions could be investigated. For example, if rows were the most predominant feature on the maze would subjects describe points based on a horizontal line descriptive category? In addition, the role of precedence could be investigated. For example, if subjects played their first game on a column based maze and described points in terms of columns, would they continue using this strategy in the next maze game even if it was not the most efficient strategy to use? These conditions were ordered alternately over players.

Thus each pair of subjects played one short practice game which was not audio-taped, followed by a first baseline game, a second monster game on a slightly more complex maze, then a third monster game on a more complex maze.

TRANSCRIPTIONS

All speech from the games was transcribed, documenting the players name, age, and the specific maze used for that game. Players were easily discriminated from the audio-tape recordings since each was on a separate track, and would be transcribed in different coloured inks to differentiate clearly between the two. In addition each turn was numbered so that specific parts of dialogue could be clearly identified. In this way each game was transcribed as a unit. The dialogues produced in each game were generally several minutes long and contained a number of location descriptions. These were highlighted and abstracted for further analysis.

CODING

A minimum of coding was used in the transcriptions, generally for abbreviations such as LHS, RHS, for left and right hand sides, or C for corner. Since pauses were not the main focus of this analysis they were not timed and only represented by a + sign. Thus anything over one second of a pause during a players speech was noted, ignoring the pause where one player ended and the other began. Overlapping speech was noted in the transcriptions, in the following way.

Player A: I'm not sure what you mean)
Player B: Oh I know)
It's the first line, at the top

Interruptions were also coded, where one player abruptly cut the other off, in the following way.

Player A: I know it's/

Player B: Oh I've got it

Once all the dialogue had been transcribed in this way, the experimenter carefully read over the transcripts highlighting the descriptions (see page 201 for a full account of a description).

3. THE SUBJECT'S PERSPECTIVE OF THE COMPUTER MAZE-GAME

In order to fully understand the joint task imposed on subjects, an account will be given from their perspective which may apply to any player on the computer maze-game.

After being instructed on the rules of the game, the player was seated alone in a sound-proofed computer booth with a set of headphones and microphone, in front of a computer terminal. A maze shape with an X and * was displayed on the screen as shown in Figure 4.4 and Figure 4.5. At this stage, players joint penalty and number of moves score are at zero since no moves have been taken. Furthermore, they have no indication of their partner's X, *, gate state and "s" configuration. Occasionally both subjects switches or barriers coincide, however, this is accidental and may occur from time to time with gate state reversals.

Thus both players have identical maze shapes, however, they are aware that their X, *, barriers, and "s" nodes are in different positions. The first player to move (player A), would see their X flashing on the screen. This flashing would continue until player A moved the X from one node to the other. It was compulsory to move when the X flashed

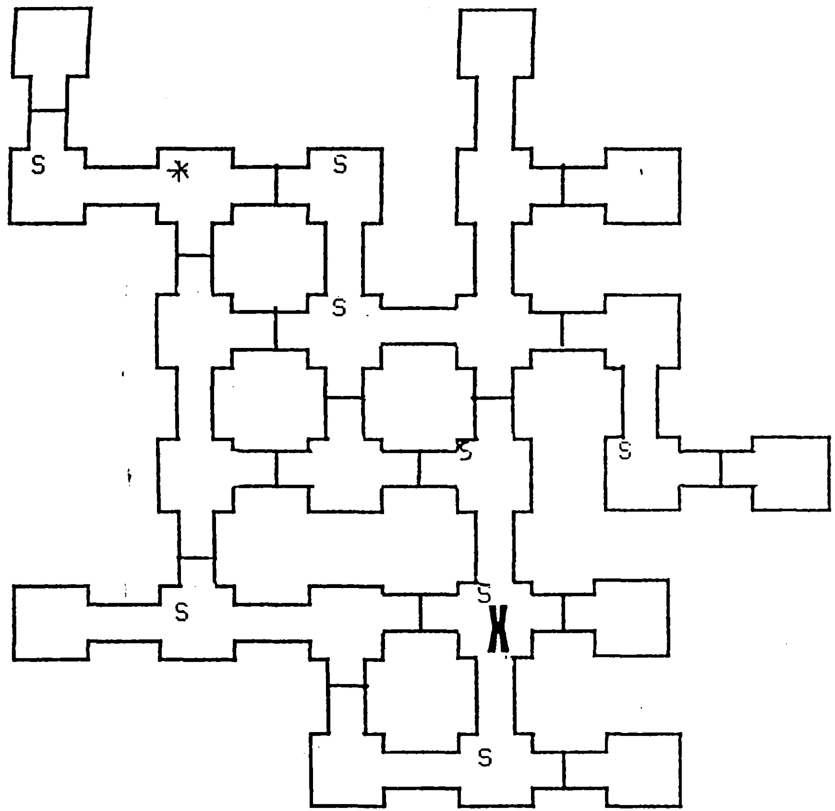


FIGURE 4.4

PLAYER A'S MAZE
x = POSITION MARKER
* = GOAL POSITION

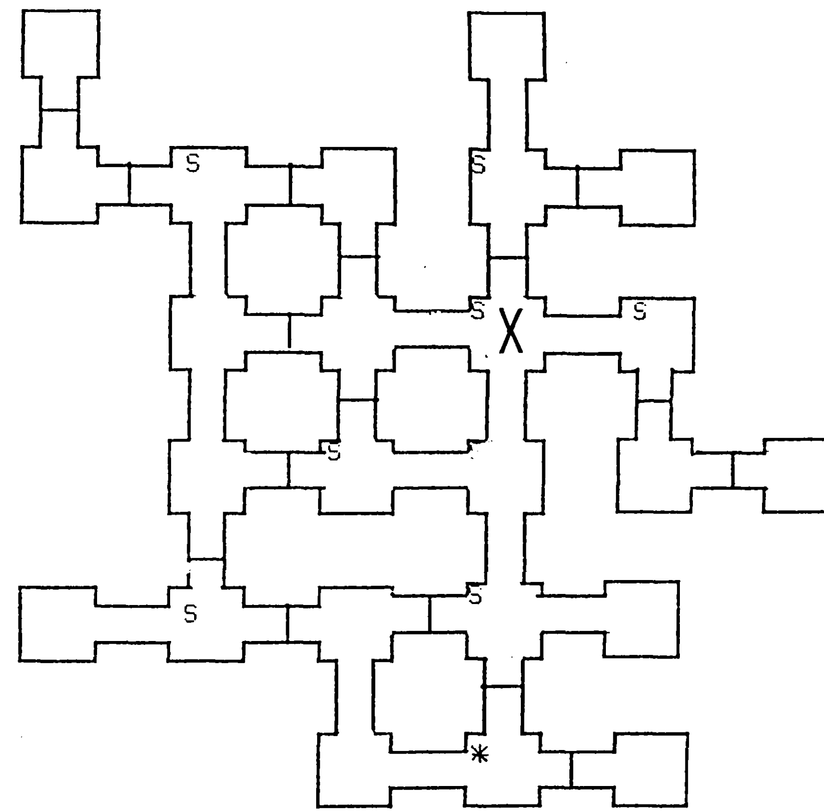


FIGURE 4.5

PLAYER B'S MAZE
x = POSITION MARKER
* = GOAL POSITION

and the only time that players could do so. From the position on Figure 4.4, player A could either move up one towards their goal, rebound off a barrier, or move down one. Since the aim is to move towards the goal and incur as few penalties as possible, moving upwards is the best solution. When player A moved upwards then both subjects see a tally with Move 1 at the bottom of their screen. This node is one of player A's "s" nodes, although it will not affect the game in any way unless player B also had an "s" node here. Players cannot affect their own gate configuration wherever they move on their maze.

Now player B's X would flash indicating their turn to move. Player A may decide to take advantage of this move since they require a barrier removed in order to proceed towards their goal. Since player B is unaware of the location of player A's "s" nodes, they have to be directed into one, preferably one in the intended direction of player B. Thus player A should first find player B's location on the maze, and goal position, and then direct them into player A's nearest "s" node. From Figure 4.5 player B may move downwards or leftwards towards their goal, however, since player A requires an "s" node activated, then they should direct player B downwards. Once player B moves into this specified node they are one move nearer to their goal, and have also reversed player A's gate state. Thus all player A's previously gated paths are now open, and all their previously free paths are now gated. Now player A's X will be flashing, and they may proceed towards their goal as further barriers permit in Figure 4.6.

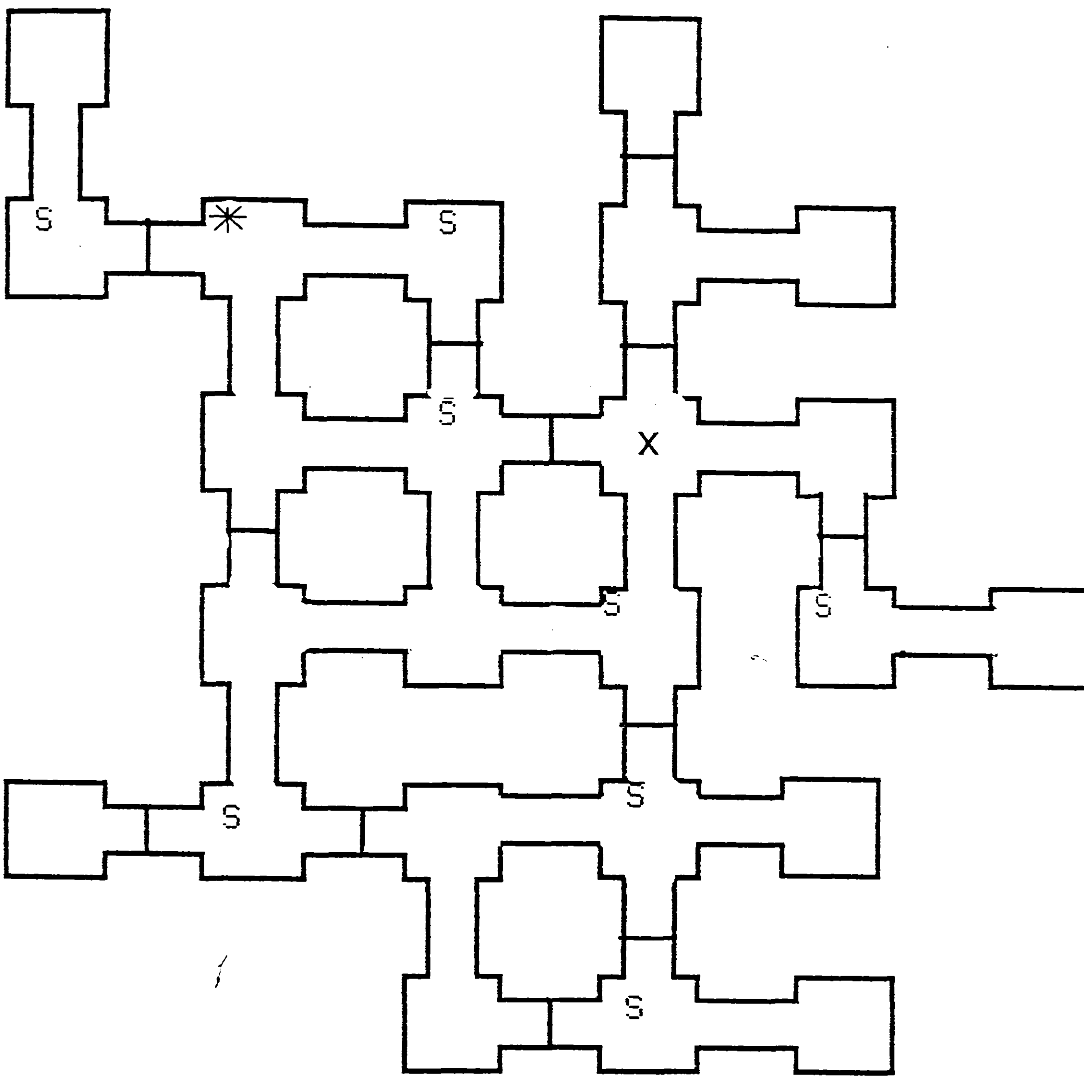


FIGURE 4.6

PLAYER A'S MAZE

X = POSITION MARKER

✳ = GOAL POSITION

This next node that player A moved into housed one of player B's "s" nodes, thus unintentionally reversing player B's gate state, detrimental to their current position, as indicated in Figure 4.7. Thus it may be in their joint interest to constantly check each others position and intended moves to ensure that no accidental gate state reversal occurs. Now player B's X is flashing, however, barriers prevent them from progressing towards their goal. Thus they decide to rebound off the barrier to remain in the same node. They require assistance from player A and do not wish to move upwards and thus further away from their goal. To attempt to traverse a blocked path results in their X rebounding back to their initial position, and both players incurring two penalty points against their joint penalty score. Thus their joint number of moves score will be at 4 and their joint penalty score at 2.

Now player A's X is flashing. Player B finds player A's position and goal, and then directs them right one, into one of player B's "s" node. Once player A moves into this designated node as shown in Figure 4.8, player B's gate state is reversed to their initial gate state as indicated in Figure 4.9. Player B's X is now flashing and they may proceed along another path towards their goal position. Their joint number of moves score will display 6, and penalties remain at 2.

This demonstrates a typical maze sequence and illustrates the interdependence of players throughout the game. Thus the rules of the game generally ensure co-operation and description generation between players to overcome their barriers and reach their goals.

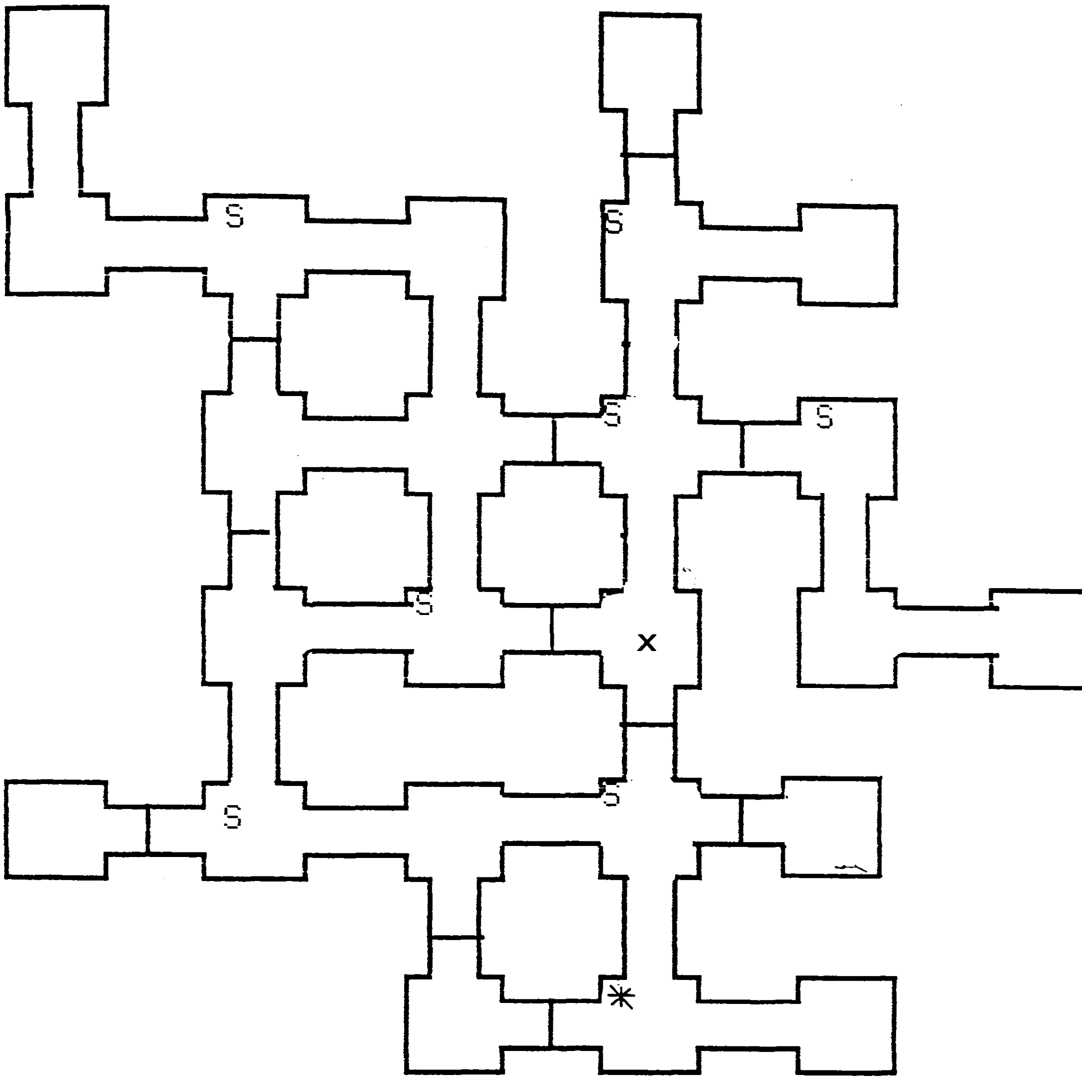


FIGURE 4.7

PLAYER B'S MAZE

X = POSITION MARKER

* = GOAL POSITION

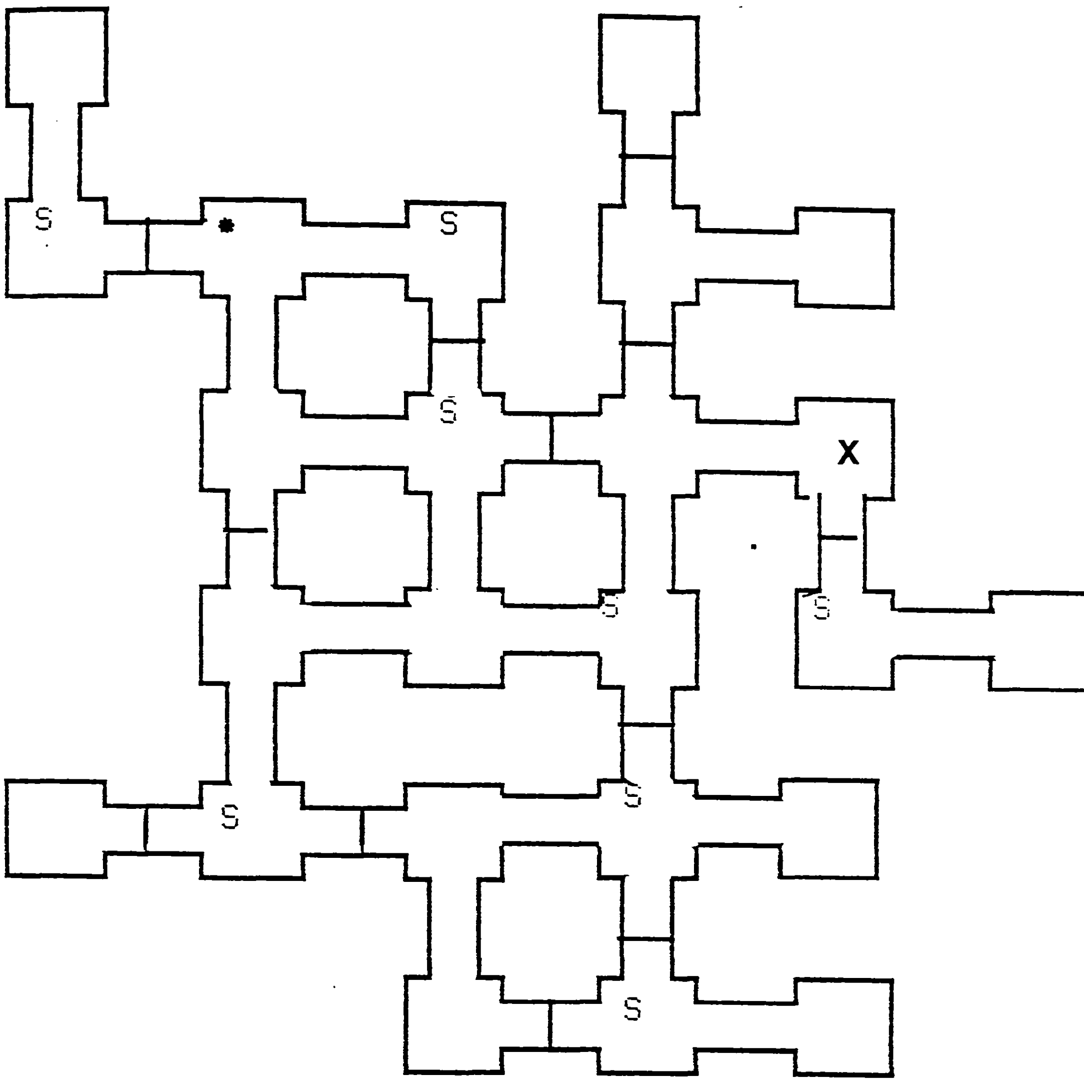


FIGURE 4.8

PLAYER A'S MAZE

X = POSITION MARKER

* = GOAL POSITION

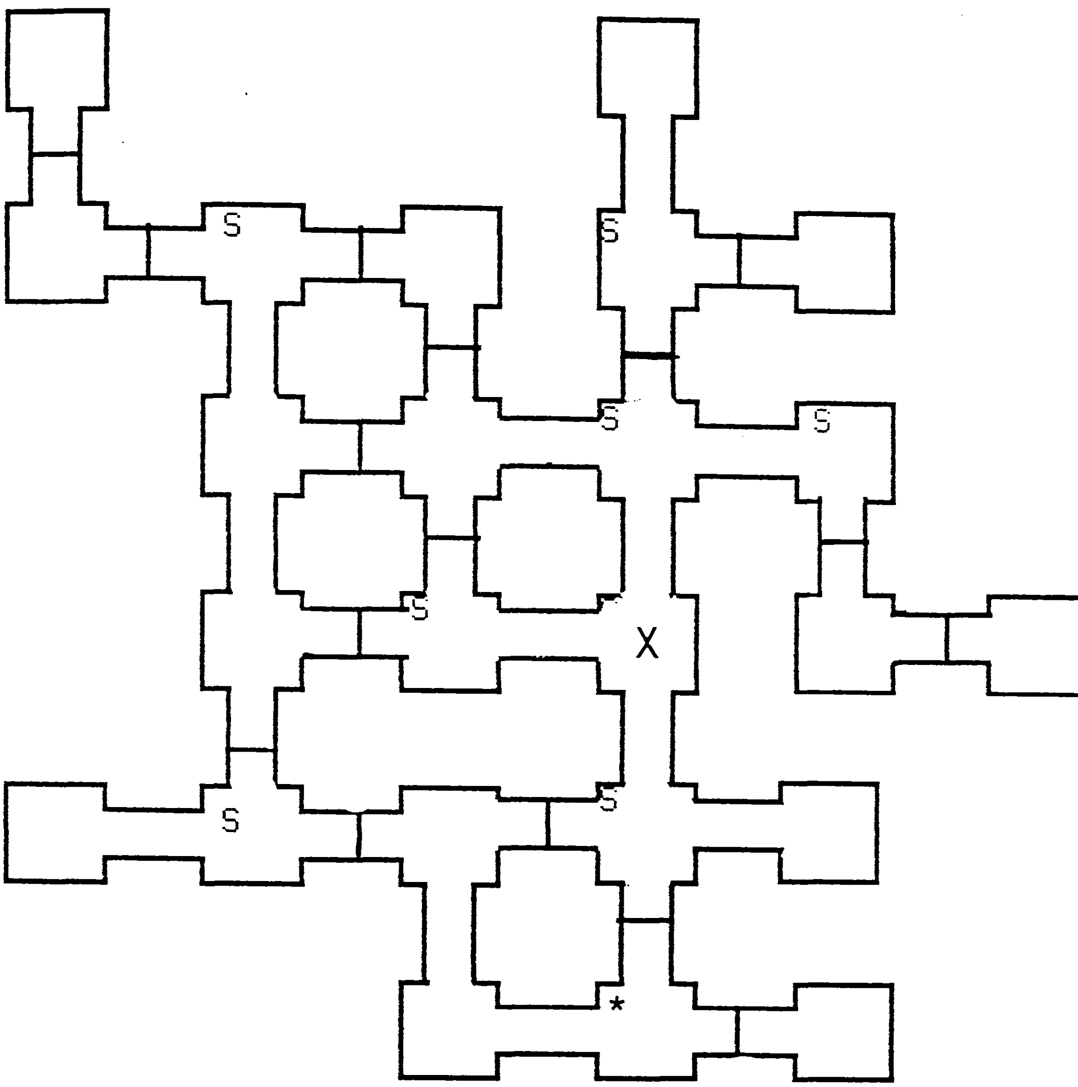


FIGURE 4.9

PLAYER B'S MAZE

X = POSITION MARKER

* = GOAL POSITION

4. CONCLUSION

The computer maze-game allows an investigation of joint language codes where subjects describe points on a structured array. Players have a co-ordination problem to solve, and in doing so must describe points on the maze, and it is these terms and what they refer to which are investigated as well as the underlying conceptual categories which may emerge.

By developing joint descriptive codes, subjects can create a system of shared meaning in which the interpretation of any expressions is mutually recognised.

The descriptions generated may be further analysed in terms of their semantic and pragmatic qualities, and the role shared and mutual knowledge play in communication. Indeed this thesis aims to investigate the extent to which mutual knowledge is required for communication, whether prior to, or during an interaction, and how it may develop in the course of an interaction, as well as over age.

Furthermore, we can investigate how communicators cope with, and often overcome, the initial difference in their descriptive strategies. In addition, many other questions may be addressed such as the efficiency of various game types and partners, the prevalence of any memory effects from one game to the next, any definite control structures that may emerge throughout the games, the effect of different maze shapes on descriptions generated, and the monster's influence on co-operation.

The following section discusses subjects' overall performance on the task, while the next deals with more detailed analyses of language performance investigating the actual descriptions generated.

B. GENERAL PERFORMANCE MEASURES

1. INTRODUCTION

This section deals with subjects' ability to solve the computer maze-game task and investigates their general performance. The task involves a joint co-ordination problem where pairs of subjects have to co-operate with each other to manipulate their barriers and manouevre their X to their * position. Since it was obviously important that subjects of all ages were able to solve the task and that there were no major developmental differences across the age groups, several overall performance measures were calculated. These were success rates, time taken to solve the game, rate of moving, and the number of utterances between moves.

The first analysis concerned the success rates for each age group on solving the task. There were three groups of 8-, 10-, and 12-year-old school children, and two types of game - those with the monster, and those without. Monster games were further divided into those where subjects defeated the monster, and those where they failed. Since all groups performed well in all conditions it was thought sensible to investigate the three age groups further.

The next analysis concerned problem solving ability across age, using four main efficiency measures. These were the time taken for that game, the number of moves required, the rate of moving, and the mean number of utterances between successive moves. This allowed comparisons between any game from any age group on these four basic measures of problem solving ability.

These four measures were calculated on four sets of maze-game data. That is, for each age group on all games, then on the first game only, on successfully solved monster games, and then on failed monster games.

Finally a comparison was made between successful and failed monster games to determine any differences in coping strategies and problem solving between those subjects who defeated the monster and those who did not.

2. CHILDREN'S ABILITY TO SOLVE THE COMPUTER MAZE-GAME

The first main analysis was to determine children's ability to successfully solve the computer maze-game task. Since three age groups of children participated - average age 8, 10 , and 12 years, with 28 in each group - it was of interest to discover how they could cope with the complex nature of the game. Each pair generally played three games, with the second and third games involving the maze-monster. The monster complicated the game, since its aim was to follow one player at a time, and attempt to occupy the same maze square. If it succeeded in doing so, the game terminated and players had failed.

Data were pooled in three ways. The first set was taken from all first games without the monster, the second from all successfully solved monster games, and the third from all unsuccessfully solved monster games. It was thought that these three areas would provide useful comparisons. For instance, to note the effect of a threatening force on subjects' performance, and compare those who succeeded in defeating the monster against those who did not. Furthermore to pool first and monster games would confound results, since the monster added an extra variable to the game. Table 4.1 illustrates success rates across each age group and for each game in proportions.

TABLE 4.1 = GAME SUCCESS RATES IN PROPORTIONS

AGE SUBJECT NO.	GAME 1 SUCCESS	GAME 2 SUCCESS	GAME 3 SUCCESS
8 YRS N=28	1	.43	.64
10 YRS N=28	1	.57	.57
12 YRS N=28	1	.50	.64

A by subjects analysis of variance was carried out with success or failure as the dependent variable, age as a between subjects independent factor, and game as a repeated measures within subject factor (ie. first game without the monster, and game2 and game3 with the monster). The analysis of variance revealed a main effect for game, $F(2,78) = 15.13$, $p < 0.001$, the treatment means being 1.0, 0.50, and 0.62, for game1, game2, and game3, respectively. This effect was explored using a Tukey test, which demonstrated that game1 > game2 = game3 at 0.05. Thus game2 and game3 (with the maze monster), had significantly lower success rates than those first maze-games without the monster. The main effect of age proved non-significant, $F(2,78) = 0.057$, and the interaction between age and game was also not significant, $F(4,78) = 0.23$ (see Appendix D, Table 1 for full analysis of variance results).

Discussion

From these results we can see that all subjects were able to cope with the complexities of the computer maze-game task, since all first games (without the monster) were successfully solved. In second and third games we see the presence of the monster reduced success rates, yet all groups performed fairly well in terms of completing the task. These results indicate that age does not play a significant role in determining success rates, and thus enable us to compare the three age groups of children on the computer maze-game.

3. PROBLEM SOLVING ACROSS AGE

The first analysis illustrated that the three age groups were able to cope with the complexities of the computer maze-game by simply measuring success rates. However, since these general success rates may appear rather crude in themselves, some alternative performance measures were also used in order to analyse any finer differences between the groups.

The four main measures of efficiency used were based on those of Anderson (1983) who compared maze-games played from four different experimental conditions with an adult population (see Chapter 3, section C. for an account of this work).

The four measures of efficiency employed were:

(i) the number of moves by both players until the game terminated. For example, the total number of moves until both players were in their respective goal positions, or until defeated by the monster. In monster games the move of the monster was not counted in this total, only that of the subjects

(ii) the time taken in minutes to reach a solution, or until the game terminated due to failure

(iii) the rate of moving, calculated by taking the number of moves by both players over the time taken giving the number of moves per minute

(iv) and the mean number of utterances by both players between successive moves, where an utterance is taken as a complete turn by one player. Thus the total number of turns in one game were counted and divided by the total number of moves by both players in that game.

In this study the third and fourth efficiency measures are dealt with in most detail. For example, the third efficiency measure of the rate of moving deals with general performance in the game by taking into account the time taken to complete the game, and the number of moves. This measure is thus determined by the first and second efficiency measures, and these measures are noted in order to illustrate this. However, since the first two efficiency measures are confounded with success they were not subjected to analysis of variance tests, since they would have produced uninformative results in the context of the computer maze-game. For example, game time, and total number of moves in the game, depend on whether subjects succeeded or failed in defeating the monster. Failed games generally produced less moves and were shorter than the successful ones and so produce artificially shortened game times (see Tables 4.3 and 4.4). However the ratio of the first and second measures provide the third efficiency measure.

Another interesting measure concerns the amount of speech associated with each move with leads us to the fourth efficiency measure which shows the mean number of utterances by both players between successive moves. It was thought that these basic efficiency measures may indicate the extent to which children were able to deal with the computer maze-game task.

These efficiency measures were calculated on three sets of data from the maze-games. The first compared the three age groups on all games. Thus for each age group, the different game types were pooled together in order to determine any general differences between the groups. The second comparison was carried out on successfully solved monster games, and the third on failed monster games, for each age group. Each of these comparisons will be explained in more detail below.

3.1 GAME COMPARISONS

This involved calculating the mean and standard deviation scores for all games in each age group on the four efficiency measures. Thus, first games and monster games were pooled in order to get an overall picture of efficiency, and determine if any general differences emerged between the three age groups. The means and standard deviations for the four measures are presented in Table 4.2.

TABLE 4.2 = GROUP MEANS AND STANDARD DEVIATIONS ON FOUR MEASURES OF EFFICIENCY AT SOLVING THE TASK

Age Subjects	1. Number of moves in game	2. Game time (mins)	3. Rate of moving (1/2)	4. Mean no. utt. between moves
8yrs N=28	M=31.95 SD=16	M=9.7 SD=3.8	M=3.2 SD=1.1	M=3.8 SD=2.1
10yrs N=28	26.7 13.7	9.6 4.7	2.9 0.9	4.9 2.1
12yrs N=28	28.5 18.5	9.2 5.8	2.9 0.95	6.0 4.7

A by subjects analysis of variance was carried out, with rate of moving as the dependent variable, with one between subjects independent variable of age, and game1 and game2 as a repeated measures within subjects. (Game3 was not included in these analyses since not all pairs played three maze-games. For example, due to extended game times and school deadlines, on several occasions children had to be returned to school after their second game.) From this analysis, the main effect of age was not-significant, $F(2, 39) = 0.87$, the means being 3.2, 2.9, and 2.9 respectively. The main effect of game was also not significant, $F(1,39) = 0.6$, and neither was the interaction of the two, $F(2,39) = 0.81$. Thus we can safely conclude that there were no significant differences in the rate of moving across age or from game1 to game2 (full analysis of variance results are reported in Appendix D, Table 2).

A by subjects analysis of variance was then carried out with the mean number of utterances between moves as the dependent variable, with age as a between subjects independent variable, and game1 and game2 as a repeated measures within subjects factor (full results reported in Appendix D, Table 3). The main effect of game was not significant, $F < 1$, the means being 4.8 for both games. However, the main effect for age, $F(2,39)$ 2.6749 $p=0.07$, was marginally significant with the mean number of utterances between moves 3.8, 4.9, 6.0, for the 8-, 10-, and 12-year-old groups respectively. This trend indicates that the means fall in the predicted direction, with some tendency for an increase in utterances per move in the older children. The interaction between age and game proved non-significant, $F(2, 39) = 0.84$.

3.2 MONSTER GAME COMPARISONS

The analyses conducted so far fail to take into account the second and third monster games which relate more importantly to success rates. This analysis now deals with this aspect, separating successful games from the failed ones. Thus either players had managed to defeat the monster by avoiding its path and reached their respective goals, or the monster had defeated subjects before they reached their goals.

In each age group there were between 26 to 28 monster games and successful ones will be reported first and then failed ones, on the efficiency measures, before comparing the two on efficiency measure 3 and 4. The comparison may determine any differences in coping strategies and problem solving abilities which may be apparent between subjects who defeated the monster and those who did not. For example, it may be that the older group require less moves than the youngest age group to defeat the monster, and produce more descriptions and detailed planning between moves. Perhaps the youngest age group are saying less and failing to devise co-operative plans until the monster is imminent. Or they may be making more moves per minute in an attempt to avoid the monster, however, fail to consider their goal. These are the type of questions explored here.

The mean and standard deviation scores are shown in Table 4.3 for each age group on successfully solved monster games on the four measures of efficiency.

TABLE 4.3 = MONSTER/SUCCESS MEANS AND SD ON THE FOUR EFFICIENCY MEASURES

Age Subjects	1. Number of moves in game	2. Game time (mins)	3. Rate of moving (1/2)	4. Mean no. utt. between moves
8yrs N=28	M=33.3 SD=20.5	M=9.5 SD=4.1	M=3.5 SD=1.4	M=4.8 SD=3.6
10yrs N=28	30.5 11.9	11.0 5.2	2.9 0.6	5.4 1.6
12yrs N=28	31.0 17.5	10.2 6.6	3.3 0.8	3.8 2.1

Table 4.4 displays the mean and standard deviation scores of the four efficiency measures for the games where subjects were defeated by the monster.

TABLE 4.4 = MONSTER/FAIL MEANS AND SD ON THE FOUR EFFICIENCY MEASURES

Age Subjects	1. Number of moves in game	2. Game time (mins)	3. Rate of moving (1/2)	4. Mean no. utt. between moves
8yrs	M=28.7	M=9.8	M=3.2	M=4.0
N=28	SD=12.2	SD=5.5	SD=1.1	SD=2.2
10yrs	18.9	7.0	2.8	6.9
N=28	12.5	5.0	1.0	5.5
12yrs	17.3	5.6	3.0	6.0
N=28	9.7	2.5	0.9	2.6

A by subjects analysis of variance was carried out on the dependent variable of the rate of moving, with age as the independent variable, and success or fail as the between subject independent variable. Missing values were estimated for that age group by calculating the mean of the available figures and substituting these. The main effect of age proved non-significant, F(2,39) = 1.0 p=0.36, and there was no significant interaction between age and success, F(2,39) = 0.8. However, the main effect of game F(1,39) = 3.0725 p=0.082, proved marginally significant. The mean for the rate of moving 3.18 for successful games and 2.97 for failed games. Thus subjects tended to make more moves per minute in successful games than failed ones (full analysis of variance results are reported in Appendix D, Table 4).

Successful and failed monster games were then compared on the mean number of utterances between moves. A by subjects analysis of variance was carried out with the dependent variable of the mean number of utterances between moves, and age as the independent between subjects variable, and game as the between subjects independent variable. The main effect of game proved non-significant, $F(1,39) = 0.02$, mean success = 4.77, mean failed = 4.83. The main effect of age proved marginally significant, $F(2,39) = 2.68$ $p=0.07$, with the means 3.79, 4.9, and 5.96, for the 8, 10, and 12-year-old groups respectively. And the interaction between age and game was also marginally significant, $F(2,39)$ 2.8836 $p=0.064$. This interaction is shown in Table 4.5. (see Appendix D, Table 5, for full analysis of variance results).

TABLE 4.5 = MEAN NUMBER OF UTTERANCES BETWEEN MOVES

AGE	SUCCESS	FAILED
8 yrs	4.5	3.9
10 yrs	5.5	4.8
12 yrs	4.3	5.8

A Tukey test revealed that none of the means were significantly different from each other at the 0.05 level.

Discussion

The main points from the monster games tended to be the marginally significant difference with the rate of moving scores, where the rate of moving was slightly lower in failed monster games as opposed to successful ones. This may have been expected, where problems which have led to failure in these games may have produced increased planning with slower rates of moving. On the whole though, we may have expected more speech in the failed monster games but this did not prove significant from the analysis of variance results. However, the analysis of variance results from the mean number of utterances between moves, partially replicated earlier results where there was a significant increase in the number of utterances between moves across age. Yet the most interesting result hints of an interaction between age and success for the mean number of utterances between moves, where there is a trend for older subjects to say more between moves in the failed monster games.

Observations of subjects' performances, and from plotting subjects' routes through the maze, suggests that on some occasions the 8-year-olds appeared to take alternative routes to their goal and avoid the monster at all cost, rather than discussing moves and enlisting co-operation from their partner to switch their gate state. They tended to react with excitement in the face of the monster and moved quickly to avoid confrontation regardless of their goal position. For example the following excerpts are discussions from different pairs of 7/8-year-olds discussing the monster:

A Oooh

B Oh oh

A What?

B We'd better move quickly

A Why?

B The monster's going to get you

A I think I'll go across again, if I go up I'll be beside the monster oooh oooh you go

B Right I'm stuck

A Where are you oooh I'm at the le right hand side

Go anywhere

B I can't go anywhere

A Go anywhere

B I'm stuck

A Go anywhere just go anywhere

A Hurry up and go

B Oh no the monster's coming

A Oh no oh no

B Oh no the monster

A Oh no you're letting it in for god's sake

B oh no it's going to bite me

In this way there was less detailed planning between moves. The older groups on the other hand, appeared to react less seriously to the monster, focusing on the task of reaching their goal position, avoiding the monster as they proceeded. In this way, more detailed planning and co-operation was required on how to avoid the monster's path while attempting to reach their goal. This more challenging approach may explain their greater number of utterances between moves, before being defeated by the monster. For example, they would be moving more carefully, and discussing routes between each move.

4. General Discussion

The four efficiency measures were used in order to determine subjects' performance at solving the computer maze-game since it was thought they may reflect skill on the task. However, determining a successful performance proved rather more difficult since low scores on time taken, and rate of moving, may not simply be equated with increased efficiency. More important for success may be increased planning through co-operation and description, indicated by the mean number of utterances between moves. For example, some of the older children spent quite some time planning their descriptions and routes to their goal before moving. For example, these conversations between 11- and 12-year-old pairs of children occurred before they moved on the maze-game:

A Hold on until I tell you where I am, I am in the top left

B OK

A And my goal is in the bottom, third from the left I think it's the same as yours

This pair continued to describe each others position as they moved throughout the maze:

B Right you are bottom left-hand corner no bottom right-hand corner?

A Uhu

A Right where are you?

B I'm on the second line two right. Where are you?

A Second line one left

While some pairs of 8-year-olds moved very quickly to solve the game in several minutes although they produced little goal directed speech (ie.descriptions from the maze). For example, rather than direct their partner into one of their switch nodes to open an immediate gate, they often followed alternative and longer routes where possible, only describing maze locations when they were totally blocked. Furthermore, they often continued moving back and forth between two blocked gates until their partner moved into one of their switch nodes by chance and seemed more pre-occupied with moving their X than any other aspect of the game. For example:

B And I've got another s three boxes along

A Can you just move?

B And I've got another s one up

A Just move

A Where are you?

B The left-hand side on the second row

A How high?

B Eh three boxes from the bottom

A It's my go

B Em four boxes from the bottom

A It's my go

A Do you mean you're on the second you're on the second?

B Never mind it's my go

Overall the efficiency measures produced some trends in performance although these were not very striking, and on the whole the results appear rather inconclusive. However, it is surprising that the results tend to indicate that the 8-year-olds can cope as well as the older children in terms of the efficiency measures discussed in this section. In terms of the non-linguistic measures there did not appear to be any clear cut developmental trends, but there were some indication of a trend with the linguistic measure (ie. the number of utterances between moves). Marginally significant results were reported for the mean number of utterances across age, where there was a trend for increasing dialogue with age. This next section will now turn to language performance in greater detail.

On closer inspection, an analysis of individual performances indicated great variability within the age groups where some 8-year-olds performed as well as some 10-, and 12-year-olds, while others as poorly across all the age groups. Thus perhaps skill, rather than age, would have produced more informative results. Recent work by A. H. Anderson, Clark, and Mullin (1989) reported this to be the case where skill was shown to be more important then age where pairs of 8-, 10-, and 13-year-old subjects solved joint communication problems. However, an analysis of skill was beyond the scope of this research since it is difficult to objectively assess exactly what constitutes a good or poor performance on the maze-game, and furthermore the sample size is too small from each age group to portion pairs into top and bottom sections, and the main concern of this thesis involved linguistic measures and the ability of subject pairs to establish shared language. Yet evidence from the transcripts indicated pairs from all age groups who performed well in terms of describing maze locations, planning their moves, and co-ordinating their goals and descriptions, to successfully manipulate the 's' nodes, while poorer performers tended to describe less, ignore each others comments and questions, and often fail to appreciate the logic of the 's' nodes. Yet the measures employed in this section ensure that the computer maze-game is roughly comparable across the three age groups of children used in this study.

C. LANGUAGE PERFORMANCE

1. INTRODUCTION

This section deals with more specific aspects of communication in dialogue and investigates the actual descriptions generated from the computer maze-game. To solve the game subjects were required to describe several points on the maze. A description was generally initiated by one subject asking the other for their position, followed by an explanation of this location, with any interaction included. This whole interactional package defined a description unit (see Chapter 5 for a full explanation of descriptions).

An investigation was made of the number of description units generated by each pair of subjects for all the games, and then for each of the three game types. That is for the first games, successful monster games, and failed monster games. In addition the number of description units per move was investigated since this controls for the overall game length, and should give a more accurate comparison of successful and failed games.

Finally the number of words in each description unit was calculated to investigate the overall length of descriptions. It was expected that this may indicate the informativeness and interactional extent of the descriptions and how garrulous the subjects were. This was carried out across age and for the various game types.

2. QUANTITY OF DESCRIPTIONS GENERATED IN THE MAZE-GAMES

First the number of description units generated by each pair of subjects was calculated. This was then analysed into the number of description units generated in each of the three game types. Thus, the total number was calculated for each age group, and then partitioned into the first games, the completed monster games, and the unsuccessful monster games.

Table 4.6 displays the totals and mean number of description units generated during the maze games and then for all first games, monster success and monster failed games. There were 14 pairs of subjects in each age group, and each pair generally played three maze-games, the second and third games having the monster present (6 subject pairs did not have time to play a third game due to school time limits).

TABLE 4.6 = MEAN NUMBER OF DESCRIPTION UNITS GENERATED BY BOTH PLAYERS FOR FIRST GAMES, MONSTER SUCCESS AND MONSTER FAIL GAMES

	TOTAL DESC IN ALL GAMES	TOT.IN GAME1	TOT. IN MS	TOT. IN MF
8yrs N=28 41 Games	334	105	130	99
Mean	23.9	7.5	8.66	8.3
10yrs N=28 40 Games	436	141	190	104
Mean	31.4	10.1	13.6	8.7
12yrs N=28 40 Games	562	263	183	116
Mean	40.1	18.8	13.1	9.67

A by subjects analysis of variance was carried out with the number of descriptions generated per game by both players, as the dependent variable, with one between subjects independent variable of age, and game1 and game2 as a repeated measures within subjects factor (as stated earlier, some subjects did not have time to play a third game due to school time-tables and so only game1 and game2 were used for the analysis of variance tests). From this analysis, the main effect of age was significant, $F(2,39) = 6.75$, $p=0.003$, the means being 7.3, 11, and 16.6 description units for the first two games, for the 8-, 10-, and 12-year-olds respectively. The Tukey test was significant at the 0.05 level for the difference between the 8-, and 12-year-old groups, but not for the difference between the 10-year-olds and any of the other groups. The main effect of game proved non-significant, $F(1,39) = 0.3$, with the means being 12.1 for game1 and 11.1 for game2, and there was no significant interaction between age and game, $F(2,39) = 1$, $p=.35$ (see Appendix D, Table 6, for full analysis of variance results).

Investigating the mean number of description units generated by pairs of subjects during all games, the 8-year-olds played a total of 41 games, and in each game both subjects generated an average of 8.2 descriptions. This increased to 10.9 in the 10-year-olds, and 14 in the 12-year-old group. In order to establish whether this was a reliable trend a Jonckheere Trend Test was carried out. This proved significant with a value of 1433, far greater than the critical value of 124, at C=3, n=28, at the 0.01 significance level. Thus the difference in description units between any of the groups proved highly reliable.

Although this analysis, of the number of descriptions generated per game, is interesting and indicative of some developmental change, it is nevertheless confounded. For example, the number of descriptions per game depends, to a certain extent, on both the number of moves made, and the time of the game, since each move gives subjects a natural opportunity to discuss their position. So the number of descriptions per move would give a more reliable account of the density of descriptions, which will be considered next.

3. THE NUMBER OF DESCRIPTIONS GENERATED PER MOVE

To control for overall game length, the number of description units generated per move by both players, was then calculated for each game type and age group. This was done by dividing the total number of descriptions for that game by the total number of moves in the game. Table 4.7 shows the number of descriptions per move for both players for game1, successful monster games, and failed monster games, and then the average descriptions per move for each age group.

TABLE 4.7 = THE NUMBER OF DESCRIPTIONS PER MOVE

	mean no. desc. units	total desc. units	mean no. moves	mean no. descr units per move	group means
8yrs					
game1	7.5	105	33.5	.22	
MS	8.7	130	33.3	.26	
MF	8.3	99	28.7	.29	.24
10yrs					
game1	10.1	141	29.6	.34	
MS	13.6	190	30.5	.45	
MF	8.7	104	18.9	.46	.40
12yrs					
game1	18.7	263	35.8	.52	
MS	13.1	183	31	.42	
MF	9.7	116	17.3	.56	.50

A by subjects analysis of variance was performed with the mean number of descriptions per move by both players, as the dependent variable, age as the between subjects independent variable, and game1 and game2 as a repeated measures within subjects factor. The main effect of age proved significant, $F(2,39) = 3.12$ $p=0.05$, the means being 0.27, 0.61, and 0.76, for the 8-, 10-, and 12-year-olds, respectively. A Tukey test revealed that the 8-year-olds provide significantly fewer descriptions per move than either of the older groups at the 0.05 level, but there was no significant difference between the 10- and 12-year-olds. The main effect of game proved non-significant, $F(1,39) = 1.76$, the means being 0.47 for game1 and 0.63 for game2, and the interaction between age and game was also not significant, $F(2,39) = 1.85$ (see Appendix D, Table 7, for full analysis of variance results).

DISCUSSION

Our results from the number of descriptions generated per game, and the number per move, show that the youngest age group generate significantly fewer descriptions than the oldest group, with the middle group lying in the predicted intermediate region. This result may have been expected since the generation of maze descriptions requires fairly complex planning and skill, and it was common for younger subjects to only describe points when necessary. Observations of the 8-year-olds performances suggests that on many occasions they appeared to experience difficulty in describing points, and so tended to avoid description unless it was absolutely necessary. The following excerpts are from different pairs of 8-year-olds avoiding description in various ways (+ represents a pause):

Pair 1

A Max where are you?

B I've just moved. Are you free?

PAIR 2

B Where are you?

A Where are you?

B I've to ask you

A But I'm stuck

B Where are you?

PAIR 3

A Nadine where are you?

B Ehm Ehm + I'm at + I am + just trapped by 2 gates

A No I mean are you up or are you down?

B Ehm I'm up ehm + haven't had my go yet

A Are you down or up?

B Yes

A No, is you + are you + across, down at bottom?

B De de de liddle (singing)

PAIR 4

B Mathew where are you?

A Ehm + I'm near the star. Mine's is flashing, I haven't tooken my go.

B Where are you?

A Ehm I don't think I can free you. Move again

B Where are you?

A Oh oh these are killing me (the headphones) I'll tell you I'm not listening now because of these

PAIR 6

A Where are you?

B I'm quite far away from it (the monster). Right your go

The older groups on the other hand, appeared to answer "where are you" questions with some kind of description, tending to describe positions at various stages of the game, and even when they were experiencing no difficulty. For instance, at the beginning of the game they often asked each others position and continued to do so throughout the game.

The dialogues appeared to suggest that the younger subjects were very concerned about reaching their * position, and perhaps not as aware of the value of describing locations in order to manipulate their barriers. The older subjects appeared to have a better grasp of the fundamentals of the game where they co-operated to solve the joint problem. Observations from the dialogues suggested this to be the case on several occasions, where a certain amount of competition was evident in the 8-year-olds games. For example:

PAIR 5

B Oh I'm stuck

A Who cares + bounce for all I care

PAIR 9

A Oh great and don't move anywhere because I want to win

B I'm going to win

A I'm going to win

B I'm going to win

A Are you stuck?

B No

A Good because I'm not going to bother to help you

These possible explanations, of the 8-year-olds having difficulty describing points, along with what they perceive as the most important aspect of the game, may account for this decrease in descriptions in the younger subjects.

4. NUMBER OF WORDS IN DESCRIPTION UNITS

An investigation was then made of the length of the description units. For example, it may be that the youngest age group communicate less and produce shorter descriptions than the two older age groups. Perhaps they are unaware of the quality and quantity of information required to describe a desired point, and thus produce inadequate descriptions. Or perhaps the youngest age group are producing descriptions with much redundancy, using more terms than necessary which carry less information. They may find it difficult to convey information in a clear and concise way. If this was the case then descriptive length should decrease with increasing age leading to more efficient and economic descriptions.

This assessment involved calculating the number of words in each description unit for each age group, and each game condition. To do so the whole description was analysed counting the total number of words from both subjects. So the number of words in descriptions from game1, successfully solved monster games, and failed monster games, were compared. This should help determine whether the type of game affects the length of descriptions generated. For example, perhaps in the monster games descriptions will increase, since it is important to plan ahead and co-operate. On the other hand, perhaps in game1 descriptions will be longer until subjects establish a familiar joint language code to describe points on the maze. As the games proceed, these descriptions may become shorter, leading to less ambiguous descriptions being generated.

Table 4.8 displays the number of words generated in descriptions from each of the three game types for each age group.

TABLE 4.8 = GROUP MEANS FOR THE NUMBER OF WORDS IN DESCRIPTIONS GENERATED FROM GAME1 MONSTER SUCCESS (MS) AND MONSTER FAIL (MF) GAMES

	GAME1		MS		MF	
Age	tot. no. words	no. words per desc	tot. no. words	no. words per decr	tot. no. words	no. words per desc
8yrs	3037	30.0	3936	30.3	3144	31.7
10yrs	4086	28.9	4766	25.1	2623	25.2
12yrs	5743	24.6	4260	23.3	2800	24.1

Since the number of words per description is similar for successful or failed monster games, all monster games were pooled together and compared to the first games (without the monster). Since some pairs played two maze-games, while others played three (see section 2), the mean of two monster games was used for the latter group. Table 4.9 gives a summary of the number of words per description in game1, and in the monster games.

TABLE 4.9 = NUMBER OF WORDS PER DESCRIPTION

Age	game1 (no M)	M games
8yrs	30	31.4
10yrs	28.9	27
12yrs	24.6	24.3

A by subjects analysis of variance was carried out with the number of words per description as the dependent variable, age as the between subjects independent variable, and game (monster or not) as the repeated measures within subjects factor. The main effect of age proved significant, $F(2,39) = 3.48$ $p=0.037$, the means being 30.7, 27.9, and 24.5, for the 8-, 10-, and 12-year-olds respectively. A Tukey test revealed that all of the means were significantly different from each other at the 0.05 level, thus the number of words per description was significantly different between the three age groups of children. Yet the main effect of game was not significant, $F(1,39) = 0.058$, nor was the interaction of age and game significant, $F(2,39) = 0.57$ (see Appendix D, Table 8, for full analysis of variance results). In this way subjects failed to produce substantially different descriptions in monster games. Age appeared to be the only main factor affecting the length of the descriptions.

DISCUSSION

The results from the number of descriptions generated per game, and then move, found a significant difference between the 8- and 12-year-olds, with the 10-year-olds falling in the predicted experimental direction, with more descriptions in the older children. We may have presumed that since the youngest age group produced the least number of descriptions, they were saying less. However, the analysis of the length of the descriptions has indicated a significant difference in description length with longer descriptions in the younger children. So perhaps the fact that the younger children are not taking the opportunities to interact and describe maze locations, (indicated by the fact that they produced the least number of descriptions per game), renders them less efficient at this task where they require more words to describe the point informatively.

From reading over the descriptions there appeared to be a certain amount of redundancy present in the 8-year-olds descriptions. This appeared evident from many of their descriptions, which tended to suggest that they were indeed having difficulty clearly expressing positions on the maze. For example:

PAIR 6

A Can you, can you + where are you Max?

B Right, you know the second bottom row?

A The second, the second bottom row. Yeh

B And you know how there's 6 squares on that row?

A 1, 2, 3, 4, 5, 6, yeh

B 4 from the left-hand side

A 4th on the left-hand side?

B Yeh + on the left-hand side

A Right 1, 2, 3, 4. So you're there

PAIR 9

B Where are you?

A Ehm you know how there ehm is + right count the middle, you know the middle one? At the bottom? + The middle one at the bottom?

B Yes

A Right ehm + you go up 3 and I'm in the number 3

B What way left or right?

A The + I'm not sure + I think it's the east

PAIR 11

B Where are you?

A Ehm + I don't know. Ehm + 1, 2, 3, 4, at 4 count down at + at on the

B Left?

A Right, left

B Left? 1, 2, 3, 4, and where else are you?

A I'm still there

B You're there?

A What?

B You're there?

A No I'm not there

PAIR 13

A I'm in the middle + 1, 2, 3, 4

B From the down? 1, 2, 3, 4 down?

A No + across and 1, 2, 3

B Down?

A Yeh

B You are 3 down?

A Yeh

B 1, 2, 3, 4 and then 1, 2, 3, 4

PAIR 14

A Where are you?

B I'm at + in the bottom + I'm in the second top line + and the second one from the left

A Oh describe it a bit better. Is it the + is it the first + the second the fourth?

B The second

A The second line? Ehm which number of line?

B It's number + the second top

A Which number? No which square?

B Which square? The second one on the second top line

On the other hand, the older children have used more descriptions and so have had more experience and practice at this task, and so may have a better understanding of the information required. In this way, the older children may be using language more communicatively and relative to the game. The following are examples of descriptions from 10- and 12-year-olds, where they appeared to have a clearer conception of how to describe locations. For example:

PAIR 1

A Where are you?

B I'm on the third line + 3 left

B Where are you John?

A Second line up + ehm 3 from your + right

PAIR 4

A Where are you?

B Second line from the bottom second box from the right

PAIR 7

B Where are you?

A I'm sort of + um + 4 up from the bottom and + 3 in

PAIR 12

A Where are you?

B Eh + the the bottom line and 1, 2, 3, along + from the right

D. CHAPTER CONCLUSION

This chapter began by explaining the rules and procedure of the computer maze-game used in this thesis. Basically the game involves pairs of subjects solving a co-ordination problem which leads to the spontaneous description of various locations from the maze spatial array. This chapter discussed the developmental differences noted while three age groups of children played the game, by investigating their ability to solve the task and produce descriptions.

The first section examined the general performance of subjects on the task and investigated such aspects as their ability to solve the computer maze-task. Results indicated high levels of success since all first games were completed, and over half of the more difficult monster games were successfully solved by all groups of children.

The next analysis discussed subjects' efficiency at solving the task, using several basic measures. The main measures concerned a non-linguistic one, the rate of moving, and a linguistic one, the number of utterances between successive moves. The only significant difference appeared to be on the number of utterances between moves, where the older children were saying more between moves than the younger ones.

Attention was then focused on the actual descriptions generated from the game. This section investigated the number of descriptions generated by each pair of subjects over all games, and then in certain game types. However, to control for differences in game length, the number of descriptions per move was also investigated. Description length was then calculated by counting the number of words in each one. The main results from these investigations were a significant difference in the number of descriptions generated across age with more descriptions generated in the older children. Yet this was not significantly different across game nor were any of the interactions significant. So older children were producing more descriptions than the younger ones both in toto and per move.

There was also a significant difference in the number of words per descriptions for age, with more efficient shorter descriptions in the older children. A detailed qualitative analysis of actual descriptions suggested a certain amount of redundancy for the 8-year-olds as compared with the more economic and efficient descriptions in the older children. It was suggested that the older children may be using language more effectively in relation to their task requirements. On the other hand, the 8-year-olds were not saying as much overall and producing fewer descriptions, therefore when they describe a location they have had less experience and may require more words to describe the point efficiently.

One other point worth mentioning concerns the length of descriptions which did not reduce over the games. Earlier research produced evidence of a progressive reduction in the length of reference over time, where interlocutors negotiate more efficient and economic codes (Krauss and Weinheimer, see page 76). Yet these tasks are not necessarily comparable to the computer maze-game, since the maze task requires the differentiation of 1 point from 36 similar others, as compared to 1 from 8 different forms from Krauss and Weinheimer's experiment. Furthermore, there do not seem to be many opportunities for anaphoric reference through pronoun in the maze-game, since each point to be described is usually different on each occasion. This may be possible with the figural type descriptions, where the reference to some configuration of nodes on the maze could be shortened over time, yet there were few of these examples generated. Indeed on any of the various efficiency measures calculated there were few differences across game. The only main significant effects appeared to be over age.

The next chapter focuses on more specific elements of the dialogues, paying particular attention to the semantics of location descriptions. This investigates the meaning of what subjects actually say, and how they interact to solve the computer maze problem.

CHAPTER 5

A SEMANTIC INVESTIGATION OF MAZE LOCATION DESCRIPTIONS

While the previous chapter discussed general performance of subjects on the computer maze-game in terms of efficiency, and quantity of descriptions and speech, this chapter deals with more specific aspects of the speech. The semantic contents of location descriptions are now considered while categorising descriptions into various types and sub-types. Descriptions involve the construction of abstract schemes where spatial networks are transformed into some mental conception. This chapter considers the underlying way that subjects refer to positions on the maze and the meaning behind their descriptions.

Many experiments have been carried out where subjects are requested to describe points in spatial arrays, indicating a variety of ways that this may be done. However, the general finding is that these fall into a few major categories. Section A. reviews some of this research and focuses on an adult study by Garrod and Anderson (1987) who used the same computer maze-game as used in this thesis, while section B. and C. examine the semantic contents of the descriptions generated from children playing the computer maze-game.

A. GARROD AND ANDERSON'S RESEARCH ON ADULTS

Garrod and Anderson (1987) analysed dialogue from 28 pairs of adults playing two computer maze-games each. They discovered a variety of ways that maze points were described, however, pairs of speakers appeared to entrain each other such that they would end up using the same particular descriptive strategy. Thus, between different pairs of subjects there were a range of descriptions used to describe positions on the maze, however, within a pair of subjects their descriptions were extremely similar.

1. DESCRIPTIVE CATEGORIES

On the basis of the 1356 descriptions generated in their experiment, four different basic schemes were found for describing points on the maze. Each will be explained in turn, and then adults' preference for each category.

1.1 LINE TYPE DESCRIPTIONS

Line type descriptions involved describing some line of nodes on the maze, and then the maze position with respect to this line. In this case the overall shape of the maze is viewed as a structure of parallel lines which may be numbered from one end to the other. Lines may refer to a horizontal, vertical, or diagonal alignment of nodes, followed by the position of the point on this line. Furthermore, these were not always referred to as a "line" of nodes, and it was common to use row or level to the same effect. Thus the terms used to define the line were not important, rather, the underlying concept of the definition of some line of nodes on the maze, followed by the position on this line. For example, referring to point Z on Figure 5.1 in terms of this category:

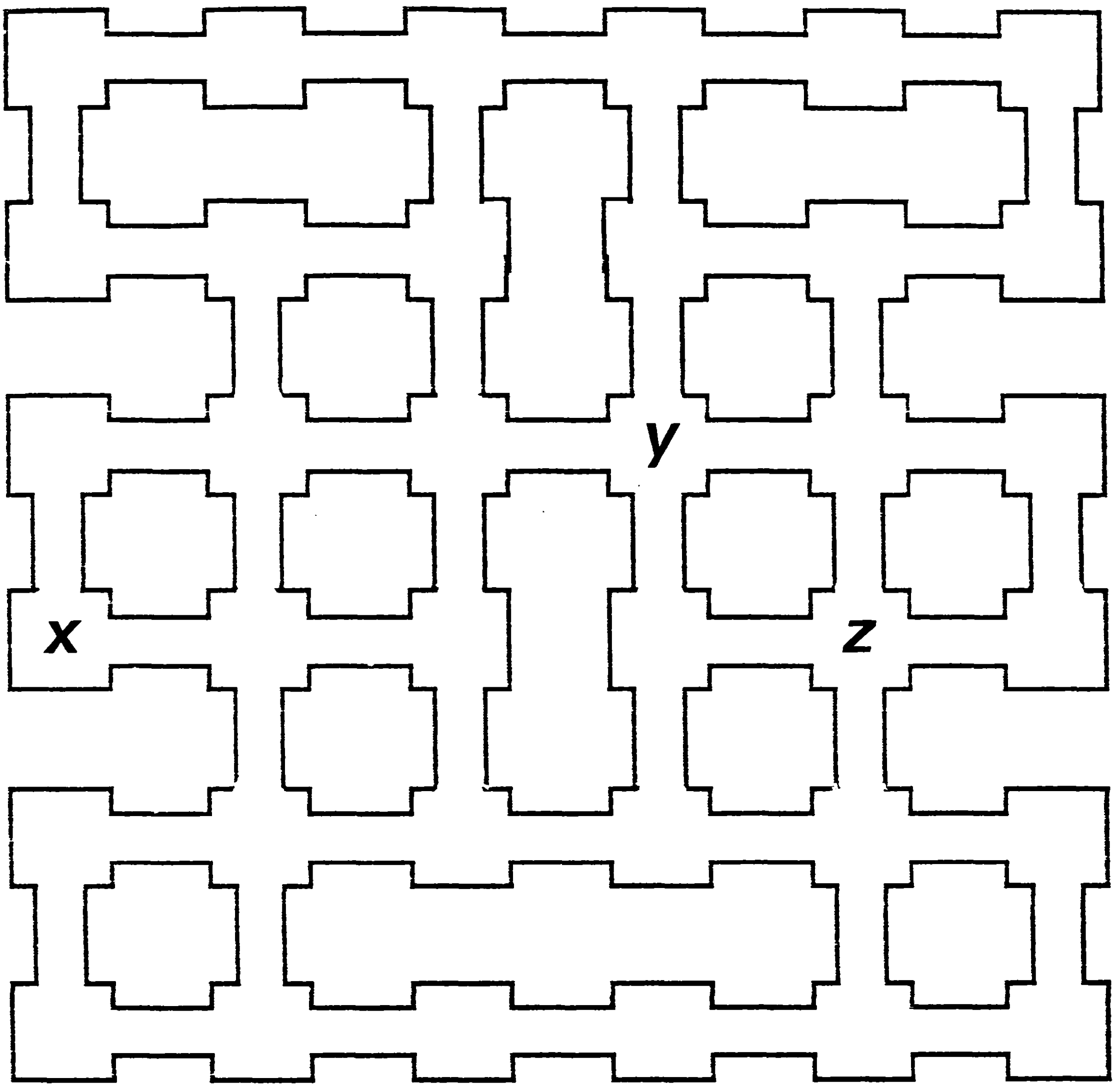


FIGURE 5.1 HORIZONTAL ROW TYPE

"I'm on the third level, second from the right".

In this instance the subject is treating the maze as an array of parallel horizontal lines, counting the first bottom horizontal line as the first one. In the third row there are gaps between several nodes, however, these gaps are ignored and an overall structure of lines is readily imposed onto the maze. In general the subject has to interpret the maze as a global configuration of lines in this rather abstract way, where they have to define the line number and impose a pre-defined code onto the maze.

1.2 PATH TYPE DESCRIPTIONS

Path type descriptions manoeuvre the listener through the actual maze pathways to the destination point. Generally a starting point was specified and then details of each step towards the point. For example, for position Z in Figure 5.1:

"See the bottom right, go along two and up three, that's where I am".

According to this category the listener would locate the starting point and then follow the speaker's directions along each path to the desired point. Path type descriptions follow the actual paths on the maze, acknowledging any gaps and abiding by exact routes. For example for point X on Figure 5.1:

"From the bottom left hand corner go along one to the right, then go up two, and then go along one to the left, and that's where I am".

In this case subjects were aware of gaps and unwilling to ignore them, thus they were carefully bypassed which increased the description length. This increases awareness of the basic shape and structure of the maze and relies on a tour of the actual maze paths.

1.3 CO-ORDINATE TYPE DESCRIPTIONS

This category consists of describing two lines of nodes on the maze, whose intersection is the point to be described. The maze has to be mentally organised into a set of abstract lines, where some particular coding scheme is established for designating the rows and columns. For example, to describe point Y on Figure 5.1 as:

"I'm on the third row and fourth column"

or

"I'm at C four".

With this scheme the interlocutors would generally negotiate the code to name each row and column. This notation is often similar to the Cartesian co-ordinates in mathematics where an overall abstract structure is imposed on a grid for naming points efficiently and unambiguously. Thus points would be described by giving two details, one for the row and one for the column and the intersection defined the point. As well as this, some origin point is required from where rows and columns are coded. Thus given the above code of C four, the listener would begin at this origin point and find row C, for example, and then column four, and locate the intersection.

These descriptions involve further abstraction from the maze than line type descriptions, since they impose a set of lines and columns on the maze, and ignore gaps and actual pathways. For example, gaps are often filled by imaginary locations in order to code the maze in the desired co-ordinate way.

Co-ordinate type descriptions are thus more difficult for both speaker and listener to formulate, since firstly an overall code for rows and columns has to be negotiated, and secondly be remembered by both participants throughout the game. The speaker must encode the point into this notation, while the listener decodes the description using the initial code. In this way, more pauses for thinking, as well as counting aloud would be expected during the encoding and decoding stages as compared to the other three descriptive types.

1.4 FIGURAL TYPE DESCRIPTIONS

With figural type descriptions a reference is made to some configuration of nodes in the maze which form an identifiable visual pattern and then the point described relative to this figure. Thus communicators have to identify some, often complex, pattern of nodes on the maze and then find the point from this. For example, to describe point Z in Figure 5.1 as:

"See the middle right indicator, well I'm on the left of it".

In this way, unique parts of the maze shape are selected and described in metaphorical terms, and then the particular point relative to this shape. The point is then generally described within the figure in terms of path type descriptions.

2. ADULTS' PREFERENCE OF DESCRIPTIVE TYPES

These four descriptive types discovered by Garrod and Anderson (1987) are summarised in Table 5.1. Each descriptive type relies upon different conceptions or mental models of the maze onto which language may be interpreted. For example, path descriptions depend upon a path network model of the maze, whereas line and co-ordinate descriptions rely on a set of models in which collections of nodes are organised into horizontal, vertical or even diagonal vectors. On the other hand, figural descriptions require communicators to identify complex patterns of nodes such as "T-shapes" or "rectangles" or "right indicators". To this extent the various descriptions are both conceptually and semantically distinct from each other.

Anderson (1983) argued that the four categories contain implicit or explicit procedural components where the descriptions give tacit instructions on how to visually scan the maze. He found evidence that while subjects generated certain descriptions, and listeners interpreted them, they often followed the procedural explanations from the four descriptive categories, tracing the schemes on the maze with their pen or finger.

From the total of 1356 descriptions, Garrod and Anderson discovered that adults had a preference for path type descriptions. 39% of the total number of descriptions were path type, while line and co-ordinate type descriptions were equally common, each comprising 23% of the total number of descriptions. Figural type were the least common, comprising 17% of the total descriptions.

TABLE 5.1

LINE TYPE DESCRIPTIONS

Some line of nodes on the maze are described and then the position of the point with respect to this line

PATH TYPE DESCRIPTIONS

The listener is instructed on a starting point and then taken through the maze pathways to the destination point

CO-ORDINATE TYPE DESCRIPTIONS

Two lines of nodes on the maze are described whose intersection is the point being described

FIGURAL TYPE DESCRIPTIONS

A reference is made to some configuration of nodes in the maze which form an identiafiable visual pattern and then the point described relative to this figure

3. REGULARITIES IN DESCRIPTIVE SCHEMES

Some of the descriptive categories found by Garrod and Anderson have been reported in other situations where subjects describe points in spatial arrays. For example, Linde and Labov (1975) carried out a monologue experiment where residents of New York City had to describe the layout of their apartments. Analysing 72 layout descriptions, they concluded that people basically use fairly consistent patterns to assist them in describing spatial arrays.

Linde and Labov noted two main ways that subjects described their apartments. The most popular type they named the "tour", which comprised 97% of the descriptions. In this descriptive type the apartment was described by a minimal set of paths by which each room could be entered. The listener was taken on an imaginary tour around the apartment, where spatial layouts were transformed into organized, linear descriptions. For example:

"You walk into a long, narrow foyer, leading into a smaller, squarer foyer eating place, dinette-area.
And uh to the right is my kitchen,
and uh to the left my living room..."

Evidence for this has also been stated elsewhere such as Klein (1981), and Garrod and Anderson(1987). For example, Garrod and Anderson found many instances of path type descriptions in their analysis from the complex array of the computer maze. Subjects began their description from a pre-determined starting point and described through the maze on a detailed tour, to the point in question.

The second type of description that Linde and Labov observed from the monologues was the "map" which constituted 3% of all the layouts given. This was a global description of the apartment, which was further analysed into more detailed local descriptions by top down processing. For example:

"I'd say it's laid out in a huge square pattern, broken down into 4 units... Now on the ends -uh- in the two boxes facing out in the street you have the living room and a bedroom."

This was similar in certain respects to Garrod and Anderson's figural category where subjects first described some readily identifiable pattern or metaphorical shape on the maze, and then their position relative to this shape.

Concentrating on the predominantly tour type descriptions, Linde and Labov noticed that this category could be further divided into sub-sections. For example, within the tour descriptive strategy people generally began describing their apartment from the front door. When they reached a fork they described one branch first, and then jumped back (in one step) to the fork and described the next branch.

These patterns were fairly consistent, leading Linde and Labov to conclude that there are certain broad similarities in the way spatial arrays are described.

Levelt (1982) found similar results while investigating descriptions of spatial networks. He was primarily interested in linearization, and how subjects organize information in a structured way. Previous work had shown that subjects use consistent strategies in linearization.

Levelt asked subjects to describe simple spatial two-dimensional networks. Starting from the arrow on the array on page 118, the subject had to describe the spatial network to enable a listener to draw the network when later presented with the description on audio tape. The listener was familiar with the spatial array and had previously seen the example networks. There were three types of structures used - linear, hierarchical, and loops. The linear structure contained a line of dual nodes, with two single nodes at each end, whereas the hierarchical networks consisted of triple or quadruple nodes (choice points for the subjects to describe), and the loop involved nodes connected by all points. Thus in effect subjects had to change this two dimensional input into a linear description - organizing the information in a step by step categorical way.

Levelt proposed that the linearization process occurred in two main ways for generating descriptions, one being predominantly 'speaker-oriented' (which Linde and Labov had discovered), and the other predominantly 'listener oriented.' In the 'speaker-oriented' model, subjects described points by following a tour of the array, where each point was closely connected and followed accurately. Where forks occurred in the diagram, subjects would describe one fork first, and then go back to the other point in one step. The difference with the 'listener-oriented model' is here, subjects did not simply jump back to the unfinished point, but, meticuously retraced their steps, one by one, thus lengthening the description by anything up to 50%. This would assist the listener further in replicating the model.

Levelt's experiment confirmed that the two main linearization models outlined earlier, existed and were distinct linearization types, since 33 out of 53 subjects exclusively jumped back to the unfinished choice points, and 16 out of 53 exclusively moved back step by step. Levelt's work also reported instances of path type descriptions in situations where people describe simple spatial arrays of nodes, of a sort similar to those used in the maze-game.

This previous work on descriptions in monologues does not seem to have elicited the wide range of descriptive schemes found by Garrod and Anderson in their dialogues. This may be due to the relatively simple spatial arrays used to elicit descriptive strategies, compared to the complex mazes used in the computer maze-game. As well as this, the lack of communication may prevent subjects from developing schemes further and using varied descriptive types. In addition, people may regard the task of describing their apartment as a relatively simple and familiar one, and may not feel the need to develop complex descriptive schemes to relate this information. Another factor contributing to the apartment descriptions would obviously be the size of the array to describe. These reasons may explain the difference in the range of descriptive types found.

The next section considers the descriptions generated from children playing several computer maze-games and investigates the range and type of descriptions found.

B. CHILDREN'S DESCRIPTIVE CATEGORIES

1. INTRODUCTION

This section investigates the type of descriptive categories generated by three age groups of children playing two or three computer maze-games (see page 166). This was performed by two independent judges reading over all the dialogues, comparing and contrasting different descriptive schemes, and recording their verdict of what categories were involved. The adult categories discovered by Garrod and Anderson (1987) were useful as a comparison, but were not used as an initial starting point for the children's descriptions. For example, it was interesting to note any differences with the adult group and whether the children would produce a broad spectrum of imaginative descriptive types, creating particularly unique co-ordinated codes, or would they find it difficult to engage and converge on joint language codes to efficiently describe points on the maze. Perhaps the 8-year-olds would exhibit egocentric qualities and be unable to venture into joint language systems evidenced by a limited amount of categories.

This analysis deals with the meaning of the various terms used to describe locations and any broad descriptive categories that may emerge by noting any consistent patterns.

Firstly an explanation of what qualifies as a description will be given followed by an outline of the basic descriptive categories that emerged from the transcripts.

2. DEFINITION OF A DESCRIPTION

A description was classified as, ideally, everything from the initial request of a position on the maze, to the successful conclusion and confirmation of this information. For example, for two players A and B the following would be classed as one full description:

B: Look where are you?

A: Right + first row on the fourth box

B: Oh + so you're down there (10 years old)

In this case player B initiated the description by requesting A's position, A provided the information, and B confirmed their understanding of the point. Thus a description encompassed both subjects contribution until players changed to another topic of conversation. For example, the following would be classed as one description:

A: Where are you now?

B: Well see the bottom left-hand corner?

A: Ehm yeh

B: Go 2 boxes along

A: Which way?

B: Ehm to the right

A: Yeh

B: Then up 2 boxes

A: Yeh

B: And that's where I am

A: Ok I've got you (10 years old)

However, descriptions were not always as neatly packaged as this and often offered without any initial requests. For example:

A: The monster's gone up

B: 'cos I'm at the bottom row three, up four + just
+ I'm in the box of my star (12 years old)

In this case B's total contribution was counted as the description since it appeared unconnected to player A's last utterance and was not followed by any affirmation. At the other extreme, some subjects followed each others positions on the maze throughout the game stating where they thought their partner was after each move.

It was noted that several of the descriptions provided partial instructions, yet some vital information was omitted on how to uniquely identify the point. However, these partial descriptions could be identified with one of the descriptive categories. For example:

B: Oh where are you?

A: I'm + on the second bottom line

B: Second bottom line?

A: Well it's not the last bottom line it's the one before

B: I know (8 years old)

This information was accepted as a description unit. 26 of the 8-year-olds' descriptions were of this partial type, compared to 13 from the 10-year-olds, and 11 from the 12-year-olds. A 2x2 Chi Square test was performed with age as the independent between subjects variable and the number of partial descriptions as the dependent factor, normalised for the total number of descriotions generated for each age group. The Chi Square value was 18.75, which was higher than the critical value of 9.21 at the 0.01 level of significance. So age was significantly affecting the number of partial descriptions generated with less occurring in the older children. There were 24 very partial descriptions which were a slight attempt at a description, yet these were not coded since they did not provide sufficient information to be classed as any particular type (16 in the youngest age group, 7 in the middle age group, and 1 in the oldest group of children).

Each utterance within a description was not coded, only the overall description that emerged. For example, if player A gave a description, and player B repeated it, or added some information, this was not coded as a separate description but part of the whole descriptive unit, that of player A's contribution. For example the following description would be classed as a line one (see page 210), attributed to player B:

B Right I'm down, I'm on the bottom, second in + right?
Right + on the bottom storey?
A Right, bottom storey, second box, and you can't move to
the right? (12 years old)

This whole unit was classed as one description including both A and B's contribution with a total number of 27 words. Player A's contribution is included in the whole descriptive unit, since it is seeking confirmation of the point.

3. DESCRIPTIVE ANALYSIS PROCEDURE

14 pairs of 8-, 10-, and 12-year-olds participated in the study where each pair generally played three maze-games (6 pairs played two games due to time restrictions with their school). All dialogue was audio-taped, excluding the practice games, and full verbal transcripts made including sighs, laughs, uhms and ers. Pauses within contributions were not measured and simply marked by a + since these were not the main focus of attention in this thesis. The use of a four-track audio-tape recorder enabled each player's contribution to be easily identified on separate tracks.

There were a total of 121 dialogues which generated 1332 location descriptions - 334 descriptions in the 8-year-old group, 436 in the 10-year-olds, and 562 in the oldest group.

These descriptions were then abstracted and analysed in terms of their semantic and pragmatic qualities. Thus for each pair of subjects their descriptions were highlighted and transferred to a separate sheet for detailed analysis, as well as any associated dialogue, such as explicit negotiations of descriptive codes.

Two independent judges - Dr. Simon Garrod and myself - each independently analysed the 1332 descriptions comparing and contrasting descriptions and looking for any broad similarities between some, yet which were fundamentally different from another set of descriptions.

Each age group was analysed separately, as well as looking for any broad similarities or differences that may emerge between the groups. Both judges recorded their verdict of what type they thought each description was. This was performed independently of Garrod and Anderson's (1987) adult classification scheme, since there was no reason to presume that children would describe maze locations in a similar way to adults. There was a high level of agreement between the two judges, and those few disagreements, which accounted for 3% of the total descriptions, were dealt with by detailed discussion. While discussing these disagreements there did not appear to be any argument for additional categories over and above the ones considered.

From casual inspection of the data, it was discovered that subjects used fairly consistent patterns to describe maze locations. A number of frequently used, similar descriptions emerged which could be grouped together and contrasted with the other categories in some fundamentally different structural way. These categories were similar in form and structure to the descriptive strategies found by Garrod and Anderson (1987) from an adult sample. However, the categories were specific to children since they were of a different quality and type.

Each descriptive category differed from the others in the way that they conceptually coded the maze-shape and interpreted its pattern. In effect each descriptive type denoted a different formula, whether implicit or explicit, of how to interpret the maze-shape.

There were two main descriptive categories, and two less frequently used categories, that emerged from the children's dialogues, which will be explained below along with numerous examples from the transcripts. A systematic list of features was prepared for each descriptive category, which documented the boundaries within which the description should fall, and which discriminated it from the other categories. Each category was by no means exhaustive or uniquely defined, and within each were a variety of ways that points may be described. For example, within the line type category there were four sub-types of line type descriptions. As well as this, descriptions varied in terms of the number of words, and interactional contributions, as indicated in Chapter 4.

3.1 LINE TYPE DESCRIPTIVE CATEGORY

The most common category to emerge from the transcripts was a line type one, which appeared similar in form and structure to the line type category discussed by Garrod and Anderson (1987) in adults (it composed 23% of adults' descriptions). From a total of 1332 descriptions generated by the children, 637 (48%) were classed as line type.

The features associated with this descriptive category involved:

1) the speaker referring to some line of nodes on the maze, whether it be a vertical or horizontal array of nodes

2) and then specifying the position of the point with respect to this line.

This category rests on the assumption that the maze is viewed as a series of distinct parallel lines in an abstract way, where less detail is paid to the individual paths and gaps between nodes but rather to the overall linear shape of the maze.

Some examples of these from the children's dialogues will be given below to give the reader a clear conception of this category.

B: Where are you?

A: Well I'm in the third line down

B: Right

A: And the + fifth box along

B: From what side?

A: From the left

B: Right (8 years old)

In this example B initiates the description by requesting A's position on the maze, and A replies by firstly referring to a line on the maze, and secondly, to their position with respect to this line. In this case B has asked for clarification of where they are calculatong the point from. However, this was often the exception rather than the rule and was generally implicit.

On some occasions the 8-year-olds described line type descriptions by 1) alone, which were accepted by their partner. For example:

PAIR 6

A I'm stuck I'm stuck I'm stuck

B Where?

A I am on the + last + I am on the last line + right?

A I am on the + second line + you know how there's 1 2 3 4 5 6 + you know how there's 6 lines + I am on the + fourth line on the left

PAIR 13

B Lorna where are you?

A I'm + eh in the third line down + oh it's my turn to move just now

Thus it was not clear whether they were aware of the need for the unique identification of a point, and how much information was required.

3.1.1 HORIZONTAL LINE TYPE

Within the line descriptive category, the term line could refer to either a horizontal or vertical alignment of nodes. For example, horizontal line type views the maze as a series of parallel horizontal lines where gaps in a horizontal line are filled by imaginary nodes and less detail is afforded the vertical plane (see Figure 5.2). 62% of the total number of line type descriptions were horizontal line type. This was expected, since the terms line or row generally evoke a horizontal image and most subjects referred to a horizontal alignment by the terms row or line. However, a few pairs referred to this as floor, layer, storey, or level. For example:

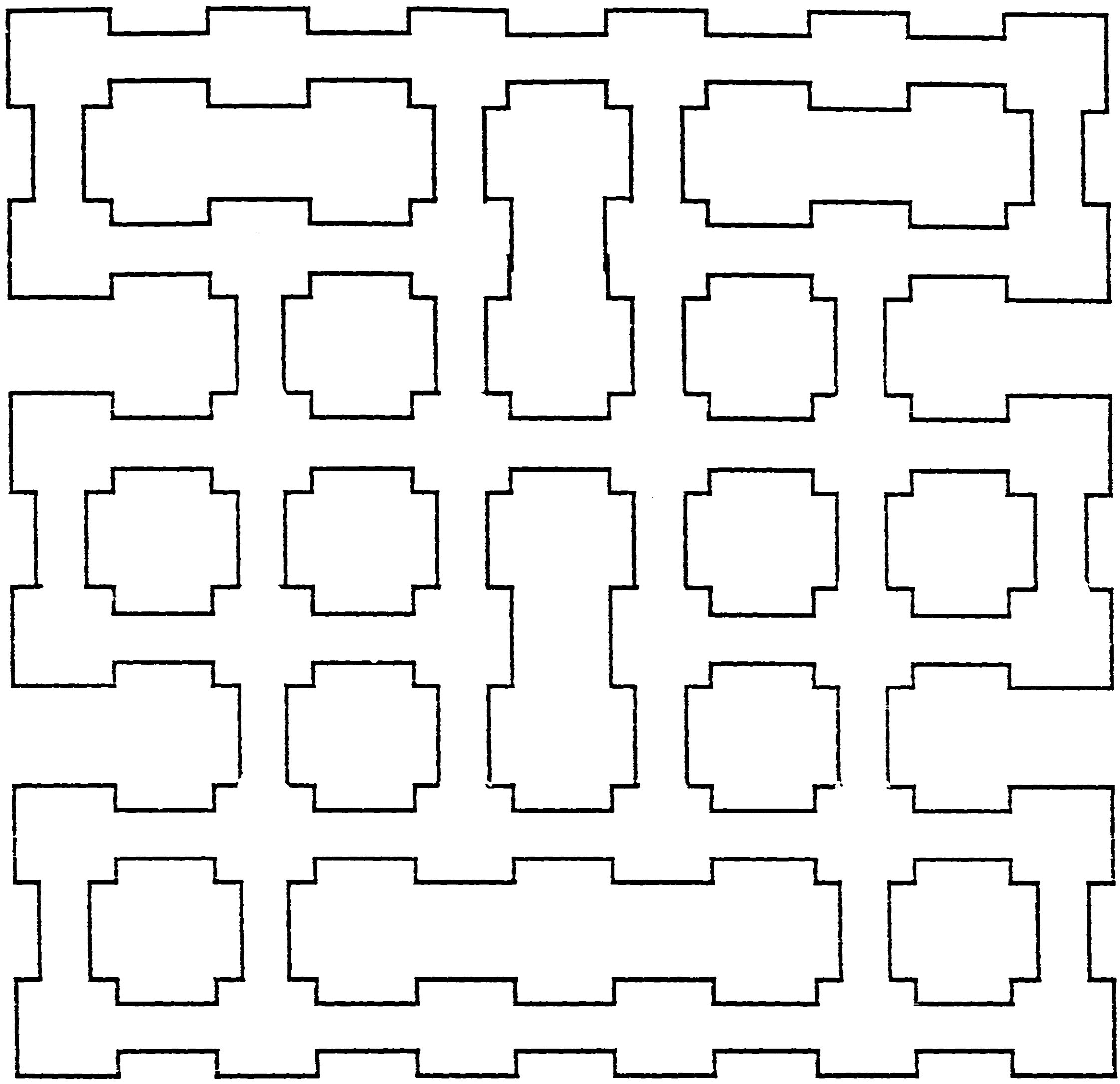


FIGURE 5.2:HORIZONTAL ROW TYPE

A I'm on the first storey ok?

B No

A Right we'll call them storeys ok?

B Right + I'm on the second storey

A Right I'm on the second storey

B Which is the first + boxes + first floor

A I'm on the very left

B You're on the very left where I've got a box?

A Right

B And I'm on the first storey, no second storey

A Right and

B One from the edge

A So you're the second storey and second box?

B Uhu (12 years old)

In the 8-year-old group there was only one instance of a 'floor' type description, compared to the 10-year-olds where 2 pairs of children used 'layer', and one 'floor', and the oldest group where one pair of subjects used 'storey' on 23 occasions, four pairs used 'floor' on 18 occasions, and one pair used 'level' on 3 occasions.

3.1.2 VERTICAL LINE TYPE

In the next examples of line type descriptions the maze was perceived as a series of parallel vertical lines where less detail is afforded the horizontal plain, or the actual gaps or paths between nodes. For example:

PAIR 9 10 years old

A: I've got to know where you are

B: Well + right you know down the way?

A: Where I am?

B: No in columns + you know in columns?

A: Uhu

B: Well I'm in the second column

A: Uhu

B: And I'm in the second square starting from the top

A: Right

A: Where are you?

B: I'm + I'm in the third column down the way in the
second box down the way

A: Well + you're in the third column, the second one from
the top

B: Uhu

Subjects have imposed a line on each vertical alignment of nodes whether it be broken by gaps or not (see Figure 5.3). In the first description B has explicitly negotiated the meaning and interpretation of their description. For example, B explains 'down the way' in

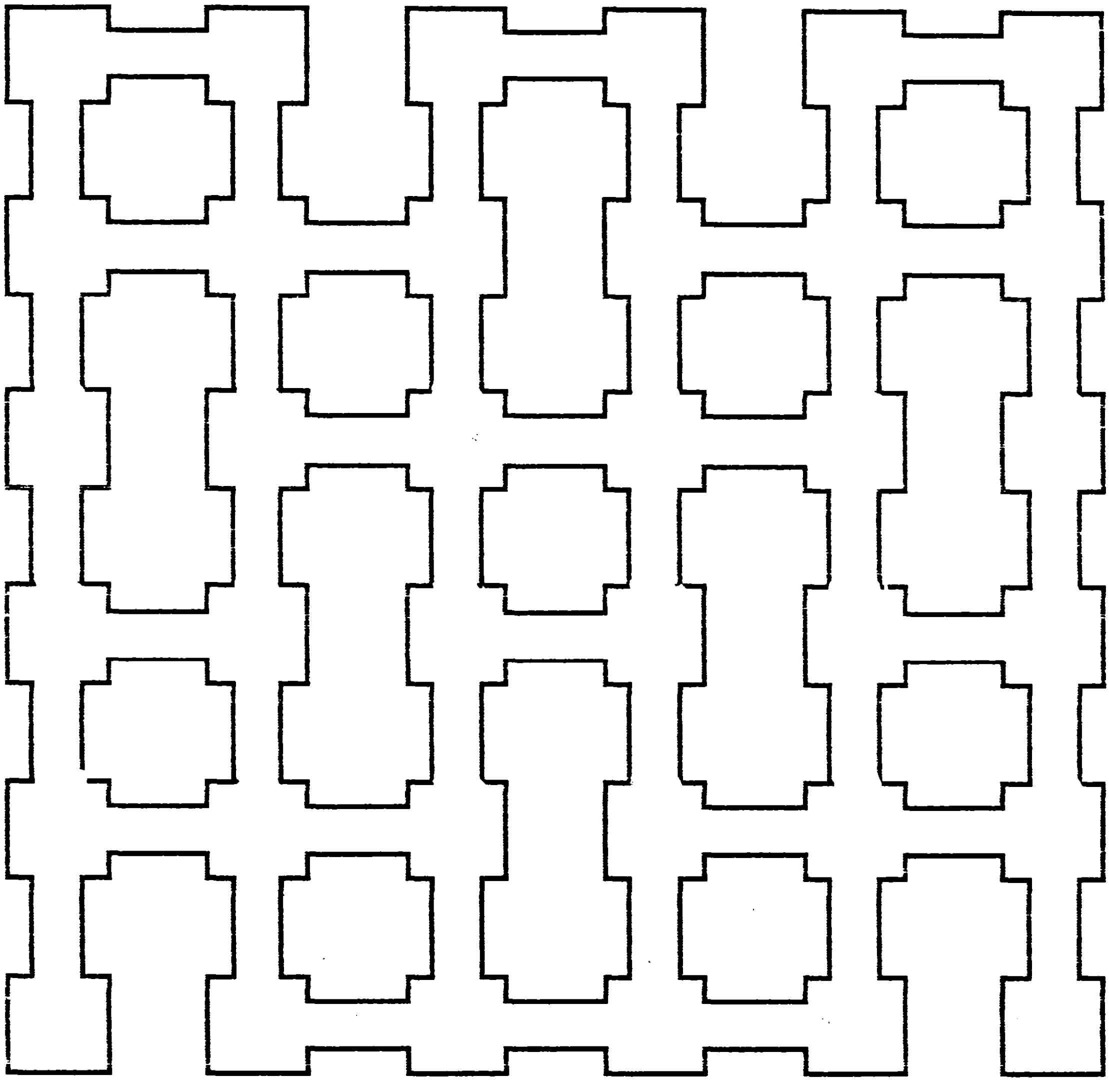


FIGURE 5.3: VERTICAL COLUMN TYPE

columns. In the next description, B now shortens this to column number, and position on the column, and later A also adopts this descriptive style producing the column number and location. Thus a descriptive scheme has been initiated, negotiated to a more efficient form, and utilized by both players to describe positions on the maze. 20% of the 637 line type descriptions were of the vertical line type.

3.1.3 UNCATEGORISED LINE TYPE

In the following examples of line type descriptions, it was not clear whether subjects were referring to the horizontal or vertical plane. This type of description was classed as uncategorised line which could refer to either plane. For example:

PAIR 2 8 years old

B: Tell me where your s's are?

A: Up in one of the left corners

B: Which row?

A: Eh + first row

A: You're on the second line, second from the top?

B: I'm on the second line + fourth box.

15% of line type descriptions fell into this sub-category where it was not definite whether the line description was of the horizontal or vertical type.

3.1.4 LINE/FIGURAL TYPE

It was noticed that some line type descriptions had several similarities with the figural descriptive category (see later), however, on closer inspection they were predominantly line type and may be a part of a transition from figural into the line type mould. For example:

A You know the first line?

B Yeh + the one with two squares?

A The one with only one square

B The one with only one square?

A Aye in it. Then the line after that

B Yeh right

A On the third one

B The third one (10 years old)

From all the line type descriptions generated this sub category accounted for 3% of the 637 line type descriptions.

3.1.5 SUMMARY

Over the three age groups there were a total of 637 (48%) line type descriptions out of a possible 1332 descriptions. This was the most predominant descriptive type. Within this line type category were four subcategories which remained part of the overall line-type category since they were all associated with the identification of some line of nodes on the maze and then the position with respect to this line. 62% were of horizontal line type, 20% vertical line, 15% uncategorised line, and 3% line/figural.

3.2 PATH TYPE DESCRIPTIVE CATEGORY

The next most predominant descriptive category to emerge from the descriptions was a path type one, which was comparable to that discussed by Garrod and Anderson (1987) and composed 39% of their adult descriptions. 516 (39%) of the children's descriptions from a total of 1332, were of this type. The features associated with this category involved:

1) stating some origin point on the maze

2) manoeuvring the listener on a mental tour of the maze, step by step, and following the actual maze pathways and gaps to the destination point.

This descriptive type differs from line or co-ordinate type, since it relies on the actual structure of the maze while adhering to its paths and gaps. For example, gaps in the maze structure cannot simply be ignored as they are in the line or co-ordinate descriptive type, but must be incorporated into the tour, describing their way around them. For example:

PAIR 5 12 years old

A Go to the right hand corner, right?

B Uhu

A Right you go one space along, right?

B Uhu

A Two spaces, right?

B Uhu

A Three spaces, right?

B Hold on

A Right, you're on the right hand side, right? (cont.)

B Uhu

A You move one space to the left, right?

B Uhu

A Another space to the left

B Uhu

A Another space to the left

B Uhu

A Stop, right?

B Uhu

A Then you move one space up

B Uhu

A One space up

B Uhu

A One space up

B Uhu

A That's where I am, right?

B Right

<u>PAIR 11 8 years old</u>

A Right where are you?

B I'm + right see the left top corner?

A Yes

B Two down

A Hmm

B One along

A Uhu

B Another one along and I'm in that one

Although subjects may be referring to maze paths, nodes, or larger configurations of squares, they generally counted the nodes joined by paths. From these examples we can see that the children take path type descriptions very seriously indeed. The speaker begins by stating an initial point, that is the right hand corner in the first example, and the left top corner in the second example, and describes each path until they reach the point in question. In addition, the speaker often seeks confirmation from the listener after each piece of information. In this way information is given in small incomplete pieces such that the processing demand is more manageable. This feedback may be important to enable the speaker to dismiss the last stage and concentrate on the present one, without having to keep track of each step they have described.

In some cases children failed to state their initial starting point, yet on the whole an origin point was generally given as one of the corners. For example:

PAIR 6 10 years old

B Where is your star?

A See four down on the left-hand side?
Right, then two to your right

PAIR 1 8 years old

A Right, on the left-hand side corner two down

B Right

A And see the bottom one, well count that as number one,
and then go three along, the very end, got that?

B Right

From this we see that path type descriptions require little pre-negotiation and may proceed with only reference to some initial starting point on the maze. These descriptions do not require much processing or abstraction from the maze and simply involve what players see in front of them.

3.3 CO-ORDINATE TYPE DESCRIPTIVE CATEGORY

The third type of descriptions which were evident in the transcripts involved a co-ordinate type, which was also independent from the other three categories in terms of the underlying conceptual structure. The components of this category involved:

1) the speaker stating two sets of orthogonal lines on the maze, one for the horizontal plane and one for the vertical

2) and the intersection concerned the point being described.

The maze is now conceptualised as a set of abstract lines with some coding system imposed on each row and column. Thus, points on the maze would be described as the intersection of two pieces of information. In the true sense of the description, some origin point should be given from where the descriptions are coded, yet this was not the case with the children's descriptions. Co-ordinate descriptions should thus begin by explicit negotiation where interlocutors specify the coding system they would use. For example:

PAIR 9 12 years old

A We're calling it lines OK? So we're calling it line1, line2, line3, and line4, OK?

B Right + I'm in line1,2 + I'm in line2, one up + so I'm one from the bottom, right?

Thus the coding system has been negotiated and devised leading to the simple co-ordinate descriptions of:

B I'm on the second line in, right? On the second storey, right?

A Right

A Where are you?

B I'm in the + second up, and 1,2,3,4th, 2,4 + 2,4, 2 up and 4 at the very right hand, OK?

A Now wait a minute + you're in the second box, second storey?

B Uhu

This descriptive type ignores the actual maze paths and gaps, and imposes a set of abstract rows and columns onto the maze, each one numbered or coded such that each location has a unique address. In this way any point may be referred to unambiguously by simply giving the name of two lines on the maze. This more complex language category requires negotiation of a suitable code, then to encode each description into this established system, and to decode the description into the maze location. In this way processing demands are high and much forward planning is involved.

The category of co-ordinate descriptions found in the child sample appeared to be a simplified version of that found by Garrod and Anderson from their adult dialogues, and could be referred to as simple co-ordinate, as seen above. Two positions of lines were given, yet they were seldom associated with the negotiation and formation of some joint code at the onset of the game. For example, each horizontal row and vertical column did not have a pre-negotiated name, such as rows 1 to 6, columns A to F. The children discussed lines and calculated locations through a straight forward counting procedure, such that less abstractions and coding was necessary. For example:

PAIR 4 12 years old

B I'm on the second line in, right? On the second storey right?

A Right, on the second line.

A And what box are you in?

B I'm in the second, second, 2, 2.

B Where have you got an s near where I am, 'cause I'm on the second, third?

A Ready + eh eh

B You'll have to move into the second, second

A No I can't, where are you + are you on the second + third?

B Uhu

A And moving into the second, second?

B I can move in there once

PAIR 14 12 years old

B Right + I'm in my goal + look tell me where you are?

A I am in the 1,2,3,4th down + 1,2,3,4th in

B Where are you?

A I'm in the + 1,2,3,4

B Just say 4,4 + you can look at it easily enough

A I'm in 4,4

B Right and I'm in 5,4 + OK?

A Right

Thus each row and column was simply counted in this way. Furthermore, co-ordinate type descriptions were more common in the 12-year-old group than the two younger groups. For example, 3% of the 8-year-olds descriptions were of this type, compared to 11% of the 10-year-olds and 17% of the oldest groups.

In the adult descriptions 23% were co-ordination type, the second equal most popular descriptive category, supplying an efficient and economic coding system, while this category composed 6% of the children's descriptions.

3.4 FIGURAL TYPE DESCRIPTIVE CATEGORY

The fourth category to emerge from the descriptions was a figural type which comprised 7% of the total descriptions. This descriptive type was similar in form and structure to Garrod and Anderson's (1987) category and accounted for 17% of their adult descriptions.

The features associated with this category concerned:

1) the speaker referring to some configuration of nodes on the maze which form some identifiable structure

2) describing the point relative to this figure, generally in a path type way.

Two sub types of figural type descriptions emerged from the children's descriptions, where they described points in either a global or local way.

3.4.1 GLOBAL/FIGURAL TYPE

In global/figural descriptions the whole maze shape was taken into consideration and then the point relative to this, such as:

PAIR 10 8 years old

A Where are you?

B I'm in the + on the left box next to my goal

A In the left box + is it round the edge or near the middle?

B Eh it's on the second floor from the bottom, in the middle

PAIR 12 8 years old

A Could you + if you eh + how many boxes are you along
from the very end?

B What end?

A Bottom

B End + what do you mean by end, edge of the side?

A Uhu

B Two

A Two boxes

3.4.2 LOCAL/FIGURAL TYPE

Local/figural descriptions on the other hand involved describing a specific part of the maze and then the position of the point relative to this shape. For example:

PAIR 5 12 years old

A Right I'll tell you where I am, right you know how
there's a wee bit at the top?

B Yeh

A The top left hand side, right?

B Uhu

A Then it's like a figure 8

B Yeh

A Right + well the bottom of the figure 8

B Oh ehm

A On the left hand side, I'm in there

B Right well

B Where are you the now?

A Right I'll tell you, right see the figure 8?

B Yeh

A Right I'm at the end of it + right three up + at the very corner on the + right hand side

B Oh yeh

PAIR 2 10 years old

B Where is your cross?

A My cross is + do you know the very left, right? There's sort of two bits going + well the last row of boxes down, right?

B You mean on the + on the left-hand side where there's something like a bone?

A Aye yes

B You mean on the top row where there's one going upwards + sort of like a bone going upwards?

A Yeh

B Yeh, right there, you're there are you?

Out of the total 1332 descriptions, 7% were figural type descriptions, and from this overall total, 57% of the figural type descriptions were of this local type, and 43% of the global type.

3.5 DISTINCTIONS BETWEEN CATEGORIES

These four descriptive categories indicated different ways that subjects chose to describe points on the maze. They were viewed as distinct from each other since each type leads to a different set of simple operations which are used as a basis for producing or interpreting spatial terms. For instance, each descriptive type delivers information on how to locate points on the maze and imposes restrictions on how this may be done.

While classifying each description a set of questions were asked which appeared to differentiate the four categories sufficiently from each other.

1) Does the description involve a line of nodes from the maze?

   If the answer is yes, then the description may be line, co-ordinate, or figural. To differentiate between these three categories the following questions were then asked:

   a) Does the description refer to a point on this line?

      If the answer is no, then move to question b). If the answer is yes, then the description is line type.

      The following questions were then asked:

      (i) Was the line a vertical one?

         If the answer is yes, then the description is vertical line type. If the answer is no, then:

      (ii)Was the line a horizontal one?

         If the answer is yes, then the description is horizontal line type. If the answer is no, then:

(iii) Could the line be either horizontal or vertical?

If the answer is yes, then the description is uncategorised line type. If the answer is no, then:

(iv) Was the line referred to by way of a figure?

If the answer is yes, then the description is line/figural type. For example, "the middle", or "it's sticking out on own its own".

b) Does the description then refer to an orthogonal pair of lines on the maze?

If the answer is yes, then the description is co-ordinate type. If the answer is no then:

c) Does the description then refer to a configuration of nodes relative to this line?

If the answer is yes, then the description is figural type. The following questions then apply:

(i) Does the description refer to a specific local figure on the maze?

If the answer is yes, then the description is local/figural type. If the answer is no then:

(ii) Does the description refer to a global figure of the whole maze?

If the answer is yes, then the description is global/figural type.

2) Does the description refer to some configuration of nodes on the maze?

If the answer is yes, then the description is figural type.

The following questions were then asked:

a) Does the description refer to a specific local figure on the maze?

If the answer is yes, then the description is local/figural type. If the answer is no then:

b) Does the description refer to a global figure of the whole maze?

If the answer is yes, then the description is global/figural type.

3) Does the description begin with reference to an origin point?

If the answer is yes, then the description may be co-ordinate or path type.

The following questions were then asked:

a) Does the description then supply two pieces of information one relating to the vertical plane, and one to the horizontal plane?

If the answer is yes, then the description is co-ordinate type. If the answer is no, then:

b) Does the description supply a step by step account of the direction through the maze, while acknowledging gaps and actual maze pathways, to the destination point?

If the answer is yes, then the description is path type.

These three main questions were able to account for all the full descriptions generated from the maze-games. There were several tricky cases which will be explained in more detail below.

For instance, the children's simple co-ordinate descriptive type should not be confused with path type descriptions of the following type:

"Go one along and one up"

since if one looks at the diagram in Figure 5.4, we see that the point Y could be described in path type descriptions as above or:

"It's two along and one up".

However, as a co-ordinate type description could be referred to as:

"It's two along and two up" but not as
"It's one along and one up"

Co-ordinate type descriptions take the horizontal and vertical planes independently into consideration. Path type descriptions on the other hand, cannot count the vertical line as two up which would clearly differentiate these two types of descriptive categories from one another in this instance. Furthermore, path type descriptions involve traversing the actual maze pathways and thus a glance at the maze could differentiate path type from co-ordinate descriptions. For example, if there were no pathways to traverse between the points

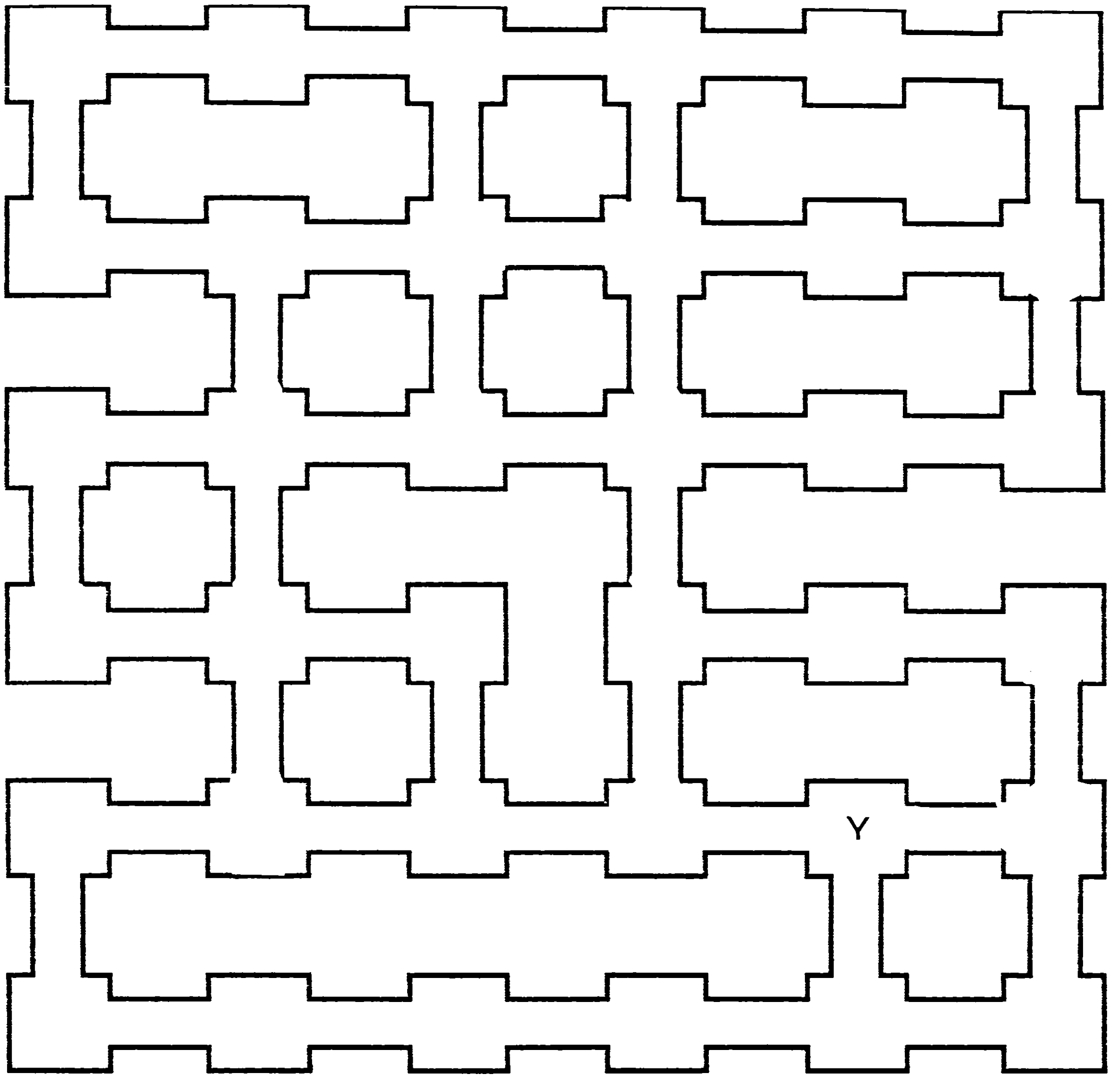


FIGURE 5.4: HORIZONTAL ROW TYPE

then it must be co-ordinate. Line type descriptions on the other hand, generally require some reference to a line first, whether it be line, row, column, floor or level. For example:

"I'm on the 1st line two boxes along".

In this way a line is required for one dimension, however, it is not required for the other one, while co-ordinate type descriptions require both dimensions to be named.

3.6 CONCLUSION

Two independent judges analysed the 1332 descriptions generated from three groups of children playing two or three computer maze-games, independently of Garrod and Anderson's (1987) adult classification scheme. Two main conceptual categories emerged for describing points on the maze spatial array (line 48%, path 39%), and two less frequently used categories (figural 7%, co-ordinate 6%). These categories were similar in form and structure to those found by Garrod and Anderson from a group of adults playing a similar version of the same specially designed computer maze-game. For example, the line type category was similar, where subjects referred to a line of nodes on the maze, and then the point on this line, and also the path type category which conducted the listener on a mental tour of the maze to the point in question.

The distribution of adults' descriptions displayed a slightly different picture from the children's pattern. For example, path type descriptions were most predominant accounting for 39% of the adults' descriptions, while line and co-ordinate type were second popular with each accounting for 23% of the total descriptions, and figural type at 17%. Thus co-ordinate type descriptions rate as high as line type, with figural type not far behind. Although Garrod and Anderson's descriptive classification acted as a good foundation with which to explore the children's descriptions, it was not used as an initial starting point. Nor were any direct comparisons made between the children's and adults' descriptive categories since there were several main differences between the experimental situations which rendered this impossible. For example, the adults' maze-games were played on a slightly different system using different maze shapes, where subjects' start and finish positions were in different positions. As well as this, the children's classification scheme was formulated independently of the adults' scheme, and specific to their descriptions. For example, the co-ordinate descriptive category was of a simplified type and more superficial than the adults' scheme based more on the wording than any underlying conceptual code.

The following section will now compare the children's semantic categories in more detail investigating subjects' preference for the various categories.

C. A STATISTICAL ANALYSIS OF THE DESCRIPTIVE CATEGORIES

1. INTRODUCTION

The last section analysed the descriptions generated from the computer maze-game and described a four-fold typology system that emerged. This section deals with a statistical analysis of these data and investigates subjects' preference for any particular descriptive scheme.

2. A SEMANTIC ANALYSIS OF LOCATION DESCRIPTIONS

The first comparison involved classifying each description in terms of the four-fold typology scheme. Thus a count of each type of description was made for each subject. Table 5.2 displays the proportion of descriptions from the total which fell into each category for each age group.

TABLE 5.2 = PROPORTION OF DESCRIPTIONS IN EACH CATEGORY

Age	LINE	PATH	CO-ORD	FIG.	Total Desc.
8yrs N=28	.35	.46	.03	.16	334
10yrs N=28	.49	.37	.11	.03	436
12yrs N=28	.47	.31	.17	.05	562

Thus in the youngest age group 46% of all the descriptions generated were path type, 35% were line type, 16% were figural, and 3% were co-ordinate.

2.1 THE NUMBER OF DESCRIPTIONS GENERATED PER MOVE FOR EACH DESCRIPTIVE CATEGORY

In order to analyse any preference for the descriptive types, the number of descriptions per move was calculated for each category, since this controls for any differences in game length. Table 5.3 displays the number of descriptions per move of either line, path, co-ordinate, and figural type, for each age group.

TABLE 5.3 = THE NUMBER OF DESCRIPTIONS PER MOVE FOR EACH CATEGORY AND EACH AGE GROUP

AGE	LINE	PATH	CO-ORD	FIG.	MEAN AGE
8yrs	.104	.111	.013	.047	.0689
10yrs	.211	.14	.044	.024	.1045
12yrs	.242	.209	.119	.041	.1528
MEAN DESCR. TYPE	.1855	.1537	.0584	.0372	

A by subjects analysis of variance was performed on the number of descriptions per move for each descriptive category. This analysis allows an investigation of any evolution of descriptions across the games, and whether there were any interactions between the age of the subjects and their preference for any particular descriptive types. The dependent variable was the number of descriptions in that category per move for each subject (ie. the number of descriptions in category N / 0.5 x the number of moves in that game). Game was a repeated measures within subjects factor, contrasting game1, with the remaining games (see page 166), and age was the between subjects independent variable.

The main effect of age proved significant, F(2,81) = 13.409 p=.000, with the means being .0689, .1045, and .1528, for the 8-, 10-, and 12-year-olds respectively. A Tukey test found the 12-year-olds to be significantly different from the 8-, and 10-year-olds, at the .05 level, yet there was no significant difference between the 8-, and 10-year-olds. These results illustrate an increase in the quantity of each descriptive type, with more descriptions generated in the older children. This result is consistent with the finding from Chapter 4, Section C, part 2. The main effect of game proved non-significant, F(1,81) = .683, thus there were no substantial changes in the number of descriptions from game1, to the later games. A significant difference was found for the main effect of descriptive type, F(3, 243) = 21.78 p=.000, the means being .1855 for line type descriptions, .1537 for path type, .0584 for co-ordinate type, and .0372 for figural type. A Tukey test found line type descriptions to be significantly different from both figural and co-ordinate type at the .01 level, and path type to be significantly different from both co-ordinate and figural type at the 0.01 level, yet there was no significant difference between path and line type, or co-ordinate and figural type descriptions. These results indicate that subjects were preferring path and line type descriptions to co-ordinate and figural type.

None of the interactions from the analysis of variance proved significant. For example, there was no interaction between the age of subjects and the number of descriptions of each type in game1, or game2 and 3, F(2,81) = 1.06 p=.35. Nor was the interaction between the age of subjects and their choice of line, path, co-ordinate, or figural type descriptions significant, F(6,243) = 1.775 p=.105. So age did not determine whether they preferred any descriptive category over the others. And the interaction between game and the choice of descriptive type was also not significant, $F(3,243) = 1.15$ $p=.327$. Finally there was no interaction between all three, that is age, game, and choice of descriptive type, $F(6,243) = 1.71$ $p=.118$. So subjects' choice of path, line, figural, and co-ordinate type descriptions was not affected by the age of the subjects or the game (see Appendix D, Table 9, for full analysis of variance results).

DISCUSSION

From the analysis of variance we have two significant results. These were an increase in the total number of descriptions of each type, with more descriptions generated in the older children, and a significant difference between the occurrence of path and line type descriptions versus co-ordinate and figural type. Thus all subjects were significantly preferring path and line type categories to the figural and co-ordinate ones. Yet there were no significant interactions between the choice of descriptive categories and either, age of subjects, or the game ie. game1 versus later played games. Thus the younger subjects were not showing a preference for say figural to co-ordinate type descriptions, but overall all subjects preferred path and line type descriptions.

3. SUBJECTS' PREDOMINANT DESCRIPTIVE TYPE

This section investigates subjects' choice of descriptive category in terms of their predominant descriptive type in each game. Thus we are not simply counting each instance of the four descriptive categories relative to the number of moves as above, but calculating what category the subject used most in each game. This separate analysis uses different information from the analysis of variance performed above, and allows an investigation of any possible age effects on choice. Thus for each subject, the most predominant descriptive type in game1, and then game2 plus game3, was coded. For example, if player A predominantly used path type descriptions in game1 followed closely by line type, path would be marked as their most predominant descriptive type. This was carried out for game2 plus game3. On any game where two, three, or four, descriptive categories were equally as popular, these data were dropped from the sample. This comparison noted the most predominant descriptive type in each game, and investigated group preference for certain descriptive types. A summary of these figures is displayed in Table 5.4, which illustrates how many subjects predominantly used each descriptive type in game1, as compared to later games.

TABLE 5.4 = THE NUMBER OF SUBJECTS WHO PREDOMINANTLY USED EACH CATEGORY

	GAME1				GAME2+GAME3			
	L	P	F	C	L	P	F	C
8 yrs N=28	8	7	5	0	11	10	1	1
10 yrs N=28	10	8	2	0	14	9	0	2
12 yrs N=28	10	11	0	6	10	9	3	1

To determine whether subjects' most predominant descriptive type differed significantly by the age of the subjects, a 3x4 Chi Square test was performed with subjects' most predominant descriptive type as the dependent variable, and age as the between subjects independent variable. This was performed on the actual frequencies for game1, and then for game2 plus game3.

For game1 the obtained Chi Square value was 18.75 which exceeded the critical value of 16.81 at 6 d.f. at the 0.01 level. Thus there was a significant relationship between the age of subjects and their most predominant descriptive category. Almost certainly this is due to the 8-year-olds preference for figural over co-ordinate type descriptions, versus the 12-year-olds preference for co-ordinate over figural descriptions. In fact it was these deviations that contributed to more than half of the Chi Square value. However, for game2 plus game3 the Chi Square value was 4.32 which was less than the critical value of 12.59 at 6 d.f. at the 0.05 level of significance, so in the later games there was no significant relationship between the age of the subjects and their most prodominant descriptive type. This is most probably due to the fact that the pattern evidenced in game1 has disappeared where the 8-year-olds predominantly used figural type, and the 12-year-olds predominantly used co-ordinate type descriptions.

DISCUSSION

From the first analysis of the number of descriptions generated per move for each descriptive type, the children's results show a general and substantial preference across all age groups for path and line type descriptions over co-ordinate and figural ones. This result is in contrast with the adult data from Garrod and Anderson (1987), who found a general preference for path type descriptions, followed by an equal preference for line and co-ordinate type, with a lower preference for figural type. So it would appear that the children are much less likely to apply a co-ordinate descriptive category as compared to adults.

The conclusion from the second analysis, dealing with subject's most predominant descriptive type, gives some indication of a shift towards the adult pattern for game1, in that while the younger subjects prefer figural to co-ordinate descriptions, the older children prefer co-ordinate to figural, even though these two categories are not nearly as predominant as path or line type. These results may have been expected since co-ordinate descriptions involve a high cognitive demand since abstractions from the maze are required. For example, some coding scheme should firstly be negotiated, then each description should be encoded into this scheme by the speaker, and decoded by the listener. Thus the maze is viewed as a series of abstract lines each with a particular code name. There exists the possibility that the youngest age group have not yet developed, or mastered this technique.

Garrod and Anderson (1987) found a developmental descriptive pattern occurring across games with their adult sample. They observed that adult speakers tend to change their descriptions between the first two games, steadily moving from relatively concrete schemes, such as path or figural, toward more abstract ones, such as line or co-ordinate. However, there was no evidence from the children's data to indicate any choices of descriptive type across game for any of the age groups.

4. THE EFFECT OF MAZE SHAPE ON SUBJECTS' CHOICE OF DESCRIPTIVE TYPE

This section investigates whether the shape of the maze affected subjects' choice of description scheme. There were two main maze shapes used - either the figural type mazes, or the line type mazes (see Appendix A for all maze shapes used). For each of these two types, each subject's most predominant descriptive type used to describe maze points was calculated. Table 5.5 shows the number of subjects who predominantly used each descriptive type to describe points from either the figural or line type mazes.

TABLE 5.5 = THE NUMBER OF SUBJECTS WHO PREDOMINANTLY USED EACH DESCRIPTIVE CATEGORY FOR THE LINE AND FIGURAL TYPE MAZES

	Line	Path	Co-ord	Figural
Line based mazes	51	44	12	4
Figural based mazes	15	18	1	4

For example, with the figural type mazes, path type descriptions were the most common descriptive type used across the three age groups of children. 47% of pairs predominantly used path type, 39.5% predominantly used line type, 10.5% used figural type, and 3% used co-ordinate type, while describing locations from the figural type mazes. A Chi Square one-sample test found this to be a reliable difference with the Chi Square value of 21.6 far higher than the critical value of 11.34 at the 0.01 level of significance at 3 d.f. In the line based mazes 46% of subjects preferred to use the line type category over any other type to describe maze locations, followed closely by path type at 40%, co-ordinate at 10%, and figural at 4%. Thus path type descriptions were almost as popular for the line type mazes as the line type category. A Chi Square one-sample test found this to be reliable since the value of 58.5 was far higher than the critical value of 11.34 at 3 d.f. for the 0.01 level of significance.

It was then decided to compare the more abstract descriptive categories of line plus co-ordinate descriptions, with the more concrete path and figural ones. A Chi Square 2x2 test was thus performed on the number of subjects who predominantly used line plus co-ordinate descriptions versus the number of path plus figural descriptions, for the line based and figural based maze shapes. The Chi Square value of 1.2 was not greater than the critical value of 3.84 at 1 d.f. at the 0.05 level of significance.

DISCUSSION

These results indicate significant differences for the use of each descriptive type for both the line and figural based mazes, yet there was no interaction between the maze shape and subjects' choice of descriptive scheme. Thus the salience of the particular maze pattern did not affect the descriptions generated. For example, subjects predominantly used path and line type descriptions, and relied on precedence more than anything else. That is, they described maze locations with the descriptive scheme they had previously been using.

Thus it appeared that the salience of the maze shape did not play a great part in determining subjects' choice of descriptive scheme, rather path and line type dominated over figural and co-ordinate type descriptions, with precedence playing a more important role.

Another way of investigating the way that subjects perceived the overall shape of the maze was attempted with a "memory test" (see page 149), yet this did not prove very informative. At the end of each maze-game, subjects were given a maze shell and asked to draw the maze shape they had just viewed (from memory). This was an attempt to understand how they interpreted the maze and what patterns or shapes they perceived as most salient. For instance, if they were using a vertical line descriptive category to describe locations on the maze, would they perceive the maze as a series of vertical parallel lines? However, all age groups of children produced partial and uninformative drawings, and appeared to find the task extremely difficult, often concentrating on drawing local aspects of the maze such as two or three maze boxes with monsters in them, rather than drawing the whole picture. Very few subjects actually completed the maze in the time allocated, although they were instructed to quickly "join up the dots with lines and draw the maze you have just seen on your screen". Some examples of the children's drawings are shown in Appendix C. Yet this in itself may demonstrate an inconsistent and unorganized view of the maze where no strong patterns were evident to the children.

D. CHAPTER CONCLUSION

This chapter was concerned with semantic and pragmatic aspects of spatial descriptions. It began by explaining some research which elicited various descriptive categories from subjects while describing spatial arrays. A study by Garrod and Anderson (1987), using the same computer maze-game on an adult sample, found four differnt basic schemes for describing points on the maze from a total of 1356 spatial descriptions. These four types were then explained in more detail along with the adults' preference for each. For example, path type were most popular, followed by line and co-ordinate, and then figural. While other research has found similar descriptive types they have not elicited such a wide range of conceptual schemes.

The following section then examined the semantic contents of location descriptions which emerged from three age groups of school children playing several computer maze-games. This considered the meaning of various terms and noted any broad descriptive patterns that emerged along with any developmental trends of the evolution of joint descriptive codes. A content analysis was carried out by two independent judges on the 1332 descriptions generated, to reveal two main descriptive categories, and two less frequently used categories. The line type category was most popular, followed by path, co-ordinate, and then figural.

The final section analysed these descriptive categories in more detail, investigating subjects' preference for each, both over age and across game. The main analysis of variance found a significant preference for line and path type descriptions over co-ordinate and figural type, for all age groups, and an increase in descriptions with increasing age. However, there was no interactions between the age of subjects and their choice of descriptive category, nor was there any effect of game1 versus later games on descriptive schemes. While investigating subjects' most predominant descriptive type in each game, a significant interaction was found between the age of subjects and their preference for figural or co-ordinate descriptions for game1, but not for game2 plus game3. Thus in game1 the 8-year-olds preferred figural to co-ordinate descriptions while the two older groups showed a preference for co-ordinate type over figural type. The last analysis in this section investigated the affect of the maze shape on subjects' choice of descriptive category and found no interaction between the two. Thus precedence of descriptions, rather than salience of the maze shape, appeared to be used for choice of reference.

The next chapter now turns to dialogue co-ordination and investigates how synchronized partners' descriptive schemes are. This provides a measure of dialogue co-ordination with which to compare any pair of subjects.

CHAPTER 6

LANGUAGE CO-ORDINATION IN THE DIALOGUE MAZE-GAME

INTRODUCTION

The last chapter discussed the type of descriptions generated by children playing the computer maze-game. The proportion of each descriptive type was then investigated across the three age groups and over the games, along with subjects' preference for each category. This chapter investigates the co-ordination of descriptive schemes within pairs of subjects and compares this to the descriptive schemes of other subjects.

Descriptive sequences were used to provide a measure of dialogue co-ordination both within and between different subject pairs. For example, the level of co-ordination was measured by subjects' choice of descriptive sequence, since if a pair of subjects were both using a particularly unique descriptive pattern to communicate maze locations then this reflected a high level of dialogue co-ordination. This co-ordination is even more pronounced if the subjects' sequence is unlike any other descriptive code used in their age group. On the other hand, lack of co-ordination could be evidenced by much misunderstanding and confusion over maze locations where subjects were not co-ordinating their thoughts and intentions clearly.

Since the computer maze-game was devised to elicit descriptions, there were generally a sufficient number from each pair to allow this analysis. It was found that a variety of different description schemes were used, yet pairs of subjects appeared to entrain each other to describe points in the same way. This implies that subject pairs were co-ordinating their language and establishing joint descriptive codes to refer to points on the maze. This analysis attempts to establish the extent of such co-ordination both within and across each age group.

The analysis was directed at three questions which will be investigated in turn:

1) The general question of the degree to which the subjects co-ordinated their language use,

2) the extent to which co-ordination increased between players over the games as the interaction proceeded, and

3) convergence and change of description schemes across games.

1. THE CO-ORDINATION OF LANGUAGE USE

The first analysis deals with general co-ordination of descriptive schemes, comparing schemes generated within a pair of subjects with those across different subjects who did not interact. Subjects' descriptive schemes were used to calculate their levels of co-ordination. For example, if dialogue partners were co-ordinating their interpretation, each should predominantly be using the same language code as the other. That is, 'within' pair communicators should be using the same terms to express the same meaning. The procedure for calculating such a co-ordination measure was taken from Garrod and Anderson (1987) who developed a technique to determine levels of dialogue co-ordination in adult descriptive schemes.

Hence, one major aspect of the analysis revolved around comparing the use of descriptions within a given dialogue, and determining the extent to which interlocutors employed the same language to describe points on the maze, as compared with other members of their group.

A detailed analysis revealed that subjects used two main descriptive schemes, and two less frequently used categories, to locate maze points which are discussed in Chapter 5. To establish each subject's pattern of use of the different schemes the following steps were taken:

i) For each speaker the total number of descriptions of each type were recorded (see Table 6.1).

TABLE 6.1 = QUANTITY OF DESCRIPTIONS OF EACH TYPE

PAIR/PLAYER		LINE	PATH	CO-ORD	FIGURAL
	A	5	4	0	1
1	B	4	3	0	1

For example, the pair of subjects in Table 6.1 played three maze-games, and player A produced 5 line type descriptions, 4 path type, 1 figural, and no co-ordinate type. Player B generated 4 line type descriptions, 3 path, 1 figural and no co-ordinate type. This analysis of descriptive type and quantity was carried out for all subjects.

ii) Each subject's scores were then ranked 1,2,3,and 4 according to frequency, with 1 being the most frequent and 4 the least, as shown in Table 6.2. Thus for player A, line type was the most predominant descriptive type and awarded the rank of one, path was the next popular and thus ranked second, figural came third, and co-ordinate ranked fourth. In this case player B's pattern of descriptions were similar and thus had identical ranking.

TABLE 6.2 = DESCRIPTIVE SCHEME RANKING

PAIR/PLAYER		LINE	PATH	CO-ORD	FIGURAL
	A	5(1)	4(2)	0(4)	1(3)
1	B	4(1)	3(2)	0(4)	1(3)

In the case of ties, where two, three, or four, descriptive types were equally predominant, the ranks were summed, and divided by the number of ties. For example, if line and path type were equal first then the ranks one and two were summed and divided by two, and path and line were each awarded the rank of 1.5.

(iii) It was then possible to obtain a measure of similarity of pattern use, by calculating the total absolute difference between rankings for any comparison pair. If the patterns are identical this will be 0, if purely by chance it should be 5. In the above example the sum of the absolute difference in ranks is 0, since both players A and B have the same pattern of choice of descriptive types. Hence total descriptive scheme co-ordination is reflected in a zero difference score.

This may appear a rather crude measure of dialogue co-ordination since the quantity of each descriptive type suffers at the expense of the overall pattern of use. For example, subject A may use 20 line type descriptions, 3 path, and no figural or co-ordinate, while subject B uses 2 line, 1 path, and no figural or co-ordinate, yet this pair would be awarded a score of 0 for total co-ordination of decriptive pattern. Furthermore, one subject from a pair could predominantly be using a line type descriptive strategy while the other a path type, yet they may understand each other, while both subjects from another pair could be using a line type strategy but in different ways such that misunderstanding occurs. Nevertheless, this measure does indicate if pairs of subjects were using the same pattern of descriptions which reflects their level of dialogue co-ordination to a certain extent, and highlights those using divergent schemes. It was assumed that those subject pairs who were using the same descriptive pattern were co-ordinating their dialogue and the meaning of the expressions at some level. Table 6.3 shows the absolute difference in ranks scores for each pair of subjects from each age group in their games.

TABLE 6.3 = THE SUM OF THE ABSOLUTE DIFFERENCE IN RANKS FOR EACH PAIR IN EACH GAME: 'WITHIN' DIALOGUE COMPARISON

PAIR/GAME		8yrs	10yrs	12yrs
1	A	3	0	2
	B	2	0	1
	C	3	-	-
2	A	2	0	2
	B	4	2	1
	C	3	-	4
3	A	0	0	4
	B	3	2	4
	C	4	0	-
4	A	2	3	0
	B	3	4	0
	C	0	2	0
5	A	4	2	4
	B	0	0	0
	C	4	0	4
6	A	3	3	0
	B	0	0	0
	C	0	4	0
7	A	2	3	0
	B	0	1	8
	C	2	2	3
8	A	3	3	2
	B	0	1	2
	C	-	6	1
9	A	4	3	0
	B	0	3	3
	C	0	3	5
10	A	0	2	5
	B	3	4	2
	C	2	0	0
11	A	4	4	4
	B	2	3	3
	C	0	0	4
12	A	2	0	0
	B	0	2	0
	C	-	0	0
13	A	0	2	1
	B	0	0	0
	C	0	0	0
14	A	2	0	4
	B	2	0	0
	C	4	0	0
Total 0		15	17	17
Average Baseline Within		1.69	1.60	1.68
Mean		1.8	1.7	1.8

DISCUSSION

Table 6.3 illustrates the number of games where pairs of subjects had an absolute difference score of 0. In the youngest age group, pairs of subjects were co-ordinating their dialogue and using the same pattern of descriptions as their partner in 37.5% of games, indicated by a 0 difference score. This increased to 43% of games in the 10- and 12-year-old groups. In each group 0 was the mode, the most frequently occurring score.

Table 6.4 displays the number of games where pairs of subjects were exhibiting an absolute difference in ranks score of 0, which reflects total co-ordination of descriptive scheme.

TABLE 6.4 = NUMBER OF GAMES WHERE SUBJECT PAIRS EXHIBITED AN ABSOLUTE DIFFERENCE SCORE OF 0

		8yrs	10yrs	12yrs	TOTAL
TOTAL 0 IN:	Game1	3	5	5	13
	Game2	7	3	6	16
	Game3	5	9	6	20
TOTAL		15	17	17	

When analysed over the three games for all age groups, the total number of 0 scores increased from 13 in game1, to 16 in game2, and 20 in game3, indicating a greater number of pairs co-ordinating their descriptive schemes as the games progressed. However, a Chi Square one-sample test calculated that this was not a significant difference between the games. The Chi Square value was 2.31 which was less than the critical value of 5.99 for 2 d.f. at the 0.05 level of significance.

This basic difference measure, illustrated above, was used to look at both intra-dialogue, and inter-dialogue co-ordination within any sample or set of games. The analysis established both dialogue co-ordination within subject pairs and allowed comparisons between patterns for all others in that group.

The 'between' dialogue similarities for each age group were calculated in the following way:

i) one player was randomly selected from each pair of subjects
ii) the subject's rank ordering was then compared with that of all other speakers in their group.

This produced 91 comparisons in each age group. For example, 1 subject from pair1 had their ranking compared with that of 1 subject from pair2, 1 subject from pair3, 4, 5, 6, to pair14, to produce an absolute difference in rank scores for each comparison. Then 1 subject from pair2 was compared with 1 from pair3 to 14, 1 from pair3 compared with 1 from pair4 to 14, and so on until 1 from pair13 was compared with 1 from pair14. These absolute difference in rank scores were then added and divided by 91 to produce the across dialogue baseline scores shown in Table 6.5.

This yielded an estimate of how similar that speaker's choice of description scheme was to all the others in the age group. Thus for a given pair, scores were calculated as the mean difference between the chosen member and every other chosen member.

TABLE 6.5 = CO-ORDINATION OF DESCRIPTIVE SCHEMES 'BETWEEN' AND 'WITHIN' DIALOGUES

Age Group	8yrs	10yrs	12yrs	Total
Between Dialogue	3.18	3.35	3.88	3.47
Within Dialogue	1.69	1.60	1.68	1.66

These results were then compared to the 'within' dialogue co-ordination scores which was calculated by simply contrasting each speakers ranks with those of the other member of the pair for that game. This contrast between 'within' and 'between' pair co-ordination of language indicated the extent to which dialogue partners were more like each other than anyone else in the group, and gives an indication of variability. For example, if everyone in that group used a certain term, then there would be nothing extraordinary about subjects within a given pair using the term, but to the extent that each were different from the group their similarities were more significant.

These data were subject to both parametric and non-parametric statistical analyses. The various hypotheses will be considered in turn.

2. COMPARISON OF 'WITHIN' AND 'BETWEEN' DIALOGUE CO-ORDINATION

The similarity scores were tested using a three factor analysis of variance, with 'within' versus 'between' pair scores as the dependent variable, and game as the repeated measures (within subjects) factor, and age as the independent (between subjects) factor. The only significant result from this analysis was the main effect of 'within' versus 'between' pair scores, $F(1,39) = 84.5$ $p<.001$, with the total 'between' difference 3.47, and the 'within' difference 1.66 (see Appendix D, Table 10, for full analysis of variance results). Thus, within each pair of subjects there was a high degree of co-ordination of descriptions occurring, which was not the case across different pairs of subjects where a wide variety of descriptions were used.

For each age group and game, there were a reliable number of dialogue pairs whose 'within' dialogue co-ordination score was significantly less than the 'between' dialogue comparison ($p<0.01$, Sign test). This implies that within any given pair, dyads were co-ordinating their language and using the same terms to express the same meaning, as compared to other members of the group.

This was further broken down into 'between' and 'within' means for each of the three games for each age group, with the means displayed in Table 6.6.

TABLE 6.6 = TREATMENT MEANS FOR THE 'WITHIN' AND 'BETWEEN' DIALOGUE CO-ORDINATION

	Game1		Game2		Gme3	
	W	B	W	B	W	B
8 yrs	2.2	3.4	1.5	2.7	1.8	3.5
10 yrs	1.8	2.9	1.4	3.7	1.6	3.5
12 yrs	2.0	4.1	1.7	4.3	1.5	3.4

In each case the 'within' dialogue mean was smaller than the 'between' dialogue score. However, from game1 to game3, the analysis of variance indicated no reliable difference over the three age groups on the 'within' and 'between' dialogue means, $F(4,78) = 0.828$.

DISCUSSION

The main analysis of variance indicated a significant difference in the level of description co-ordination occurring within pairs of subjects for all age groups, as compared to subjects from different dyads. However, it was also expected that dialogue co-ordination would increase from the first to the third game, where descriptive schemes were progressively negotiated and developed. Yet the results from the main analysis of variance produced no evidence of any reliable improvement of descriptive co-ordination from game 1 to game 3 for all age groups, $F(2,78) = 1.026$. The relevant means are displayed in Table 6.7.

TABLE 6.7 = 'WITHIN' AND 'BETWEEN' DIALOGUE CO-ORDINATION ACROSS GAME

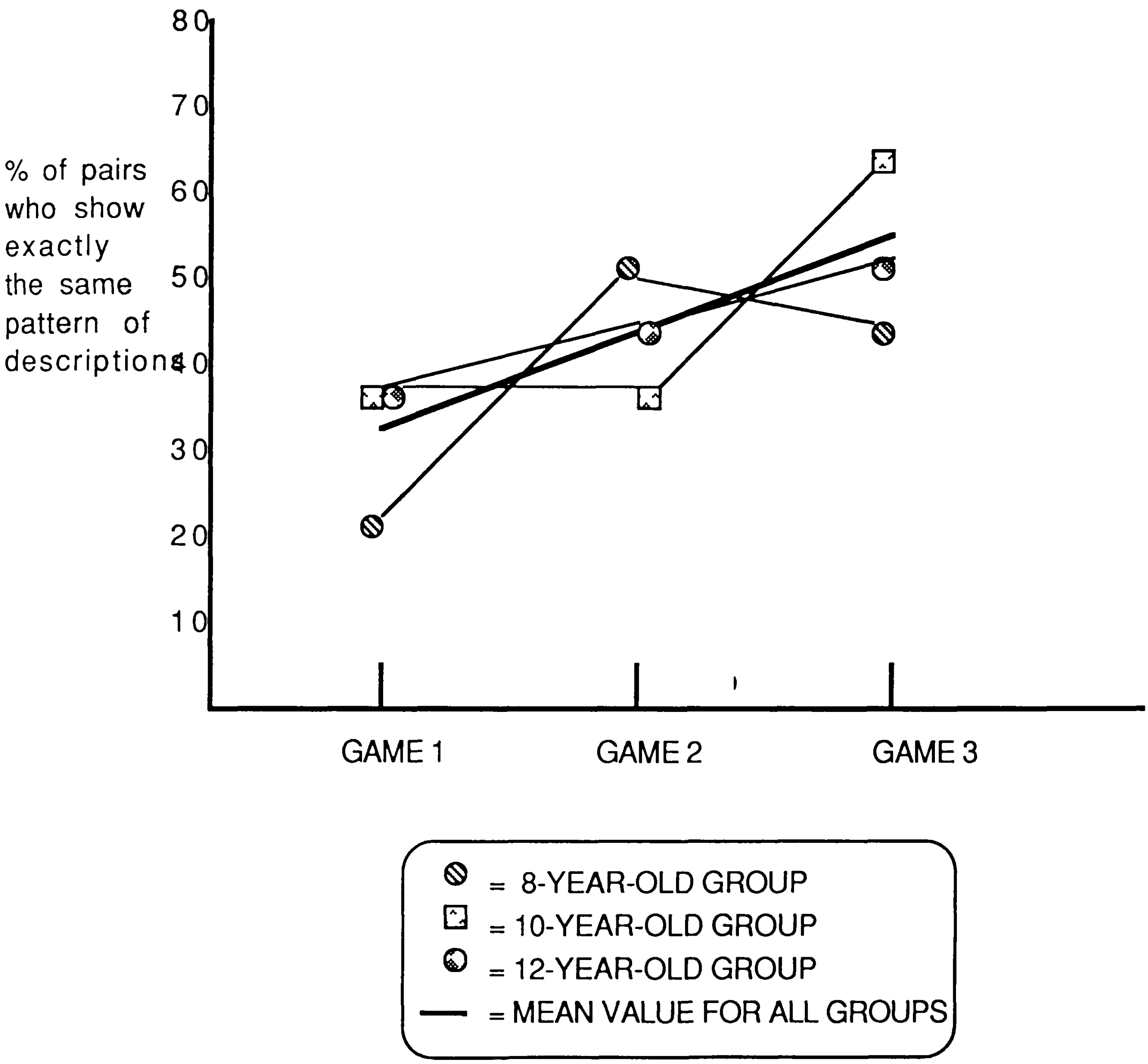
Game	1	2	3
Between Dialogue	3.45	3.54	3.42
Within Dialogue	2.00	1.55	1.64

Another way of investigating descriptive co-ordination from one game to the next, involves counting the number of games where the absolute difference in ranks was 0. Thus in 31% of all first games, subjects exhibited exactly the same pattern of descriptions as their partner, which increased to 43% in the second game, and 52% in the third. These data is illustrated by the thick mean line on Figure 6.1. This was then analysed to show each age group separately and their group co-ordination pattern. The three lines in Figure 6.1 illustrate each groups pattern of co-ordination over the three games.

This further examination indicated some improvement across all age groups between the first and second game with 21 out of the 32 comparisons showing increased co-ordination (p=0.05 Sign test). Thus for all age groups there was evidence of increased dialogue co-ordination between the first two games. Furthermore, in numerical terms the two older groups continued to increase co-ordination of dialogue to the third game, while the youngest age group decreased, thus confounding the overall increase in group co-ordination.

The final analysis looked at the number of instances where subject pairs decreased their absolute difference in ranks over the three games, and included those cases where they remained co-ordinated with a 0 rank score. This analysis takes the ceiling effect into account where subject pairs have increased their co-ordination to 0 from game1 to game2. So if they remained co-ordinated at 0 from game2 to game3 this would now be included. This investigation indicated improvement in description co-ordination across all age groups from game1 to game2 where 27 out of 42 comparisons illustrated increased or total co-

FIGURE 6.1
THE % OF SUBJECT PAIRS WHO HAVE TOTAL DIALOGUE CO-ORDINATION, FOR EACH AGE GROUP AND ACROSS EACH OF THE THREE GAMES

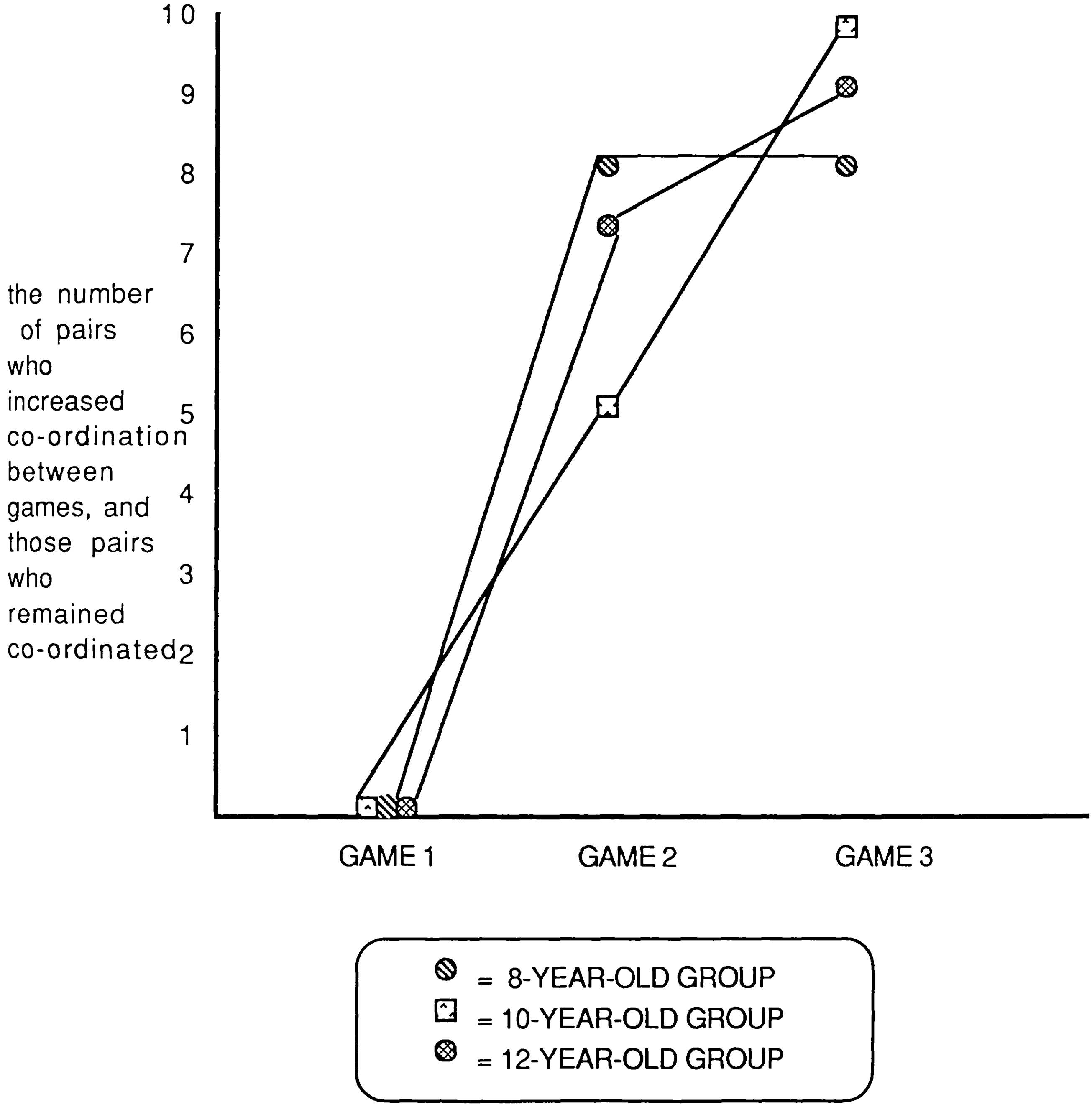


ordination (p=0.05 Sign Test), and 26 out of 42 comparisons from game2 to game3 showing improvement in co-ordination (p=0.05 Sign Test), with the results illustrated in Figure 6.2.

Bearing in mind that the main analysis of variance found no significant improvements in descriptive scheme co-ordination from game1 to game3, these further analyses should be treated with caution. Figure 6.1 deals with the number of cases where subject pairs had an absolute difference in ranks score of 0, and found increased dialogue co-ordination between game1 and game2 for all age groups, where subjects were demonstrating early entrainment and engaging onto each others language. This may have been expected since when players first interact they often use different descriptive schemes which become more similar following communication. Yet there was no evidence of any improvement in description co-ordination from game2 to game3 across all age groups. The result may reflect a discrepancy in each players descriptive scheme where one of the pair for example, changes the joint scheme to a more efficient one, while the other fails to incorporate this change. Figure 6.2 displays the number of cases where subject pairs increased dialogue co-ordination from one game to the next, and included those cases where they remained fully co-ordinated at 0. This analysis found increasing dialogue co-ordination over the three games for all age groups.

FIGURE 6.2

THE NUMBER OF PAIRS THAT INCREASED CO-ORDINATION BETWEEN GAMES AND THOSE PAIRS THAT REMAINED CO-ORDINATED



3. CONVERGENCE AND CHANGE OF DESCRIPTION SCHEMES ACROSS GAMES.

The next analysis investigated the dynamics of the descriptions used - that is the type of description used by subjects over the games. For example, a pair of subjects may both predominantly use path type descriptions in game 1, and then change to use a line type code in game 2, or perhaps only one of the players changes to this scheme while the other remains with the first. When two independent systems engage, they often converge on descriptive types and then may jointly progress to another scheme. From this we can investigate the likelihood of change and any general patterns that may arise throughout the age groups.

Evidence has indicated that younger children may be less flexible than older ones, rigidly adhering to the first suitable scheme that works (Werner, 1945), and failing to incorporate more efficient changes over time. Garrod and Anderson (1987) observed that adult speakers tend to change their descriptions between the first two games, steadily moving from relatively concrete schemes such as path or figural toward more abstract ones such as line or co-ordinate. Furthermore, most of the adults who changed schemes did so as a pair. In other words the speakers were not changing to a scheme used by the other members of the pair in game 1, but rather changing together to a new scheme. 70% of adults who changed did so as a pair.

By comparison this does not seem to be the case for the younger speakers (see Table 6.8) where the three age groups appear more rigid than the adult groups studied by Garrod and Anderson. On average only 28% of the children moved schemes between the first and second game, and only 15% between the second and third game. Thus they may both begin by using different descriptive schemes and it all depended on who dominated the other, rather than negotiating a new descriptive scheme and both adhering to this. For example, if one subject used line type, the other subject generally followed suit, rather than both negotiating a path or co-ordinate one and changing to this.

TABLE 6.8 = PROPORTION OF SUBJECTS SHIFTING SCHEME BETWEEN GAMES

Age Group	8yrs	10yrs	12yrs	Total
Game 1 to Game2	46%	24%	18%	28%
Game 2 to Game 3	17%	17%	9%	15%

Looking at each age group separately 46% of the 8-year-olds shift schemes from game1 to 2, whereas only 24% do so in the 10-year-old group, and 18% in the 12-year-old group. A Chi Square test was performed on the number of subjects who changed their most predominant scheme from game1 to game2, and then from game2 to game3. These scores were normalised for the total number of available games where subjects had a predominant score. For game1 to game2 the Chi Square value was 4.6 (of which 3.7 of this value was made up of the 8-year-old's score) which was less than the critical value of 5.99 for 2 d.f. at the 0.05 level of significance. For game2 to game3 the Chi Square value was 0.24 which was much less then the critical value of 5.99 required for the 0.05 level of significance for 2 d.f. So there was no significant differences between the age of the subjects and their choice of descriptive schemes between two games.

Table 6.9 displays the proportion of subject pairs who either both shift to a new scheme or one converges with the other. Only 46% of the children change scheme as a pair, where both subjects have changed to a new scheme together, rather than one simply dominating the other.

TABLE 6.9 = PROPORTION OF PAIRS WHO SHIFT SCHEMES WHO EITHER BOTH SHIFT OR CONVERGE

	8yrs	10yrs	12yrs	Total
Both Shift	50%	40%	50%	46%
Converge	50%	60%	50%	54%

This last result is consistent with the view that children predominantly change their descriptive schemes to converge on the same description scheme as that used previously by their partner. 54% of all children converged on the same descriptive type as their partner, thus more than half shift in order to merge with their partner's scheme. In 46% of cases on the other hand, both shift to a new scheme.

Since the number of descriptions generated per game is less than for the adults and older children, there is less opportunity for the younger age groups to converge per game. Thus if the youngest subjects were allowed to continue communicating for an extended period then increased convergence may occur, where their schemes may develop into more abstract ones. Indeed compared to the adult data by Garrod and Anderson (1987), all children say considerably less than adults, therefore there is less opportunity for the younger children to converge. Thus perhaps we are not seeing the whole picture and if our oldest age group interacted for a longer period of time, the pattern may be similar to the adult one in a systematic way.

4. CONCLUSION

This chapter investigated the co-ordination of description schemes both 'within' and 'between' pairs of subjects. It was found that within each pair of subjects there was a high degree of entrainment occurring where speakers were using the same pattern of descriptions as their partners. The next section discussed improvements in co-ordination across the games and for each age group. There was some indication that for all age groups co-ordination increased from game1 to game2, although this did not prove significant in the analysis of variance. While investigating the proportion of subject pairs that were fully co-ordinated a reliable pattern emerged between all games for all age groups.

The final section looked at convergence and change of description schemes across the games. All of the age groups illustrated strong evidence for a general convergence on a similar description scheme across the dialogue. From the dialogues this appeared to occur implicitly where one partner began using a certain descriptive scheme and the other followed suit. For example, with this pair of 10-year-olds, player A began describing points from the maze in the following way, which was shortly taken up by player B:

PAIR 2 10 years old

A I am + bottom row

B Right it's my turn

A Bottom row four from the right, four from the left

B Right

B Where are you?

A Fourth row up + two from the right

A Where are you Sandie?

B I am + the bottom row + three from the left

PAIR 3 10 years old

B Hang on what layer are you on?

A Well I'm on the bottom layer, what layer are you on?

B I'm on the second layer

A Where are you?

B I'm on the 1, 2, 3, 4th layer

A Yes

B On the third box

PAIR 4 10 years old

B Where are you?

A Third row third position

B Fourth line fourth position?

A Third line third position

PAIR 1 12-year-olds

B I'm in the second storey

A Right

B And the second box in

B Right I'm on the second storey

A Right I'm on the second storey

B Which is the first + boxes + first floor

A I'm on the very left

B You're on the very left where I've got a box?

A Right

B And I'm on the first storey, no second storey

A Right

B One from the edge

A So you're the second storey and second box?

B Uhu

Implicit negotiation was by far the most common form of entrainment, yet on several occasions descriptive schemes were changed explicitly where one partner explained the scheme they should use. Explicit negotiation of descriptive schemes occured in 3.3% of the total number of descriptions. For example:

PAIR 1 10 years old

A Right we'll take it from top to bottom this time + like line1's the top + line2's the next and so on

PAIR 6 10 years old

A Hang on this is getting a bit confusing + we're calling it lines OK + so we're calling it line1 line2 line3 line4 OK?

B Right + I'm in line1 + 2 + I'm in line2 + one up + so I'm one from the bottom + right ?

PAIR 7 12 years old

B Well what way are you describing the maze?

A Um right pretend there's a + pretend it's just like + eh you know like a grid?

B Yeh

A Without all those chunks out of it, so I'm just two up and two in

B Two up from the right or from the left?

A From the left

PAIR 14 12 years old

A I am in the 1 2 3 4th down + 1 2 3 4th in

B Where are you?

A I'm in the + 1 2 3 4th

B Just say 4 4 + you can look at it easily enough

A I'm in 4 4

B Right and I'm in 5 4 + OK?

A Right

PAIR 12 10 years old

B Hey when we're saying no and yes we've got to say affirmative and negative + OK?

A Right

B Where are you?

A Bottom left corner two jumps

B Right could you go along + one jump + left?

A Negative

B Could you go + up one jump?

A Infirmative

B Not infirmitive, affirmitive.

B Are you starting from the bottom row two jumps, over and out?

A I am bottom left corner + 2000 miles

B Is that two jumps?

A Yes

B Right

A 2000 miles to the + right + up 3000 miles

B That isn't + 2000 + that's two jumps though isn't it?

A Or 2000 miles up, you say 2000 for jumps

B Right

PAIR 3 12 years old

A Right Barry where are you?

B Right do you know how there's three columns?

A There's six columns

B How's there six?

A Oh you mean three double ones?

B Uhu

A Right

B Just say this whole grid

The above finding of general convergence onto a similar scheme between particular dialogue partners, is consistent with results from adult studies where there was evidence of convergence onto a similar descriptive scheme over time. The main difference with the adult statistics seems to be in the dynamics of choice of description across the games. The adult picture is one of a progressively increasing co-ordination, linked to the steady development of more abstract and generally more efficient languages of description. On the other hand, the younger dialogue partners seem to only show a steady but weak increase in co-ordination initially, which seems to be associated mainly with convergence on a single description scheme. The rule seems to be that when a scheme works successfully, subjects tend to adhere to it, rather than developing a new and possibly more efficient one.

The fact that the younger subjects did not seem able to, either adopt novel schemes once they have converged, or readily employ more abstract descriptions, might therefore reflect a rigid adherence to Garrod and Anderson's (1987) output/input co-ordination principle described in Chapter 3, section C.

Finally, something should be mentioned about comparisons between the various age groups in the sample. The most striking thing is how similar they all are, at least with respect to the somewhat crude measures of co-ordination discussed above. All groups seem to demonstrate co-ordination and all show some improvement between the first and second game. It is interesting to note just how similar even the youngest group are to adults with respect to the general process of co-ordination, which would suggest that this basic process is a central component of all human interactional dialogue.

The next chapter involves an independent study which investigates the generalizability of the descriptive schemes found in the computer maze-game. It explores the type of descriptions produced in a less interactive environment, as compared to those generated from the computer maze-game.

CHAPTER 7

AN EXPLORATION OF DESCRIPTIONS PRODUCED IN A LESS INTERACTIVE ENVIRONMENT THAN THE COMPUTER MAZE-GAME

INTRODUCTION

This chapter explores the generalizability of the descriptive schemes found from the computer maze-game, based on an independent study by Anderson (1983). As explained in Chapter 3, Anderson concluded that adults described maze locations in four main ways. These categories were path, line, co-ordinate, and figural type, which he hypothesized:

"may reflect four distinguishably different ways of conceptualising, or mentally modelling, the maze shape."

In addition, he carried out a further study to determine if these four basic categories would emerge in a situation independent of the computer maze-game, or whether they were inextricably linked to the game itself. The study involved subjects describing points from photo-copied maze diagrams on paper, into a tape-recorder.

The study reported in this thesis is a partial replication of Anderson's (1983) Pencil and Paper study (P&P), modified to use on children. This allows an investigation of the generalizability and consistency of the underlying descriptive types which emerged from children playing the computer maze-game. Furthermore, several other aspects may be investigated, such as the accuracy or ambiguity of the descriptions, the number of points correctly located by the listener, the use of certain descriptive types, and a comparison of monologue with dialogue.

A. ANDERSON'S (1983) PENCIL AND PAPER STUDY

1. PROCEDURE AND CONDITIONS

Sixteen same-sex pairs participated in the study. These subjects were first-year undergraduates in the Psychology class at Glasgow University. The task involved subjects describing several points from a photo-copied maze diagram into a tape-recorder, with or without a listener. Eight different photo-copied maze diagrams were used, five from his computer maze-game experiment, and three designed especially for this study. The eight mazes had several points marked on them. There were three main conditions in the experiment where the level of interaction was manipulated to investigate its effect on the descriptions generated.

a) INTERACTIVE CONDITION

In this condition, adults participated in pairs, seated across a screened table to avoid any non-verbal communication. Both subjects received identical booklets containing five different maze shapes with eight locations to be described on each by either subject. For example on Maze 1, one subject would have eight points to describe to the other subject who was required to locate these points and mark them on the maze. On Maze 2, the previous listener would now successively describe eight location points to the other, and so on. Thus each dyad generated forty descriptions, during which the listener could ask any questions. All dialogue was audio-tape recorded.

b) NON-INTERACTIVE CONDITION

In this condition one subject was requested to describe all forty points, eight on each of the five mazes, to the other. The listener was aware that they may ask any questions in response to the descriptions. In this way each dyad generated forty descriptions, which were audio tape-recorded.

c) MONOLOGUE CONDITION

In this case a solo subject described the forty points from all of the five mazes, into an audio tape-recorder in the absence of a listener, generating forty descriptions.

2. SUMMARY OF ANDERSON'S RESULTS

Anderson found a 'partial replication' of the previously discussed four-fold categorical system emerging from the descriptions. While using the computer maze-game he discovered that adults predominantly used path type descriptions, followed by line and co-ordinate descriptions, and then figural ones. In his P&P study, he found path descriptions most prevalent, followed by line, then figural, with a total absence of co-ordinate descriptions. This replicated three out of the four categories which were found in the maze-game.

Anderson had predicted such results, since from a semantic stance, similar maze shapes would be expected to generate similar descriptive types. However, due to the differing cognitive and social demands a certain degree of incompatibility was expected. He offered several explanations for these differences. Firstly, the computer maze-game involves a greater degree of collaboration, where subjects are in an interdependent situation, with a joint problem to solve. In the P&P study there is more independence between subjects since co-operation is not essential in solving the task. In addition, the speaker and listener roles are well established where one subject is clearly either the instruction giver or instruction follower. Secondly, the spontaneous nature of the computer maze-game allows subjects to describe locations at any point in the game. However, the P&P study involves a fairly rigid and limited situation, where descriptions are the main point of focus, and less negotiation is required. Thirdly the dynamics of both differ where changes in the maze-game occur over time, whereas this is not the case with the P&P study where subjects simply describe one point after another.

In addition, social factors are considerably different in both conditions, especially in relation to what Orne (1962) termed 'demand characteristics'. Orne emphasized the social importance of the experimental situation where subjects usually participate at their own will, yet with an aim to comply with the experimenter's demands. Similarly, the experimenter is generally enthusiastic regarding the experimental results, and this often influences the subjects' behaviour, especially in the desired experimental way. Orne describes demand characteristics as:

"..the totality of cues which convey an experimental hypothesis to the subject."

Anderson explained some of his results as due to the perceived demand characteristics of the experiment. For example, in the computer maze-game, time-pressures and total number of moves to the goal are important. Thus subjects may predominantly use co-ordinate type descriptions, since these are a very efficient way of precisely locating points, leaving increasing time to complete the task. On the other hand, the P&P study involves no such time-pressure, which may influence their choice of descriptive strategies.

Anderson also attributed the differences to differing degrees of conscious awareness in the two tasks. For example, in the computer maze-game subjects are predominantly "aware-of-self-as-subject" and thus less aware of the language they produce, while in the P&P study subjects are aware that they are the object of interest, and thus "aware-of-self-as-object" and more conscious of the descriptions they generate. This was indeed evident in the two tasks.

8. THE PRESENT STUDY

The study reported here involves a modified version of Anderson's (1983) P&P study, using the Interactive condition on three age groups of school children from Hillhead Primary School (see page 150). There were 10 children in each group of average age 8, 10, and 12 years old, who had not participated in the computer maze-game experiment. These children were paired with others from the same class.

1. DESIGN AND PROCEDURE

APPARATUS

Subjects were positioned across a screened table to avoid any visual contact. A small portable Philips N2234 audio tape recorder was used to tape all the dialogue onto three BASF 90 minute cassette tapes.

STIMULI AND DESIGN

Eight photocopied maze diagrams were used in this study, five from Anderson (1983) and three designed especially for this study (see Appendix E for the 8 mazes used). These eight mazes were stapled together in the form of a booklet and labelled Maze1 to Maze8. Each pair of subjects were given an identical booklet, consisting of the eight photocopied maze diagrams (the order of the mazes was changed for different pairs of subjects). Subject A had a number 1 and 2, marked on Maze 1,3,5, and 7, in red ink, whereas subject B had a number 1 and 2 marked on Maze 2,4,6, and 8, in red ink. Players were instructed to look at the first maze, and the person with a number 1 and 2 on their maze, then described these points to the other player to enable them to mark it on their maze in black ink. They were instructed to state clearly the number and then describe its position.

ink colour enabled the experimenter to clearly differentiate the speaker and listener in each maze. Thus each pair described a total of 16 points, with each subject describing 8 points.

PROCEDURE

Subjects arrived at the school room in pairs, and were positioned at a table and chairs, and were each given a maze booklet. They were instructed that four of their mazes would have a number 1 and 2 marked on them in red ink. From maze to maze, the subjects with the red 1 and 2, should describe the position of each point very clearly and accurately such that their partner could specifically locate it and mark the number on their maze. The listener was instructed to ask any questions during the task if they were unsure of points. Children were rewarded for participating in the study with various school utensils. They were aware that their speech was audio-taped, and of the experimenter's presence. The tapes were later transcribed and the descriptions analysed.

2. RESULTS AND DISCUSSION

There were four main areas of investigation which will be considered in turn.

2.1 To investigate the range and occurrence of the four-fold typology system of line, path, co-ordinate, and figural, type descriptions.

2.2 To consider the accuracy with which the listener found the desired point and marked it on the maze. However, since this is dependent on the quality and informativeness of the description, then

2.3 the ambiguity of the speakers' descriptions were analysed to give a weighted estimate (baseline) of the likelihood of finding a specific point.

2.4 To measure co-ordination within a given pair of subjects by determining their similarity of descriptive schemes.

2.1 PRELIMINARY ANALYSIS OF DESCRIPTIONS

A preliminary analysis of the transcriptions revealed a predominance of line and path descriptions, with a total absence of co-ordinate ones. Table 7.1 displays the proportion of descriptions which fell into each type.

TABLE 7.1 = PROPORTION OF DESCRIPTIONS FROM EACH AGE GROUP FALLING INTO THE DIFFERENT DESCRIPTIVE CATEGORIES

MEAN AGE	LINE	PATH	CO-ORD	FIGURAL	TOTAL
8 n=10	.72	.28	0	0	80
10 n=10	.18	.79	0	.04	80
12 n=10	.14	.86	0	0	80
TOTAL	.35	.64	0	.01	240

In all groups co-ordinate descriptions were totally absent from the dialogues, and figural ones negligible. One striking difference across age concerns the proportion of line and path descriptions. Whereas the youngest age group predominantly used line type, the two older groups preferred path type.

Since path and line type choice of descriptions are reciprocally related to a certain extent, a Chi Square one-sample test was carried out on the row frequency of path and line descriptions separately. For the line type descriptions, the Chi Square value was 45.14 much greater than the figure of 9.21 at 2 d.f. required for significance at the 0.01 level. With the path type descriptions, the Chi Square value was 26.62, once again much greater than the value of 9.21 for 2 d.f, required for significance at the 0.01 probability level. Thus both results were highly significant where the youngest group were preferring line to path, and the two older groups preferring path to line type descriptions.

It was noted that the descriptions were slightly different from those generated in the computer maze-game. This may be due to the various maze shapes used, such as the diagonal one, which was not used in the computer maze-game. Yet subjects replicated two of the four-fold descriptive categories. These were path and line type descriptions, which were similar in form and structure to those generated in the computer maze-game study. These results mirrored that of Anderson (1983) where he replicated path, line, and several instances of figural type descriptions, but no co-ordinate type.

In the computer maze-game the youngest age group did not demonstrate any preference for either line or path type descriptions, yet in the P&P study they indicated a preference of line to path type descriptions. It was suspected that the younger age group may prefer path to line type descriptions, since pre-negotiation is unnecessary apart from mentioning a starting point, and cognitive demand is at a minimum. However, in the P&P study the 8-year-olds generated less path type descriptions (than line type), and proved poor at locating them (see p279), which perhaps influenced the decreased use of this category. With path type descriptions, where the listener has to follow a set of directions, there may be more opportunities for the listeners to get confused on the route. The 8-year-olds were able to locate as many line type descriptions as the two older groups of children (see p279) since perhaps there was less chance of getting confused with different pieces of information as given in the path type descriptions. Their preference for line type may be reflected by this success rate.

The two older groups did not demonstrate any preferences for line or path type descriptions in the computer maze-game, yet the P&P study found a significant preference for path type descriptions. In the P&P study the quality of descriptions improved in the two older groups, where descriptions were less ambiguous (see p284). The two older groups may prefer path type descriptions in an attempt to produce clear unambiguous descriptions given the nature of the task. For example, the main aim of the experiment is for subjects to describe points on the diagram. Subjects are much less interactively involved and may evolve a good appreciation of the task. They may thus prefer path type descriptions since these are the less ambiguous of the descriptive types to use when there is less interaction and pre-negotiation of codes. For example, since there are few points to be described, and less opportunity for interaction subjects may not wish to set up a descriptive code for line or co-ordinate type descriptions. Path type descriptions may offer the best solution to allow explicit directions when there is little interaction available. The older children may also be more capable of following their partner's path type directions.

2.2 ANALYSIS OF CORRECTLY LOCATED POINTS

The second investigation concerned the listener's ability to locate the correct point from the speaker's instructions and mark it on their maze. Two main factors may influence the subject's ability to locate the desired point on the maze. One is their guessing ability to infer the best solution from the alternatives, while the other is their referential ability to use the appropriate skills to choose the correct referent from the set of alternatives. Both these skills have been found to improve over age and so the older children may be at a considerable advantage to the younger group.

From all age groups a total of 240 points were described (80 points for each age group) and 75% were accurately located by the listener. This was calculated by simply checking if two points matched up. This percentage appeared quite high compared to the ambiguity of the speaker's descriptions. The 8-year-olds located 68% of descriptions, which increased to 79% in the 10-year-old group, and 80% in the 12-year-old group.

A Chi Square one-sample test was carried out on the actual frequencies of the number of correctly located descriptions, by age. The Chi Square value was 1 which was less than the critical value of 5.99 for 2 d.f. at the 0.05 level of significance. Thus although we have a slight numerical pattern in the predicted direction with the older children successfully locating more points from their partner's description than the younger subjects, these results are not statistically significant.

Since path and line type descriptions were most common, a separate analysis was carried out to determine the number of each type which were correctly located. The actual frequencies of this analysis can be seen in Table 7.2.

TABLE 7.2 = NUMBER OF PATH AND LINE TYPE DESCRIPTIONS CORRECTLY LOCATED

	8 years		10 years		12 years	
	LINE	PATH	LINE	PATH	LINE	PATH
HITS	47	6	17	44	11	53
MISSES	10	17	0	16	0	16
TOTAL	57	23	17	60	11	69

A Chi Square test was carried out on the number of correctly located line descriptions for each age group, and then for the number of correctly located path type descriptions. Both analyses were normalised for the total number of each descriptive type. For the number of correctly located line type descriptions the Chi Square value was 0.94, which was much less than the critical value of 5.99 at 2 d.f at the 0.05 level of significance. Thus subjects' ability to locate a line type description was not affected by age where the 8-year-olds were able to locate a high number of these, and the two older groups demonstrated complete accuracy. For the number of correctly located path type descriptions the Chi Square value was 5.99 which was equal to the critical value of 5.99 at 2 d.f. for the 0.05 level of significance. So the ability to detect path type descriptions was affected by age, where the older children had more success in locating path type descriptions than the younger children.

The results from all age groups indicate that the older children are better at locating path type descriptions than the younger ones. The 8-year-olds have more line type descriptions than path, and when they get a path type description they have more misses than hits. With path type descriptions information is generally given in a number of small units and perhaps this gave the 8-year-olds more opportunities to get confused with the directions. In the computer maze-game children did not mark where they thought the point was and thus it was impossible to know whether the listeners were able to detect the location of a path type description. There were no developmental differences in children's ability to detect a line type description. Line descriptions may enable the listener to locate points, where they find the appropriate line on the maze and then the point on this line.

2.3 AMBIGUITY OF DESCRIPTIONS

From reading over the transcriptions, speakers appear to generate fairly ambiguous descriptions. For example, the following descriptions could lead to several points being located, and not necessarily one unique point.

1)Number 2's on the third line + fourth along (8 years old)

2)Ehm, well it's + top line, you count along + five boxes along on the top line, and then it's three down (10 years old)

3)First line, three along (12 years old)

Without referring to the actual maze used, these descriptions appear highly ambiguous. For example in (1) and (3) the speaker has not indicated what a line refers to, after all it could refer to either a horizontal or vertical alignment of nodes. The speaker has also omitted the initial reference point of their description, and failed to define what a 'box' entails. For example, a 'box' may be counted as: a small square node on the maze, the path joining two nodes, or the larger square box made up of four square maze nodes.

Thus a description such as (3) above, could refer to any of the following points on Figure 7.1.

In general there were few descriptions which would serve to pick out a point uniquely, although they did occur occasionally as in the following:

B Well you go to the top one

A Top left one?

B Yes

A And then go along one to the right

B Go along one box?

A Yes, and that's number one (10 years old)

In this case the left/right, and top/bottom, dimensions have been mentioned, as well as how many boxes to move along, although a box has not been defined.

Natural language is inherently ambiguous when analysed out of context. However when descriptions were viewed in the context of the maze shape they were generally far less ambiguous, where it was often obvious that they referred to only one point, or two at most.

Each description was then investigated in terms of the whole interactional unit, since descriptions which were ambiguous in the

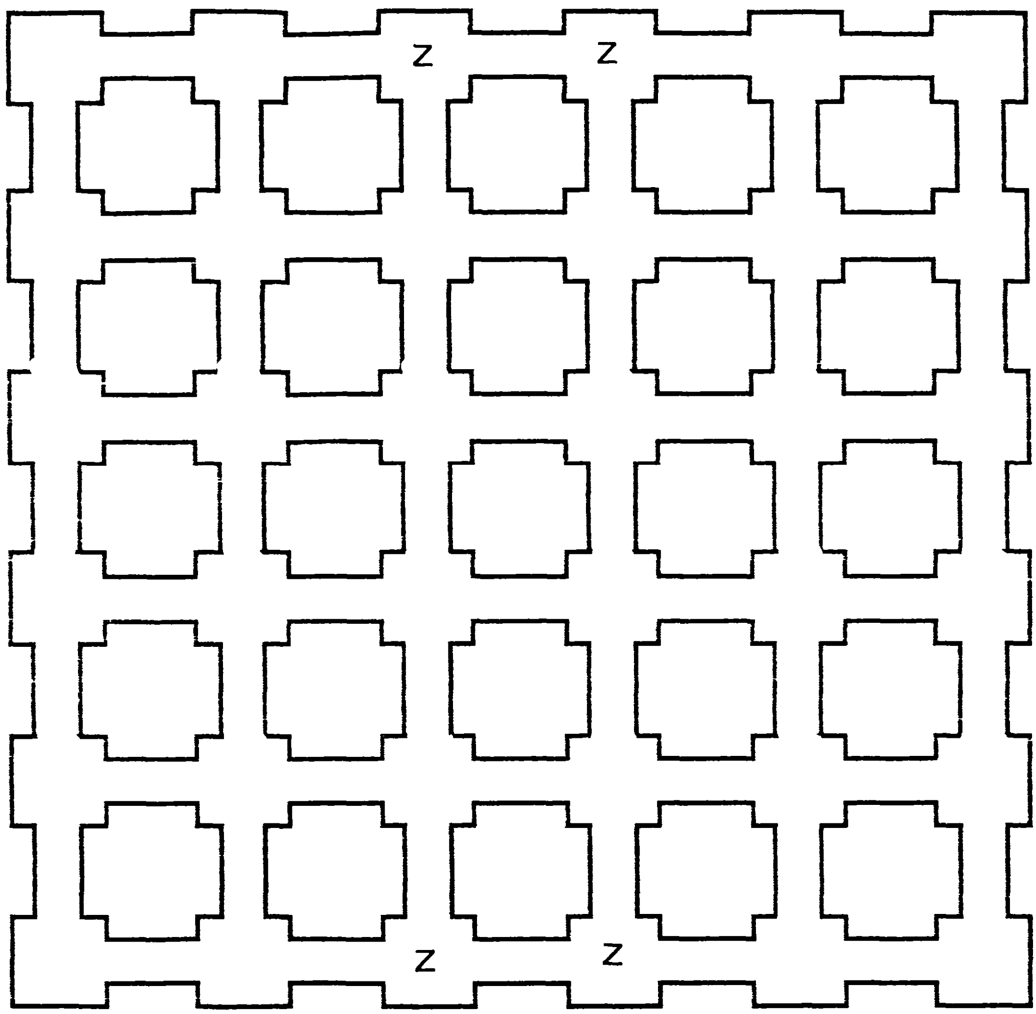


FIGURE 7.1 The description 'first line, three along' could refer to any of the above points marked by a Z.

early stages of the game often became less so over time where terms were expanded and clarified.

A classification scheme was devised where descriptions were assessed in terms of their ambiguity. Firstly, certain defaults were taken as being reliable and constant. For example certain terms appeared to be shared knowledge amongst the sample of children, such that a row almost always referred to a horizontal alignment of nodes, similarly a column to a vertical alignment. In addition most children began counting and describing points from an origin point of the top left hand corner. Similar results have been found in picture coding where this point acts as an implicit reference. This may develop and be reinforced by learning to read and write from here, and cross-cultural studies on people who read and write from other reference points may prove this to be the case. On the other hand, some evidence indicates that more sophisticated describers use the bottom left-hand corner as a reference since this is the origin of graphs. The first line generally referred to the first, bottom horizontal row, yet in Britain at least, the bottom ground level of a building is almost always referred to as the ground floor, with the next level referred to as the first floor. And floors are always ordered from the ground.

There were 240 descriptions generated in this study and each description was classified in terms of an ambiguity scale using the specific maze diagram for reference and assessing its position in the dialogue. Each description was classified in terms of whether it was ambiguous or not, and if it was ambiguous, then to what degree. For example, could the description refer to 2, 4, or 6, points? The scale was as shown in Table 7.3.

TABLE 7.3 = AMBIGUITY SCALE FOR ASSESSING DESCRIPTIONS

	UNAMBIGUOUS	AMBIGUOUS				
		2	3	4	5	6
PAIR1	2	8		3		3

Thus for this pair of subjects in Table 7.3, 2 of their descriptions were classed as unambiguous, and their remaining 14 descriptions were ambiguous to varying degrees.

This analysis was carried out on all the descriptions by three independent judges, who were myself and two Psychology Honours students who were familiar with the experiment. The judges were instructed to analyse each description, along with the relevant maze, and rate it in terms of whether it was ambiguous (ie. could the description refer to more than one point on the maze), and if so then how many points could the descriptions refer to. There was a very high level of inter-judge agreement and those cases where disagreements occurred were dropped from the analysis. The results, in proportions, are summarised in Table 7.4.

TABLE 7.4 = THE PROPORTION OF DESCRIPTIONS FALLING INTO EACH LEVEL OF AMBIGUITY

AGE GROUP	UNAMBIGUOUS	AMBIGUOUS 2 3	4 5	6	TOTAL AMBIG.	TOTAL LOCATED
8 years n=10	.16	.4	.2	.2	.84	.68
10 years n=10	.61	.16	.16	.05	.39	.79
12 years n=10	.47	.16	.2	.15	.53	.80
TOTAL	.42	.25	.2	.14	.58	.75

A Chi Square one-sample test was performed on the number of ambiguous descriptions to determine whether there was a significant difference between the age groups. The Chi Square value was 20.7, which was much greater than the critical value of 9.21 at 2 d.f. at the 0.01 level of significance. Thus the age of subjects determined the number of ambiguous descriptions generated with fewer produced in the older children. Table 7.4 illustrates how the 8-year-olds generated more ambiguous descriptions than the two older groups, and it is quite striking how the 10-year-olds produced less ambiguous descriptions than the 12-year-olds.

From all age groups, with a total of 240 descriptions, 100 were classed as unambiguous, compared to 140 classed as ambiguous. Yet listeners succeeded in discovering 75% of the appropriate points from their partner's description. Generally there were a number of positions the description could refer to. For example, if there were 36 points on the maze, then by chance alone there would be a 1 in 36 chance of guessing the correct location. To calculate the reliability of the number of correctly located points, the number of points which may have been found by chance alone was used. Thus a weighted baseline was calculated for each age group on the basis of the number of descriptions in each ambiguity slot, multiplied by the corresponding number of points it could refer to (for example, .5, .25, or .17), and divided by the total number of points being described, which was 80 in each group. The figures generated act as a baseline to the amount of descriptions we may expect correct by chance. Thus if a child was insensitive to descriptions and failed to give any feedback, we would still expect this percentage correct by chance. This figure may now be compared to the actual figures for the three age groups, to discover if our results are significant or not. The results indicated that all groups were able to get more from the descriptions than chance alone compared against the potential ambiguity.

The ambiguity of each description was then correlated with its correct location, with the results displayed in Table 7.5.

TABLE 7.5 = THE NUMBER OF UNAMBIGUOUS AND AMBIGUOUS DESCRIPTIONS AND THE TOTAL CORRECTLY LOCATED

AGE	UNAMBIGUOUS	AMBIGUOUS	NO. LOCATED
8 YEARS	14	66	54
10 YEARS	49	31	63
12 YEARS	37	43	64

This analysis did not prove particularly informative. For example, 66 of the 8-year-olds descriptions were classed as ambiguous and 14 as unambiguous, yet listeners correctly located 54 points from the speaker's descriptions. Thus it may be more informative to correlate unambiguous plus low ambiguous descriptions (where the description could refer to two points) with the correct location of the point. Table 7.6 indicated that most listeners found the desired point whether the description was unambiguous or slightly ambiguous.

TABLE 7.6 = THE NUMBER OF UNAMBIGUOUS PLUS LOW AMBIGUOUS DESCRIPTIONS AND THE TOTAL CORRECTLY LOCATED

AGE	UNAMBIGUOUS + LOW AMBIG. (2 points)	AMBIGUOUS (4&6 points)	NO. LOCATED
8 YEARS	45	35	54
10 YEARS	62	18	63
12 YEARS	52	28	64

A Pearson Product-Moment Correlation was carried out on unambiguous plus low ambiguous points, against the correct location of the point, across all the age groups. The Product Moment correlation was 0.69 which was greater than the value at the 0.01 level (r=0.64) d.f. = 13, to conclude that there was a significant relationship between low ambiguity of descriptions and partner's success in locating the point.

Three separate correlations were than carried out for each age group on these two measures to determine any developmental differences between low ambiguity and correct location of the point. For the 8-year-old group the value was 0.455 which was a modest correlation, yet not a significant one. The two older groups both had a high correlation score at the 0.01 level (r=0.765) d.f.= 8. The values were 0.84 for the 10-year-old group, and 0.79 for the 12-year-old group. Therefore the two older groups demonstrated a significant relationship between low ambiguity of descriptions and success in locating them. Thus although the general correlation on the age groups was significant, when analysed separately the youngest group did not demonstrate a significant correlation between the two measures.

It appeared that errors in locating points were only evident when the descriptions were extremely vague with speakers making gross errors such as confusing their left and right.

The following type of ambiguous descriptions were generally located without any difficulty:

First line third square, number 1
Third line second last, number 2
It's on the third line and it's the first one
Three boxes along on the first line
Ehm five, five, boxes along from the third line
(8 years old)

It appeared that only very vague descriptions such as the following were confusing and impossible to locate:

A See the fifth row, fifth row, have you got it?

B Uhu

A Go to the second, three steps towards the right, go
like one, two, three, move to the other

B Uhu (8 years old)

A Look where number 1 is, right?

B Uhu

A Look all the way down to them boxes and then look on
the next row, look at the very fourth row, right?

B Uhu

A From the bottom count four steps and then you come to
number four, just write number 2 in that box

B Uhu (8 years old)

The listener was often willing to accept such descriptions without querying the speaker. A count was then made of the number of ambiguous descriptions which were accepted by the listener without any queries. Thus for each age group this was separated into the number of ambiguous descriptions which could refer to two points (low-ambiguity), and those that could refer to more than two points (high-ambiguity), and whether they were queried by the listener, with the proportions displayed in Table 7.7.

TABLE 7.7 = THE PROPORTION OF AMBIGUOUS DESCRIPTIONS ACCEPTED WITHOUT ANY QUERIES FROM THE LISTENER FOR EACH AGE GROUP

Age	Ambiguous descr. could refer to two points	Ambiguous descr. could refer to more than two points
8 years	90.6	77
10 years	46	61
12 years	93	31

Thus, the 8-year-olds accepted 90.6% of low-ambiguity descriptions without any questions, compared to accepting 77% of high-ambiguity descriptions without querying them. It is surprising to note that the 8- and 12-year-olds accepted nearly the same amount of low-ambiguity descriptions without querying them, whereas the 10-year-olds accepted a much lower number of these descriptions. A Chi Square one-sample test was performed on the actual number of cases where subjects accepted low-ambiguity descriptions without questioning them, for the three age groups of children. The Chi Square value of 2.68 was less than the critical value of 5.99 required at the 0.05 level of significance at 2. d.f. A Chi Square one-sample test was then performed on the actual number of high-ambiguity descriptions accepted without query, for the three different age groups. The Chi Square value of 1.95 was less than the critical value of 5.99 required for the 0.05 level of significance at 2 d.f. Thus the suspected trend of the younger children accepting more high-ambiguity descriptions without querying them, than the older children did not prove a significant one. Thus the only general findings were the correlation of low ambiguity with the successful location of the point, and the substantial number of ambiguous descriptions which were unqueried by any of the age groups in the sample.

2.4 RANK ORDER CHOICE

In order to discover the level of co-ordination occurring between subjects, their descriptions were investigated for similarity. A rank order of choice table was tabulated to display the similarity of descriptive scheme within a pair of subjects. This was calculated in the following way:

a) For each subject the actual number of descriptions of each type were calculated. For example:

GROUP 1		LINE	PATH	FIG.
PAIR 1	A	7	3	0
	B	5	2	0

b) These scores were then ranked from 1 to 3 according to frequency, with 1 being the most frequent and 3 the least.

GROUP 1		LINE	PATH	FIG.
PAIR 1	A	7 (1)	3 (2)	0 (3)
	B	5 (1)	2 (2)	0 (3)

c) It was then possible to obtain a measure of similarity of descriptive pattern by calculating the total absolute difference between rankings for any comparison pair. Zero indicates identical patterns, while if purely by chance it should be 3.5. Although this may appear a rather crude analysis, it nevertheless indicates co-ordination of descriptive scheme within any dialogue. For example, if dialogue partners are co-ordinating their language, then by coding the occurrence of these particular expressions will allow a measure of co-ordination. Thus if the absolute difference in ranks is 0, this indicates total descriptive co-ordination between this pair. So for each pair their 16 descriptions were coded as either line, path, or figural, and then ranked and the absolute rank difference scores are noted in Table 7.8.

TABLE 7.8 = SUBJECT PAIRS ABSOLUTE DIFFERENCE IN RANKS

AGE	8 years	10 years	12 years
PAIR A	2	2	0
PAIR B	1	0	0
PAIR C	0	0	0
PAIR D	1	0	2
PAIR E	0	0	0
MEAN RANK N	0.8	0.4	0.4

In the youngest group, two pairs had total entrainment, where they were using the same descriptive scheme as each other, which increased to four pairs displaying total entrainment in the 10- and 12-year-old groups. A Chi Square one-sample test was performed on the total number of subject pairs displaying an absolute difference in ranks score of 0, to determine if this was affected by the age of subjects. The Chi Square value was 0.83 which was much less than the critical value of 5.99 at the 0.05 level of significance at 2 d.f. indicating that the increase in co-ordination from the 8-year-olds to the two older groups is not a significant one, and may have occurred by chance.

C. CONCLUSION

This study is a modified version of Anderson's (1983) interactive condition from his P&P study to investigate the generalizability of the four-fold typology scheme which emerged from the computer maze-game. In addition various other aspects were considered such as the quality of the information and the ambiguity of descriptions, the listener's ability to find the desired point, and the level of dialogue co-ordination occurring within pairs of subjects.

Anderson found a predominance of path type descriptions, followed by line, and then figural, with a total absence of co-ordinate type. He explained this due to several main differences between the two tasks, such as collaborativeness, spontaneity, dynamics, and social aspects.

The present study similarly found path type descriptions to be most predominant followed by line, then figural, with a total absence of co-ordinate type. There were also developmental preferences, with the youngest age group preferring line type to path, while the two older groups preferred path to line type. In this respect the older children were performing more like adults where they show a preference for path type descriptions.

In all three groups listeners managed to successively locate a high number of points with 75% being correctly located. Yet the corresponding descriptions appeared to be extremely ambiguous. An ambiguity count revealed 100 of the 240 descriptions to be classed as unambiguous, and 140 as ambiguous. These ambiguous descriptions were then coded further as to whether they could refer to 2,3,4,5, or 6 points. While inspecting the relationship between ambiguity and correct location of the corresponding point it was discovered that low ambiguity correlated with success, rather than with unambiguous points. Thus listeners seemed able to deduce the correct point from the speaker's unambiguous and low ambiguous descriptions. Furthermore, a high number of ambiguous descriptions were accepted without query by the listener, perhaps because ambiguous descriptions did not pose great problems. Probably as adults, we would require greater specification since our experience leads us to seek out alternatives in order to uniquely identify the point in question. On the other hand, children may be unaware of complications such as mentioning a reference point, or whether a line refers to a vertical, horizontal, or diagonal alignment of nodes. For instance, they may share classroom conventions where they automatically begin counting from the top left hand corner. This may explain their partner's willingness to locate a point on their maze without any queries. Another explanation is that they may believe that they are at fault and not that their partner's message is to blame, and so fail to approach their partner for more information. A further analysis revealed a high level of dialogue co-ordination occurring in the groups, where subjects pairs were using the same descriptive language as their partner.

From the results there appeared to be two main differences between the age groups. The first is the difference in their choice of descriptive scheme, since the 8-year-olds preferred line to path type, while the two older groups preferred path to line type. The second concerned the ambiguity of descriptions, where the youngest age group generated more ambiguous descriptions than the two older groups, yet their partner still found a high number of these points. This may be due to the limitations and restrictions on the number of possible alternatives that the description may refer to.

Since the experiment reported here used a limited number of subjects it seems that firm conclusions cannot be made. However, this study has been useful in replicating Anderson's results, and analysing several other issues.

The next chapter of the thesis reports the final conclusions from the studies, and relates the experimental findings to the research reviewed in the earlier chapters.

CHAPTER 8 CONCLUSIONS

The work reported in this thesis explored the development of communication skills as they relate to language, paying particular attention to the process where speakers and listeners co-ordinate on the shared meaning of natural language expressions. In particular, semantic and conceptual co-ordination was examined in 14 pairs of 8-, 10-, and 12-year-old school children, in the context of a specially designed computer maze-game.

A main strand of the thesis focused on the process of semantic negotiation and how this may occur in natural dialogue. In relation to this investigation, two basic types of knowledge were discussed - shared knowledge which refers to the portion of information we have in common with others, such as what the terms "up" and "down" refer to, or that a "column" is generally a vertical line while a "row" generally refers to a horizontal line, and mutual knowledge which develops from actually knowing that certain knowledge is shared. For example, in the following discussion Player B explicitly describes columns as "down the way", such that both subjects become aware that each is referring to columns as a vertical alignment of nodes:

A I've got to know where you are

B Well + you know down the way?

A Where I am?

B No in columns + you know in columns?

A Uhu

B Well I'm in the second column

A Uhu

B And I'm in the second square starting from the top

Although some type of mutual knowledge is required for successful communication, it remains debatable how the knowledge is assessed, and what mechanisms are involved in the process.

Semantic co-ordination was considered at two levels. Firstly in relation to general meaning within populations where they come to share certain interpretations of terms, and secondly in relation to specific encounters where communicators arrive at the same interpretation of expressions. Schelling (1960), and Lewis (1969), have argued that general co-ordination problems, such as the convergence on the meaning of natural language expressions, may be solved through explicit agreement when possible, or the use of various heuristics and tacit knowledge, such as conventions of use, when communication is not available. For example, Schelling proposed that co-ordination problems were solved using several heuristics - namely salience, familiarity, uniqueness, and precedence. From the computer maze-game it appeared that in the main, subjects relied on precedence to describe maze locations. For example, once one type of description had been used, both partners generally followed suit, and continued to use this code over the games. And salience of the maze shape did not play a great role in describing points from the figural or line based mazes, since path and line type descriptions dominated over all other descriptive schemes regardless of maze shape. However, Anderson and Garrod (1987) found evidence that the nature of the maze shape affected the descriptions generated from their adult subjects who were influenced by both the salience of the maze and precedence of descriptive schemes.

In particular cases of semantic co-ordination, such as definite reference, the controversy concerned whether a certain degree of mutual knowledge was required prior to, or during the interaction, and how mutual knowledge may develop. Clark and Marshall (1981) for instance, have argued that mutual knowledge is required prior to the interaction by the use of certain heuristics, while others such as Johnson-Laird (1982) have argued that mutual ignorance may even be an incentive to communicate since success in itself implies the existence of shared and mutual knowledge.

Semantic negotiation was investigated within the general framework of an interactionist approach, promoted by Rommetveit (1968, 83), which emphasises the relationship between the speaker and listener, the knowledge they share, and the social context of the exchange. It was argued that language use is inherently a social process and so depends on a variety of social-pragmatic factors for its success. This approach was contrasted with the traditional view which focuses on the isolated sentence as the basis of meaning without recourse to the speaker, listener, or social context of the exchange.

The data from the present studies tend to support the view that meaning evolves from the interaction, and the relationship between speakers and listeners in a dynamic way. From the dialogues from the computer maze-game, subjects did not appear to be totally dependent on a set of pre-determined assumptions but used alternative meanings of terms between different subjects pairs. All age groups produced evidence of joint language codes relative to the task, where subject pairs devised the meaning of terms at a local level in a spontaneous and dynamic way, using a variety of specific terms to the same effect. For example, some subject pairs referred to a horizontal alignment of nodes by the term "layer", while others used "storey", "floor", "row", "level", or "line". The following pair were using the term "row" to refer to a vertical alignment of nodes:

PAIR 5 10 years old

A What's your position?

B My position is + ehm + you know + on the + right-hand-side?

A Yes

B You know on the second box on the right the second line on the + the second row on the right?

A Yes

B I'm the second from the top

A Right

B Now where are you?

A I am + the very left row, third top box

A Where are you again?

B Eh + I'm I'm in the right-hand-side the second + the second + the second row from the right on the top + the second top

There was some indication of different mechanisms being used to achieve this semantic negotiation. Garrod and Anderson (1987) offered an output/input co-ordination principle to account for their observations of semantic negotiation from their adult data. To produce reference they hypothesised that speakers should attempt to use what succeeded previously, where they equilibrate production with comprehension. While they managed to simulate many description sequences with a computer model, they noted several limitations of the scheme. For instance, it blocked the development of novel schemes, and the fact that communicators can never be certain they share the same scheme but only to the extent that they can interpret the descriptions against their own scheme. In terms of the mechanism used to produce descriptions from the children's data, this output/input control principle may suit well since subjects appeared to rely on precedence, and there was not any great change in descriptive schemes across game. Furthermore, the children's descriptions did not always rely on success, since descriptions often failed and were inadequate yet they continued to be used (see examples on p212). Thus, with the youngest children at least, the output/input control principle could account for a number of the descriptive sequence dialogues. However, with the older groups it may not be able to account for the development of more efficient descriptive schemes over time.

The main mechanism used to achieve semantic co-ordination with the children appeared to be implicit negotiation where dialogue co-ordination occurred tacitly with one player introducing (by mentioning) a certain descriptive code and the other following suit (see examples on p262/3). Furthermore, there was little evidence of mutual knowledge being established prior to the interaction. In general children simply communicated plans and descriptions to their partner. Lewis's (1979) principle of 'master/slave' appeared to suit the rule, since often one child dominated the other by requesting the other's position on the maze, and implicitly defining the descriptive category to use. Yet contrary to the conclusions of Schelling (1960), and Lewis (1969), concerning the role of explicit negotiation in this process, it did not play a great role in solving the computer maze-game problem. Infact, only 3% of the descriptions were explicitly negotiated, where terms and their meaning were devised and explained openly between the subject pair. When this type of explicit negotiation did occur it was often after problems cropped up with descriptive scheme interpretations, rather than when subjects were initially devising a scheme. Most of the examples of explicit negotiation on p264 occurred after problems had arisen in the dialogues, such as the following:

PAIR 6 10 years old

B What are you talking about, I don't understand?

A Well there's 1 2 3 4 5 6, there's 6 layers isn't there?

A You know where I am don't you? In the second column, second from the top?

B Are you talking about columns down the way or columns across?

A Down

B Oh + and the second wee box?

A Uhu

B Starting from the top?

A Uhu

With access to the position of the children on the maze, one was able to observe the exact position being described at any time, and the problems encountered with misunderstandings, and how these were overcome. For example, player A is located at position A on Figure 8.1, and player B at position B, and they described their positions as:

PAIR 4 8 years old

B Look where are you?

A Right first row on the fourth box

B Oh + so you're down there? And I'm on + ehm the fifth row + on the first box

In this example it would appear that the players have different conceptions of the ordering of the term "row". For example, player B appears to order the rows from bottom to top, while interpreting player A's position, yet describes their own position ordering rows from top to bottom. However, this was tacitly rectified with player B's subsequent consistent ordering of the rows from top to bottom.

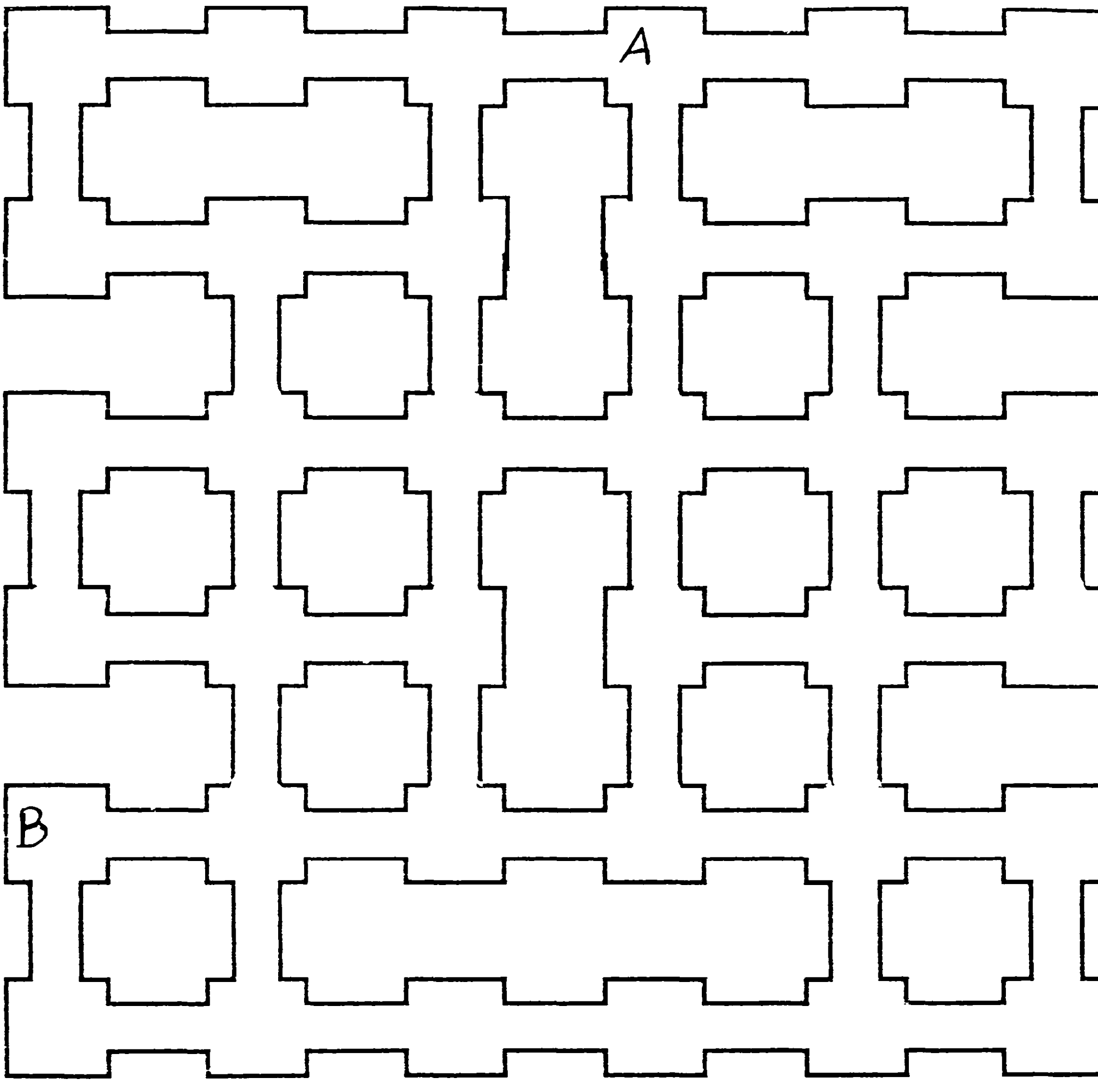


FIGURE 8.1

The following excerpts of dialogue illustrate another example of misunderstanding and how this was cleared up. Player A and Player B are located at the positions indicated in Figure 8.2:

<u>PAIR 9 10 years old</u>

A Where are you?

B Ehm + know where the + first line?

A The first line, yeh

B Ehm + three up

A Three up?

B Aye

A Look you mean the first two squares?

B Yeh the first two squares

In this example, Player B is referring to the right-hand full vertical alignment of nodes as a "line", whereas Player A uses explicit negotiation to define the first "line" as the first top horizontal alignment of nodes with the two squares on it. Yet when player A queries this description and asks if the first top horizontal alignment of nodes with the two squares is the "line" in question, player B agrees. This ability to readily accept player A's conception of "line" although incongruent with Player B's own definition, tends to indicate a type of superficial semantic co-ordination, where player B accepts the statement without fully understanding it. In many similar cases it was difficult to determine the level of semantic co-ordination occurring between the players, and to what extent they were genuinely co-ordinating their interpretations.

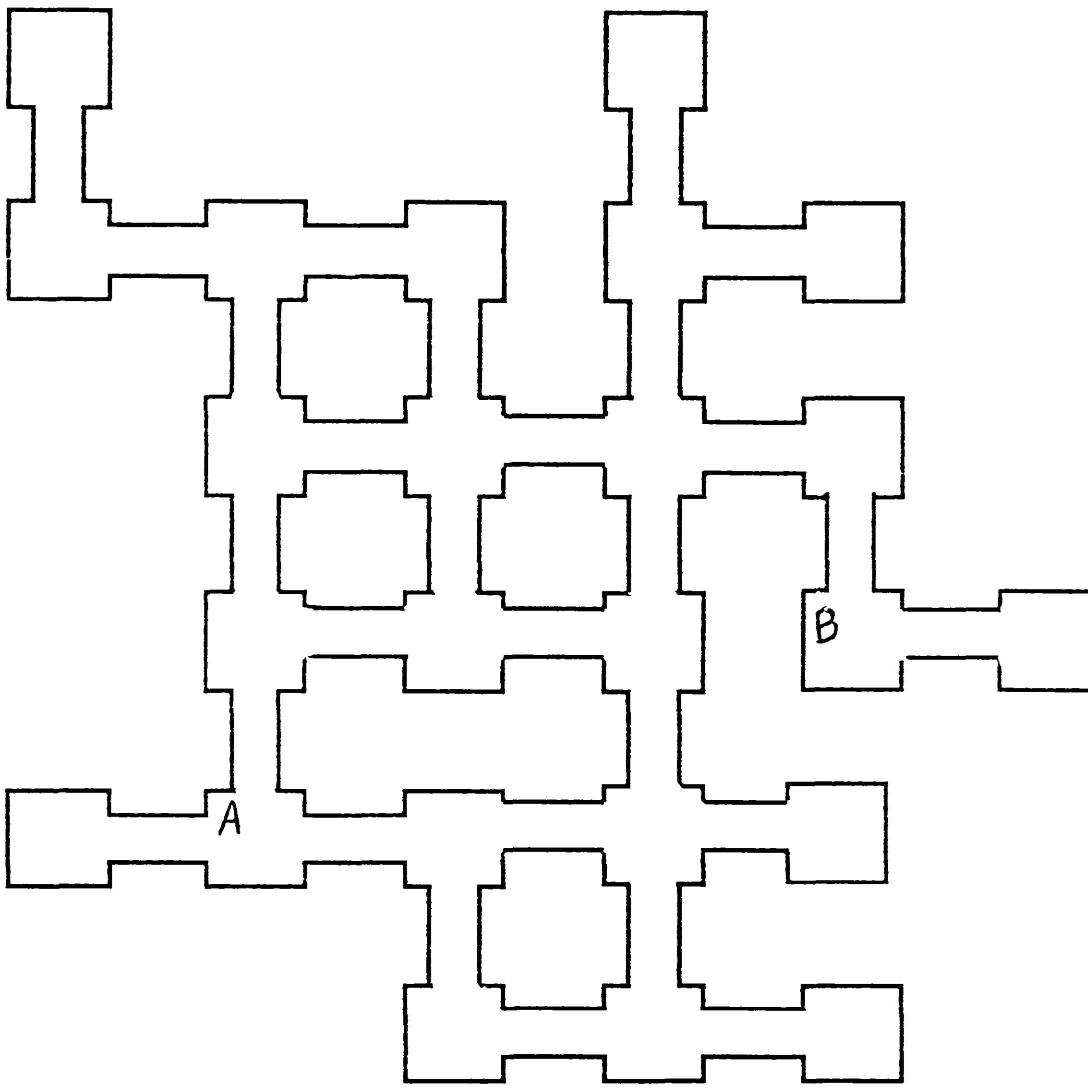


FIGURE 8.2

To continue with the above example, player B then described their position in the same manner but explicitly defined what they meant by the "first line":

A Where are you + tell me?

B OK + the first line on the right

A The first line on the right? + Alright I got that

B Eh three up

A Three up?

B Aye

A But there's no three up

At this point Player A is referring to the furthest right line with the one square sticking out, while Player B is referring to the next vertical line. The description continues:

B No you know the first line?

A Yeh + the one with two squares (now referring to the top, first horizontal alignment of nodes)

B The one with only one square (furthest right box sticking out)

A The one with only one square?

B Aye in it + then the line after that?

A Yeh right

B On the third one

A The third one

At this point both players appear to understand the descriptive scheme and have a mutually shared conception of the term "line", and so perhaps we now have true semantic co-ordination occurring between this pair of subjects. Thus their shared knowledge of what a "line" refers to has developed into mutual knowledge where A knows B's conception of the term "line", and B knows that A knows their conception of the term "line" and so on.

Thus although children demonstrate convergence on the names of similar expressions to use, it was not clear whether semantic co-ordination was occurring as regularly between pairs. The three groups produced statistical evidence of co-ordination of descriptive schemes, yet in some cases it was doubtful whether the 8-year-olds in particular, were co-ordinating on the meaning of expressions and understanding each others descriptions. For example, they often accepted partial and very inadequate information and were most concerned with whose turn it was to move rather than their partner's position on the maze (see examples on p174). It was possible that they were co-ordinating on the form of expressions at a superficial level, where the listeners were very passive, failed to monitor content and ask relevant questions, and accepted vague descriptions, since no objective scoring protocol procedure was required on their part. For example:

PAIR 3 8 years old

B Right + i'm on your left + I'm on my left-hand-side

A Right

B Two away from ehm the black screen OK?

A OK

PAIR 4 8 years old

A I'm over at the right one

B The right one + aha + found it + you're over on the right

B I'm over on the left one

A I can't see you

B I'm in the left one + over there + left top

A Where are you?

B I'm in + in the + left + I'm in the left ehm middle space

A Middle?

B Uhu

PAIR 6 8 years old

A I am about + the second line

B Second line?

A No the + yeh the second line

A What line are you on?

B About number three

A 1 2 3 shall I press down or up or sideways or left or right?

On the other hand true descriptive scheme co-ordination appeared to be occurring when the listener actively participated in the description by evaluating the contents of the message, asking relevant questions, and providing feedback in such ways that illustrated their understanding of the maze conception (see example on p303). Using a task based game, Brown (1985) found differences in the communicative styles of good and poor communicators due to the interaction between pairs, where success depended on the active involvement to note inconsistencies and act upon them, while failure to monitor content and ask appropriate questions resulted in poor performance. However, in the computer maze-game this distinction between superficial and true descriptive scheme co-ordination is difficult to establish objectively so more detailed investigations were not carried out.

The developmental review in Chapter 2 focused on how the child may develop such a shared meaning system, and the necessary skills to cope with communication in dialogue - whether through innate abilities, or due to early pre-linguistic experiences. This section emphasised the importance of parents for this development, which takes place within communicative experiences in the cultural environment, as well as the underlying influence of hereditary factors which play a more obscure role. The early developmental research generally concluded that young children demonstrate many problems while interacting, shown to improve over the school years. Piaget's (1926, 1955) egocentrism principle was one of the earliest and best known explanations for this failure, which blamed the child's inability to adopt a listener's perspective. However, the research conducted in this thesis concluded that this was not the case with the sample used. Young children proved to be fairly efficient communicators, where all three age groups were able to co-ordinate their language and interact to describe points on a complex computer maze. For example, all of the base-line games were successfully solved, and more than half of the more difficult monster games were completed by all age groups.

The experimental results from the computer maze-game were also incongruent with those of Krauss and Weinheimer (1964, 1966), and Anderson and Garrod (1987), in terms of a progressive reduction in description length in future use of a term. Krauss and Weinheimer concluded that interactors negotiate and develop private two-person idiosyncratic codes during communication where they exclusively share the specific meaning of the reference. Furthermore, they suggested that children may be poor communicators of reference because they are incapable of this co-operation. However, this thesis produced evidence that children were able to negotiate a shared conception and set of interpretations for the expressions they were using within particular dialogues. Even the 8-year-olds negotiated idiosyncratic codes to describe maze locations. Yet the length of maze descriptions (in terms of the number of words), did not reduce over the games. For example, game type did not affect the length of descriptions, and subjects were not producing more efficient and economic codes across game, at least not in terms of description length. Age appeared to be the only significant factor affecting the length of the descriptions.

Others such as Asher and Oden (1976) proposed that children produce uninformative reference because they ignore the nonreferents and so produce ambiguous descriptions. Descriptions generated from the computer maze-game and P&P study were generally ambiguous, yet this did not appear to be so much of a problem, and subjects accepted a high number of ambiguous descriptions without querying them. Infact the youngest age group produced more ambiguous descriptions than the two older groups, yet located just as many points, proving themselves to be exceptionally skilful at locating points from ambiguous descriptions. It was argued that this may be due to their limited set of possible alternatives for the location of the point, so that they have less chance of choosing the wrong point. On the whole it appeared that only very ambiguous descriptions were unsuccessfully located. In this respect subjects may be relying on salience as Schelling and Lewis claimed, since although many descriptions were ambiguous, their partner chose the most salient meaning from the set of alternatives which often proved correct. This analysis was impossible with the computer maze-game since listeners were not requested to physically locate a position from their partner's description.

Other sets of studies produced evidence that young children were able to communicate referentially with a listener if the tasks were simple, and the child was aware of the skills to use, and possessed the necessary lexicon to express their intentions. Further evidence from the literature review concluded clear age divisions in children's ability to evaluate and monitor the contents of information (Markman, 1977). So from this developmental section it was concluded that children either fail to monitor messages, or monitor but fail to note inadequacies, or note inadequacies but fail to act upon them unless prompted by an adult. The maze-game data produced many examples of the younger children failing to monitor due to task involvement (see examples on p171/2), as well as their apparent lack of awareness of what constitutes an informative description (see examples on p305). For instance, they often seemed to request maze locations from their partner only because they had grasped this from the rules of the game, yet accepted some weak and partial information.

Deutsch and Pechman (1982) found that social interaction alleviated many communication deficits and improved performance and referential communication, which was also shown to be beneficial in the maze-game. The use of feedback in the way of queries, interruptions, clarifications, and so on, greatly improved and developed the descriptions in many cases (see example on p303), since interaction led to an increased chance of more information with the possibility of success. Yet it proved impossible to classify the adequacy of a response on the computer maze-game since one was never completely sure whether this indicated greater semantic co-ordination since subjects were not dealing with specific objects from a limited spatial array. Furthermore, since the main focus of this thesis fell on descriptive scheme co-ordination, time did not permit a detailed analysis and classification of quality of response.

In the computer maze-game several efficiency measures were employed on the children's data to investigate problem solving ability across age and game, concentrating on a non-linguistic measure of the rate of moving, and a linguistic measure of the mean number of utterances by both players between successive moves. These efficiency measures were based on those of Garrod and Anderson (1987) from adults' performance on the computer maze-game. For all games the only significant difference among the child subjects was on the mean number of utterances between moves where the older children were saying more between moves than the younger ones, which tends to indicate that speech focusing on the problem increases with age. From a detailed analysis of the actual performances, the younger subjects appeared to be far more excited in relation to the monster and so moved quickly to avoid its path regardless of their goal position. In this way they tended to plan less between moves. The two older groups appeared to have a better conception of the rules of the game and so attempted to avoid the monster, while focusing on the task of reaching their goal, therefore more detailed planning and co-operation was required between moves, which was reflected in the dialogue.

Using a task oriented game A. H. Anderson (1988) found that more difficult tasks produced greater communication from subjects. Yet in the more difficult monster games in the computer maze-game this did not appear to be the case. For example, there were no significant differences in the number of descriptions produced across game, nor of the number of words in descriptions across game. The only significant difference was in the number of descriptions generated across age, with more descriptions generated in the older children, which were more economic and efficient in terms of word length. When successfully solved, and failed, monster games were compared the only significant result was the rate of moving which was higher for successful than failed monster games for all age groups.

The 1332 descriptions generated from the children's games were then investigated in terms of their semantic contents. Results were in accordance with Garrod and Anderson (1987), since children used fairly consistent schemes to describe points on the maze spatial array. For all the age groups of children a content analysis revealed a line and path type category to be most predominant, with figural and a simplified version of a co-ordinate scheme being less popular. There was also a preference for figural and co-ordinate type descriptions across age. Whereas the younger subjects preferred figural to co-ordinate descriptions, the two older groups preferred co-ordinate to figural type.

While Garrod and Anderson noticed continuous improvement in co-ordination of descriptive schemes from game1 to game2 in their adult data, there was no evidence of continuous improvement in the children's dialogues. However, on the number of games where subject pairs had an absolute difference in ranks score of 0, all groups of children increased co-ordination from game1 to game2, but not game2 to game3. The initial increase in co-ordination may demonstrate early entrainment and convergence onto a description scheme, while the result from game2 to game3 (ie. no increase in co-ordination) may reflect some discrepancy in partner's schemes, where one partner changes to a more efficient scheme while the other fails to incorporate the change. Garrod and Anderson also found that most adults changed scheme as a pair, therefore they were not changing to a scheme used by the other but both changing together to a new scheme. In comparison the children in the computer maze-game were not doing this. One member of the pair generally changed to suit the other, where it appeared to depend on who dominated. Thus they shift in order to merge with their partner's scheme. Although it would have been interesting to look at this aspect of dominance in more detail, it proved rather difficult to define since in some cases there was a dominant partner who persistently asked the other for their location on the maze while avoiding description themselves, yet the describer was the dominant one who was defining the descriptive scheme to use. Thus general dominance, and descriptive scheme dominance, would firstly have to be defined. In other cases of explicit negotiation of schemes (see example on p264/5) one partner was clearly determining the descriptive scheme used, yet this type of negotiation was quite uncommon compared to implicit negotiation. Thus a definition of dominance required a more subtle and specific analysis which did not fall within the scope of the present research. Indeed many other potential investigations fell outwith the range of the thesis, such as how descriptions evolved over time and move number, the quality of response from the listener, general overall planning techniques, meta comments, pauses, question and answer sequences, and so forth.

The type of task based approach used in the thesis emphasised the interactional possibilities of the exchange, where communicators negotiated certain solutions, such as reference, over a whole series of interactional turns. Subject pairs appeared to use the interaction to produce greater understanding of descriptive schemes over sections of dialogue. This process mirrors the way that parents and elders take advantage of the interaction to increase communicative success with the developing child and maintain the conversation. For example, word meaning develops gradually in the young child through precedence of the parents' use of the term, and from the interaction surrounding the use of the word. Yet earlier studies generally investigated the development of word meaning through detailed analysis of a single young child. The type of task based approach outlined in this thesis offers a more realistic and informative picture of the child's communication skills over a longer time period, since there is the opportunity for free interaction, similar to real life encounters. Through the computer maze-game structure we can observe how terms are introduced into the conversation, and how local meaning gradually develops, such that both players come to use specific terms to refer to the same concept. Indeed this process of word meaning is not confined to early childhood but continually occurring throughout our everyday life where we encounter new words, and tacitly negotiate their meaning through precedence and the interactional opportunities in the conversation.

These findings from the computer maze-game have implications far beyond the task employed, and have broad applications for the development of meaning on the whole, and indeed any process that involves the establishment of a semantic system within a particular context. For instance, since all of the age groups of children demonstrated strong evidence for general convergence on a similar description scheme, this would tend to indicate that poor communication may not be due to co-ordination of meaning. It was found that children of 8, 10, and 12 years old, were able to engage in semantic negotiation, and co-ordinate on the form and meaning of expressions in certain occasions of use. To this extent, they were inferring meaning from the interaction to co-ordinate their interpretations with others, rather than depending on the conceptual contents of the words alone. Thus social interaction with others, and the use of social-pragmatic factors, play a critical role in establishing a shared meaning system. This would tend to suggest that social-pragmatic factors are essential to a theory of meaning and should be considered in relation to the development of interactional skills.

Surprisingly this research did not produce any main developmental effects over a period from 8 to 12 years old. Recent work by Anderson, Clark, and Mullin (1989), produced evidence that skill has important effects on communicative performance rather than age alone. In the studies reported in this thesis most of the analyses used the age of the subjects, and the game, as the main variables of investigation. Although the factor of age produced significant differences across several of the maze-game analyses (such as the length of descriptions, and the number of descriptions generated, and in the P&P study on the ambiguity of descriptions, and subjects' preference for certain schemes), there were very few differences found across games, apart from some indication of increased co-ordination between game1 and game2. There also appeared to be a selection of good and poor communicators from each age group, thus perhaps IQ, and partner variables, are more important for successful reference than simply age alone. It may have been interesting to analyse each subject's performance in terms of skill and compare top and bottom performers from all age groups. Yet the studies reported in this thesis were not devised with this in mind, and it was not clear what constituted a 'good' or 'poor' performance on the maze-game. For example, were the best measures of success the time taken to reach the goal, the number of moves used and penalties incurred, or the planning structure and level of descriptive scheme co-ordination? In any future studies some independent intelligence score and objective performance measure may be more useful and necessary to produce more informative results which reflect communicative performance.

This research demonstrated that some of the 8-year-olds coped as well as the older children on many of the aspects investigated. This might suggest that children are not improving and developing over this age span on the measures discussed - that is on the skills involved in referential communication, and the ability to co-ordinate their language and produce joint descriptive schemes. Perhaps this indicates that reference does not pose a real problem in everyday interactions, unless one has to specifically identify some object from a detailed array, such as the earlier referential communication tasks involved. Shared knowledge may be an important aid for this process which is constantly available and enables an idea of meaning even before the interaction occurs. Another reason for the lack of developmental findings may be that the skills investigated in the thesis are perhaps well established by 8 years old. There is much evidence for the presence of a real basic communication skill from early childhood, although the nature and precision of the communication remains debatable. In this case efforts should be directed at a wider age span to incorporate a younger age group of children.

Finally, the three age groups of children investigated appeared quite similar in terms of the co-ordination onto similar description schemes. For example, all groups demonstrated co-ordination of description schemes, with some improvements in co-ordination over the games. However, it appeared that, with the youngest children at least, they shared common expressions without fully understanding them. For example, although all children were co-ordinating their descriptive schemes, it was not clear whether the youngest age group were actually co-ordinating on the meaning of the expressions.

However, with this one proviso, the results indicated that establishing meaning is essentially an interactive process, and that children were able to infer the meaning of terms from the interaction in specific contexts of use. Whether the youngest age group fully understood or not, they still produced evidence of co-ordination of terms. This tends to suggest that this basic process of co-ordination is a central component of all human interactional dialogue.

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APPENDICES

APPENDIX A: Mazes Used in the Computer Maze-Game

Maze 1 Row and Column Type

Maze 2 Horizontal Row Type

Maze 3 Horizontal Row Type

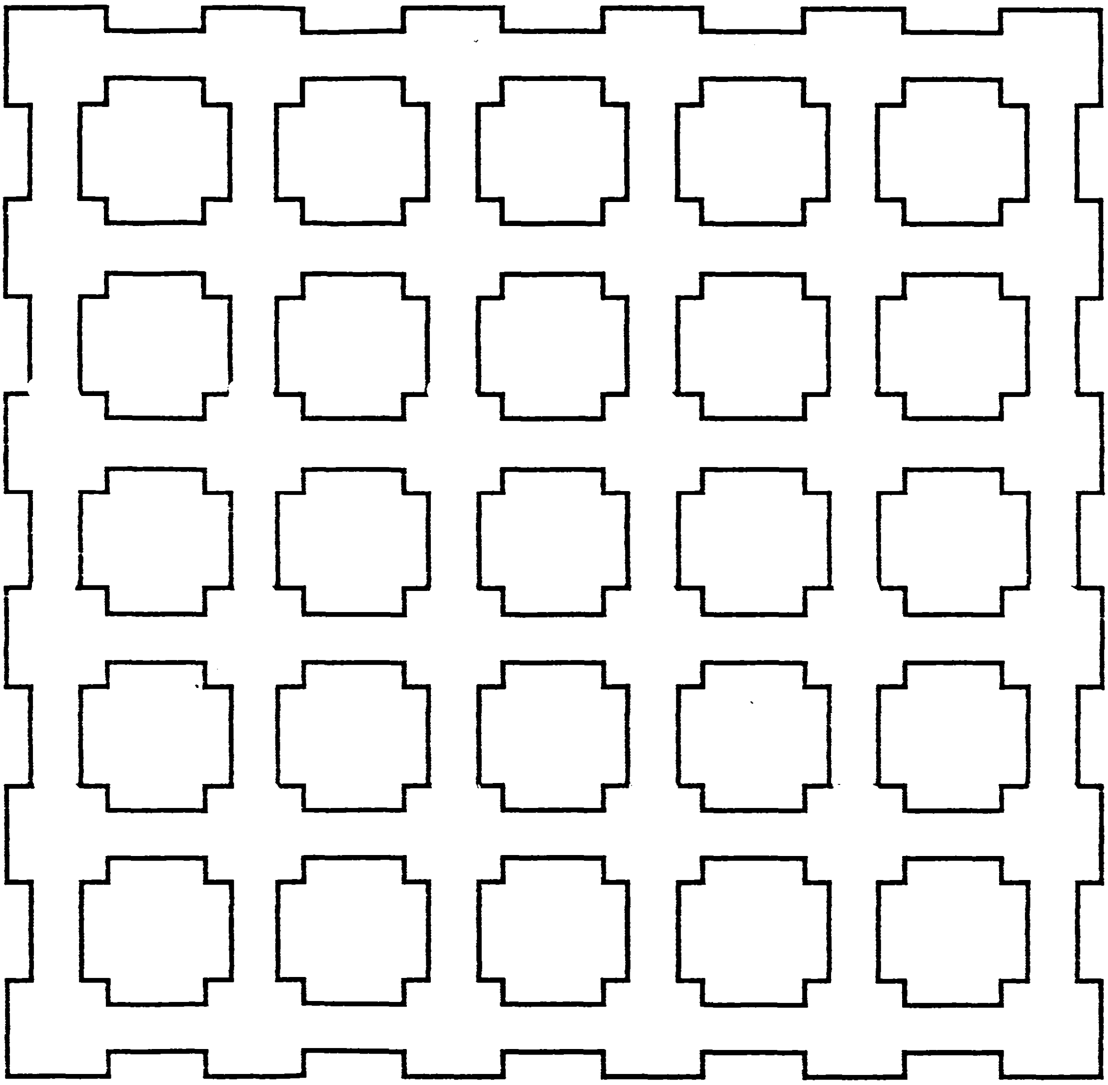
Maze 4 Horizontal Row Type

Maze 5 Vertical Column Type

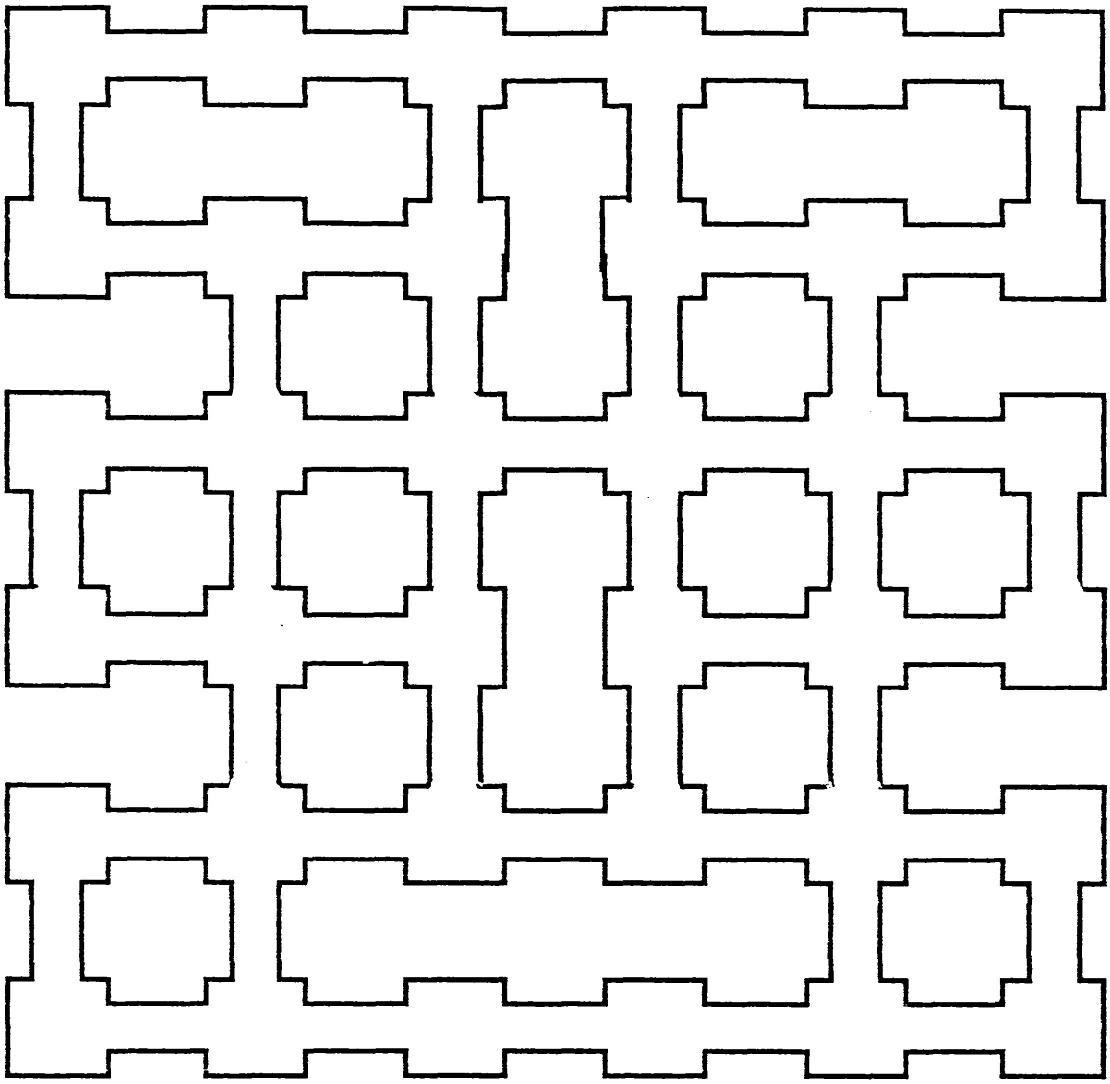
Maze 6 Figural Type

Maze 7 Figural Type

Maze 8 Mixed Type



MAZE 1 ROW AND COLUMN TYPE



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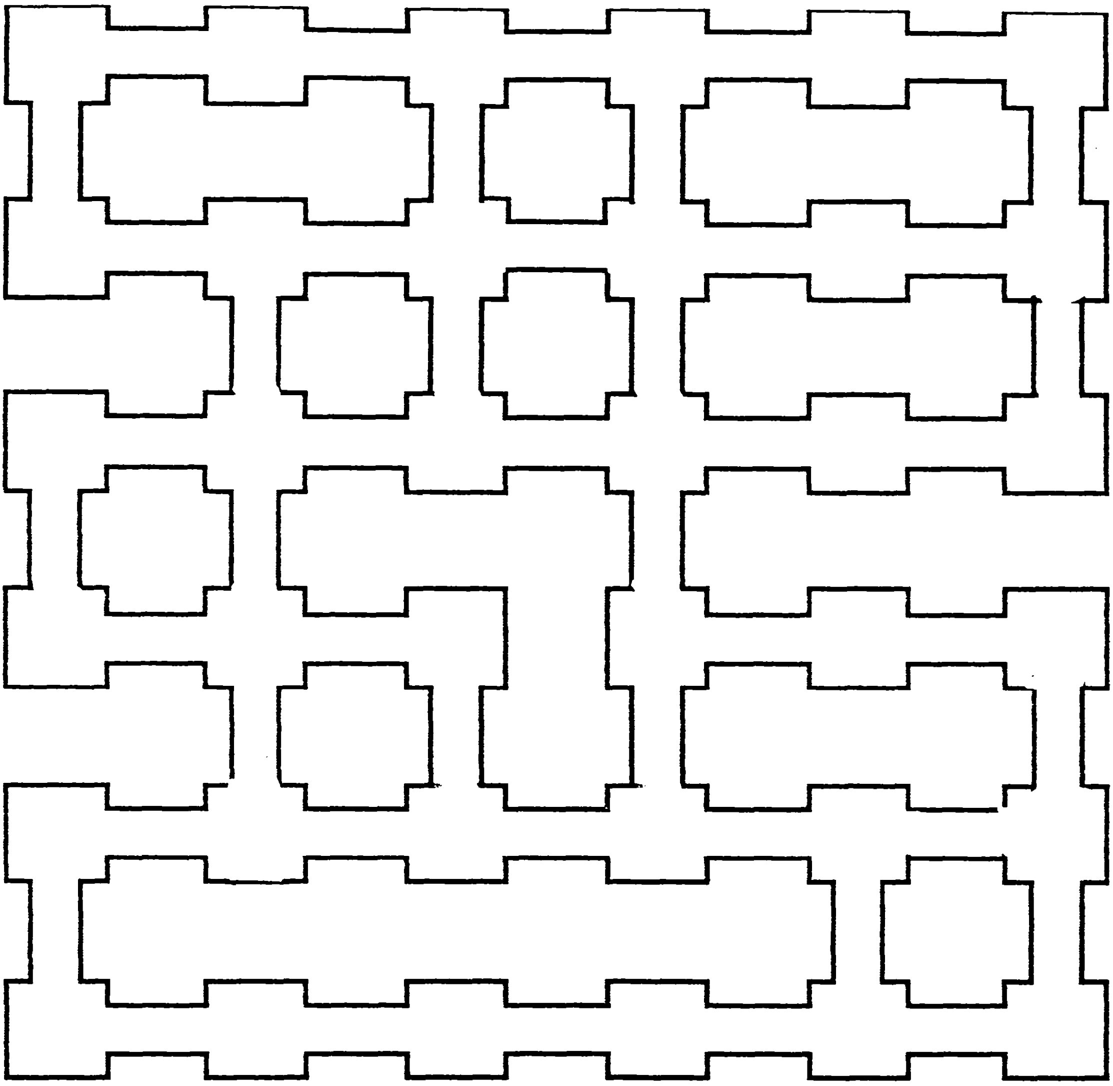

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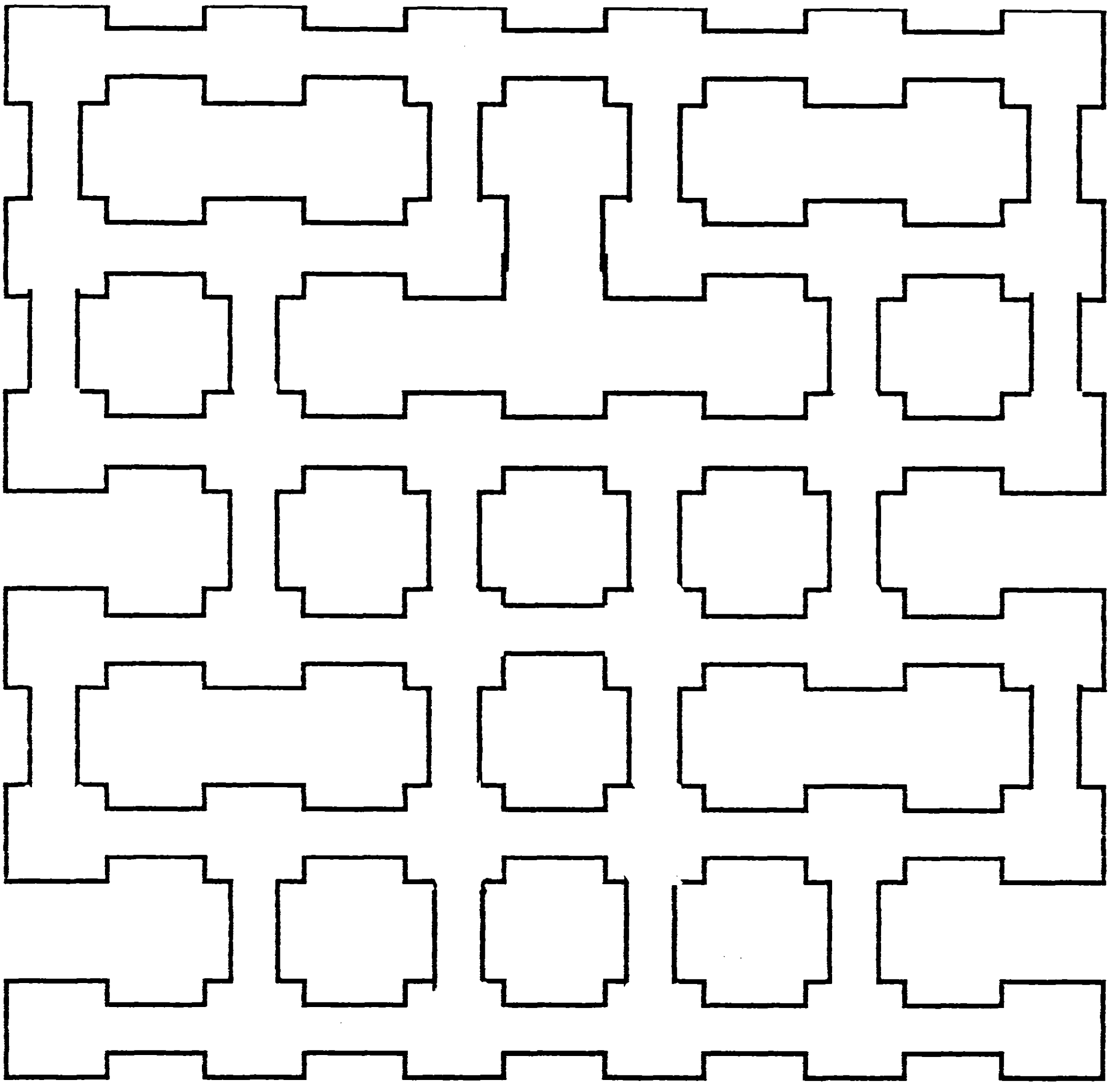

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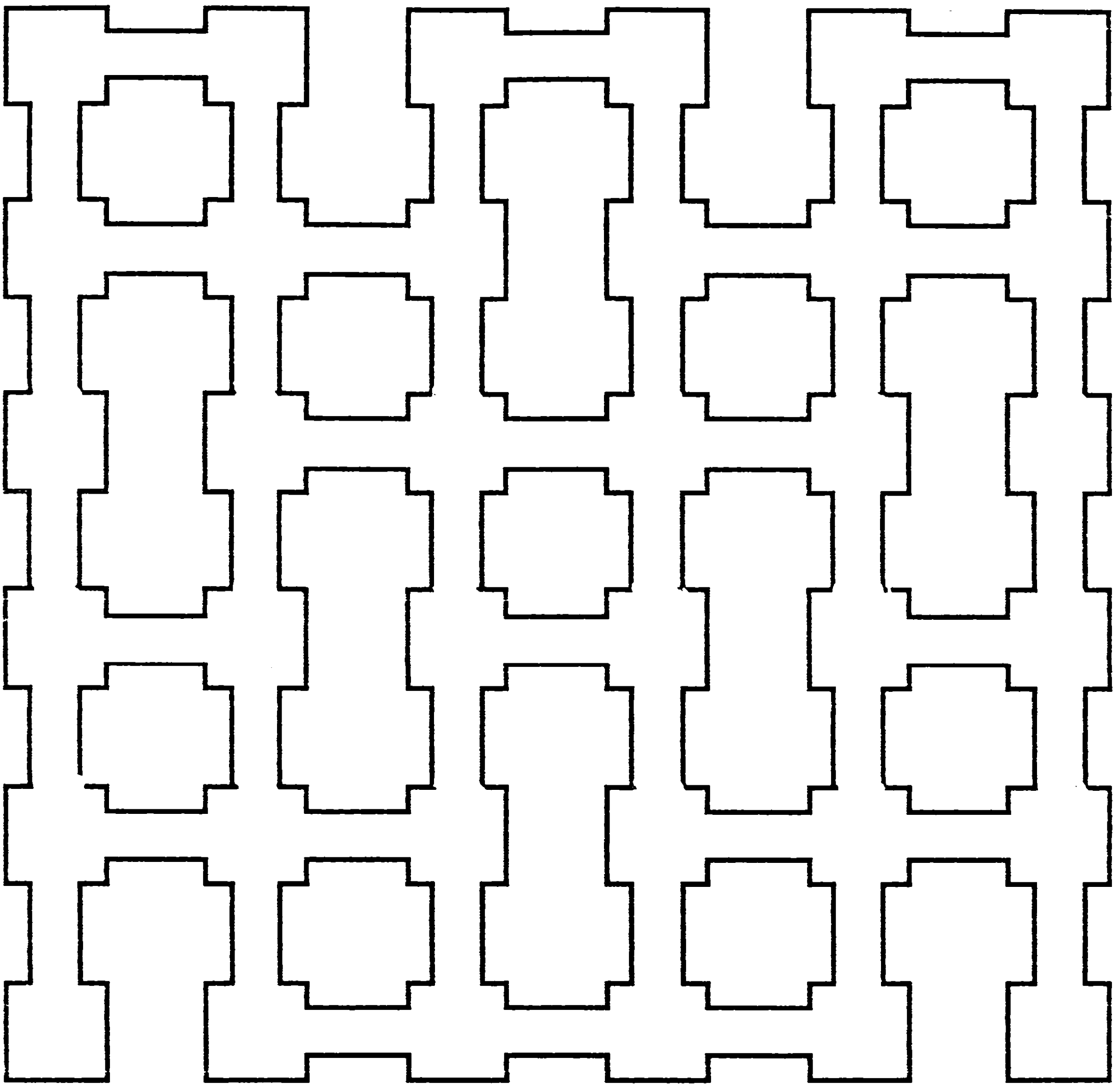
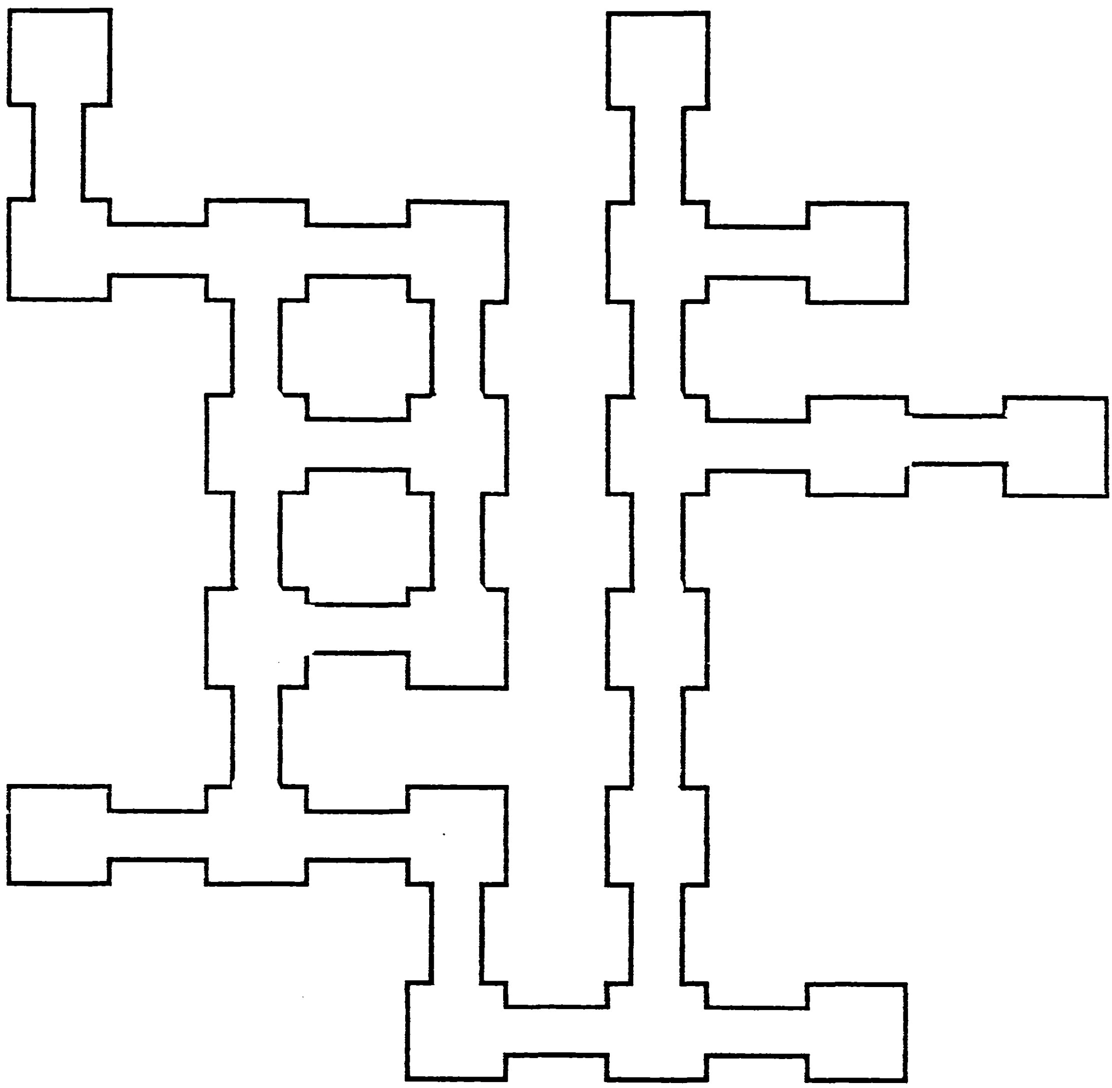
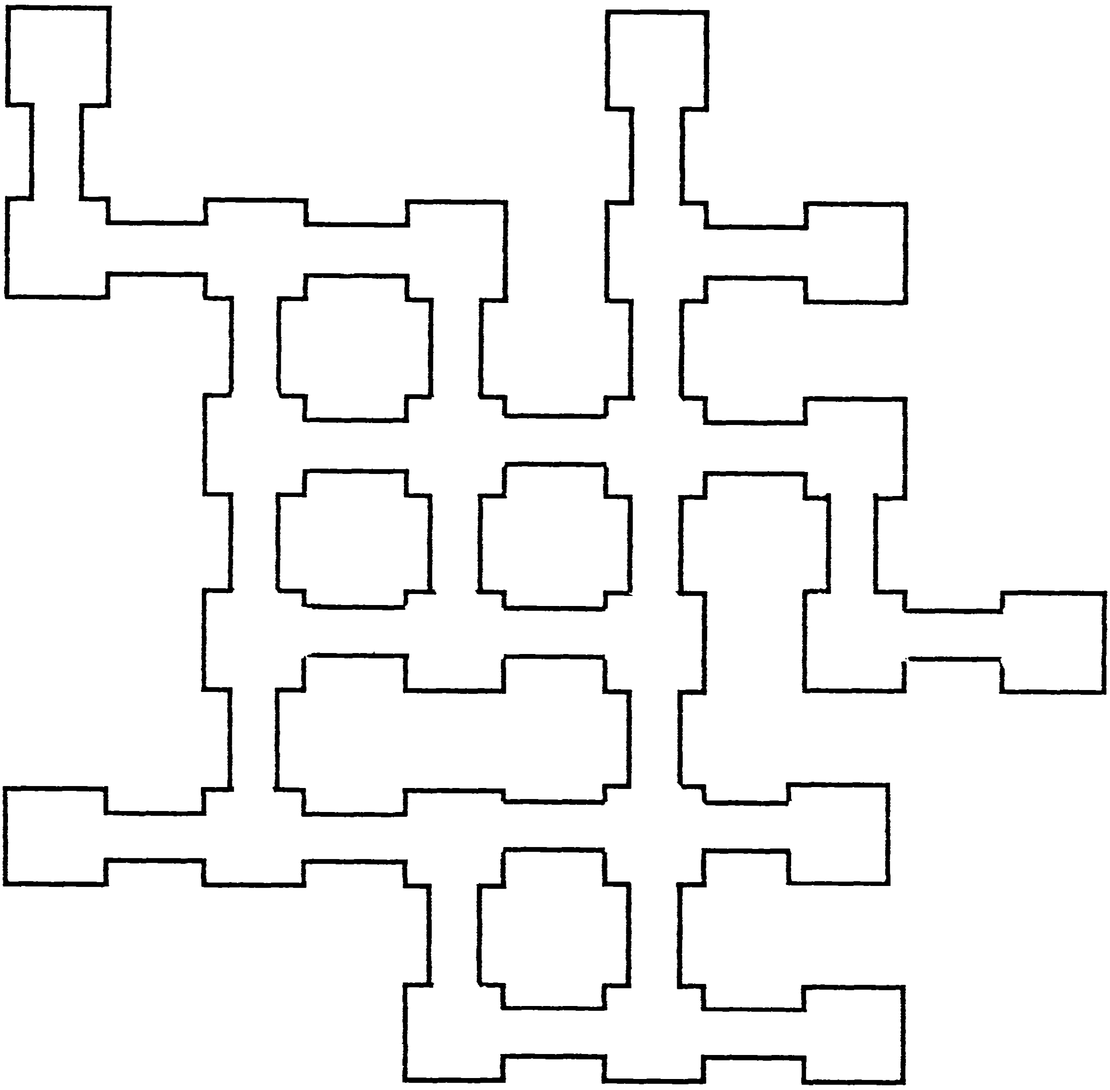


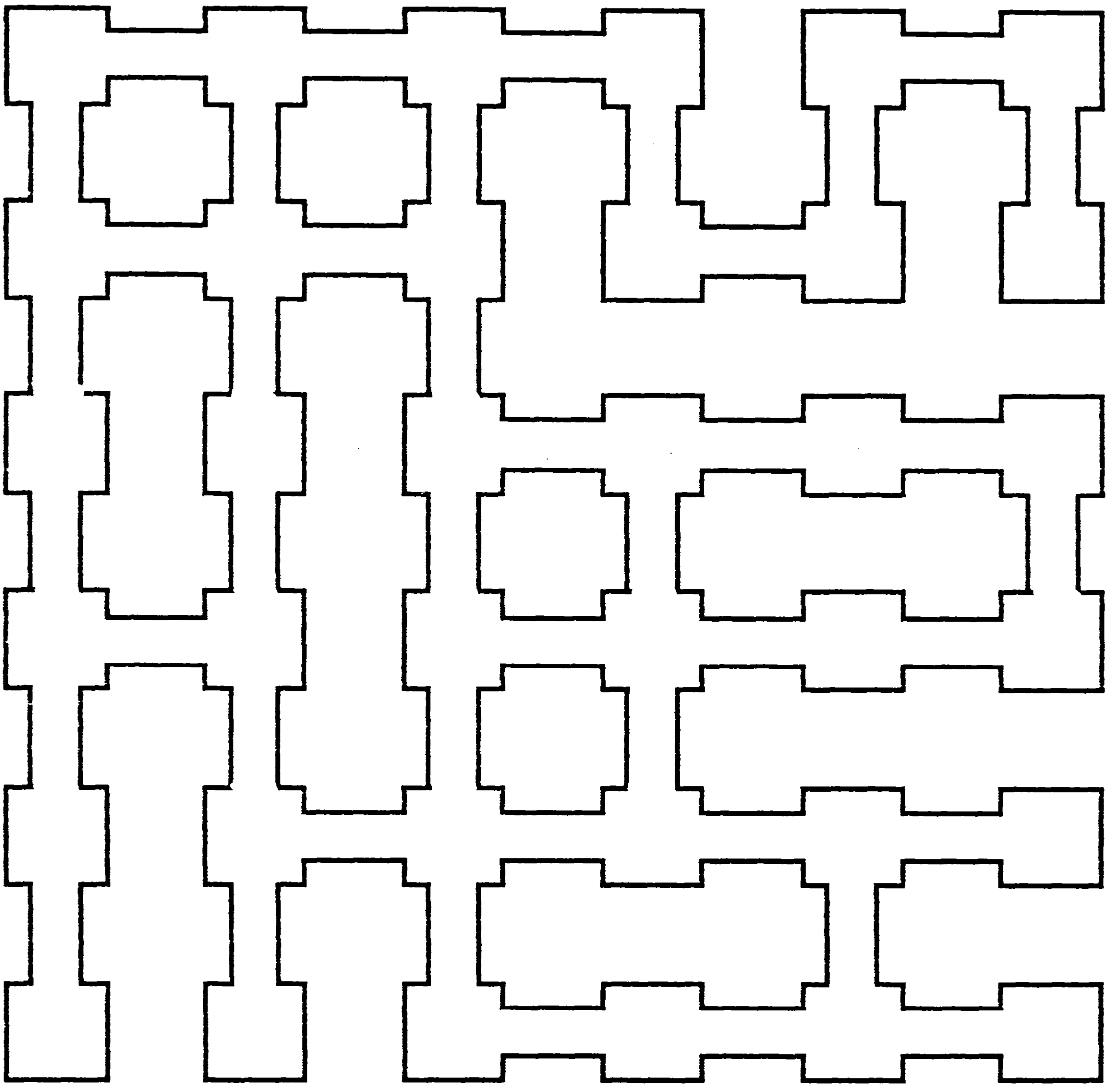
MAZE 5 VERTICAL COLUMN TYPE



MAZE 6 FIGURAL TYPE



MAZE 7 FIGURAL TYPE



MAZE 8 MIXED TYPE

APPENDIX B: Example of a Maze Computer Printout

MAZELOG: LOGAC6C

MAZE USED: MAZEC4

COMMENT: LUKE(7)/MAX(6)

START POSITION: PLAYER A- 4 PLAYER B- D MONSTER- M

GOAL POSITION : PLAYER A- C PLAYER B- 9

MAZE SHAPE: RECTANGULAR

PLAYERS COULD NOT SEE EACH OTHERS' POSITION

PENALTY VALUE: 5

FIRST TO MOVE: PLAYER A

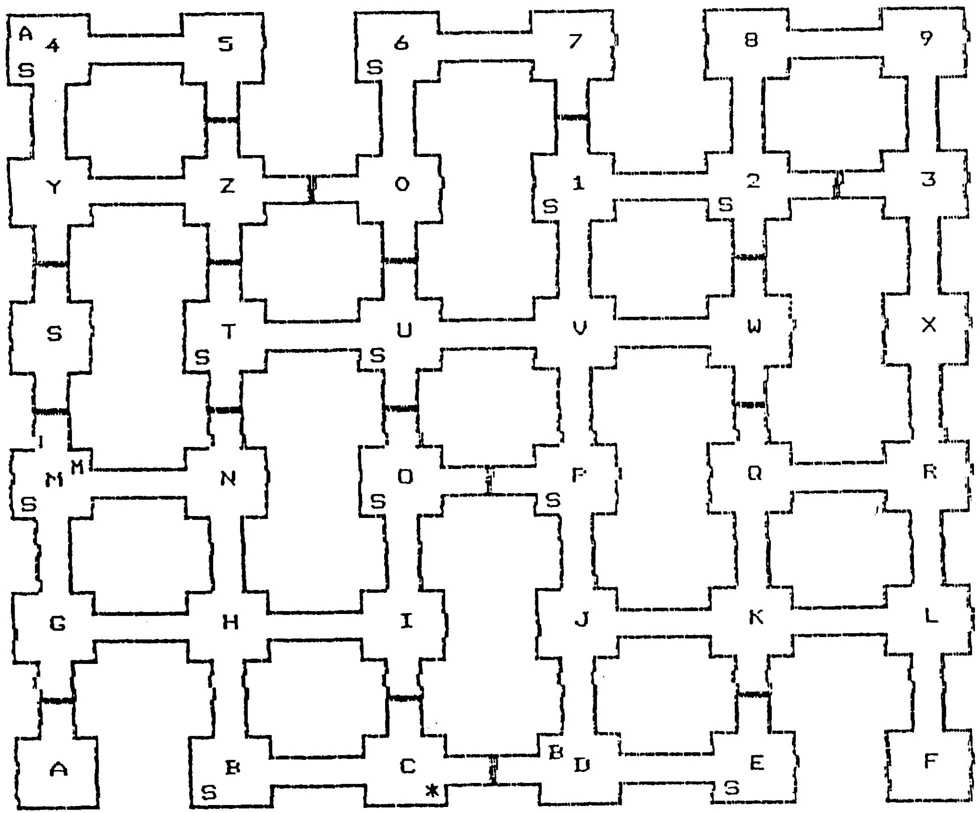
GAME TERMINATION STATE: PLAYERS FAILED

TOTAL NUMBER OF MOVES = 28

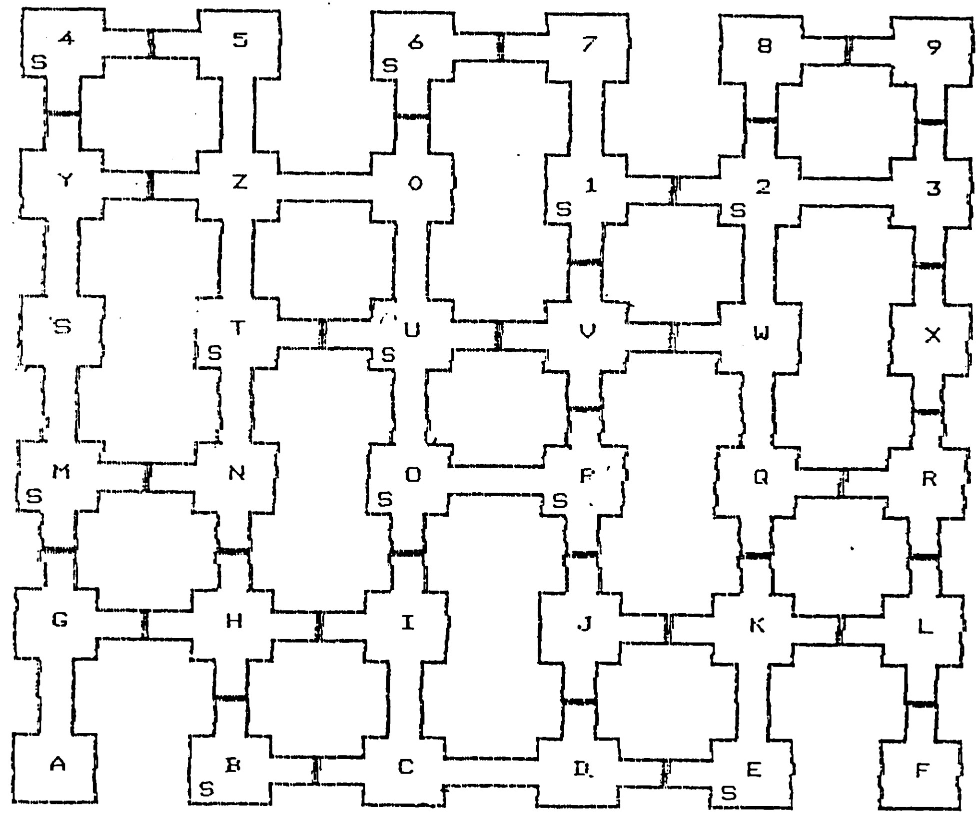
TOTAL NUMBER OF PENALTIES = 30

```
  1 [00:07]   A MOVED DOWN FROM 4 TO Y (GATE STATE 1)
    [00:21]   B MOVED LEFT FROM D TO C (GATE STATE 1)

  2 [00:28]   A MOVED RIGHT FROM Y TO Z (GATE STATE 1)
[00:34]   M MOVED RIGHT FROM M TO N                     (CHASING PLAYER A)
    [01:03]   B MOVED UP FROM C TO I (GATE STATE 1)

  3 [01:07]   A MOVED LEFT FROM Z TO Y (GATE STATE 1)
    [01:20]   B MOVED UP FROM I TO O (GATE STATE 1)
[01:29]   M MOVED UP FROM N TO T                        (CHASING PLAYER B)

  4 [01:35]   A MOVED DOWN FROM Y TO S (GATE STATE 2)
    [01:58]   B BOUNCED RIGHT FROM O TO O (GATE STATE 2)
                3 PENALTIES INCURRED. CURRENT TOTAL = 3

  5 [02:04]   A MOVED DOWN FROM S TO M (GATE STATE 2)
[02:09]   M MOVED RIGHT FROM T TO U                     (CHASING PLAYER B)
    [02:21]   B BOUNCED RIGHT FROM O TO O (GATE STATE 2)
                3 PENALTIES INCURRED. CURRENT TOTAL = 6

  6 [02:34]   A BOUNCED DOWN FROM M TO M (GATE STATE 2)
                3 PENALTIES INCURRED. CURRENT TOTAL = 9
    [02:44]   B BOUNCED DOWN FROM O TO O (GATE STATE 2)
                3 PENALTIES INCURRED. CURRENT TOTAL = 12
[02:49]   M BOUNCED DOWN FROM U TO U                    (CHASING PLAYER B)

  7 [02:59]   A MOVED UP FROM M TO S (GATE STATE 2)
    [03:07]   B MOVED RIGHT FROM O TO P (GATE STATE 1)

  8 [03:19]   A BOUNCED DOWN FROM S TO S (GATE STATE 1)
                3 PENALTIES INCURRED. CURRENT TOTAL = 15
[03:24]   M MOVED DOWN FROM U TO O                      (CHASING PLAYER B)
    [03:39]   B MOVED UP FROM P TO V (GATE STATE 1)

  9 [03:45]   A BOUNCED UP FROM S TO S (GATE STATE 1)
                3 PENALTIES INCURRED. CURRENT TOTAL = 18
    [04:22]   B BOUNCED RIGHT FROM V TO V (GATE STATE 1)
                3 PENALTIES INCURRED. CURRENT TOTAL = 21
[04:28]   M MOVED RIGHT FROM O TO P                     (CHASING PLAYER B)

 10 [04:37]   A BOUNCED DOWN FROM S TO S (GATE STATE 1)
                3 PENALTIES INCURRED. CURRENT TOTAL = 24
    [04:43]   B BOUNCED RIGHT FROM V TO V (GATE STATE 1)
                3 PENALTIES INCURRED. CURRENT TOTAL = 27


 11 [04:56]   A BOUNCED DOWN FROM S TO S (GATE STATE 1)
                3 PENALTIES INCURRED. CURRENT TOTAL = 30
 [05:01]   M MOVED UP FROM P TO V                       (CHASING PLAYER B)

 GAME ENDS HERE
```

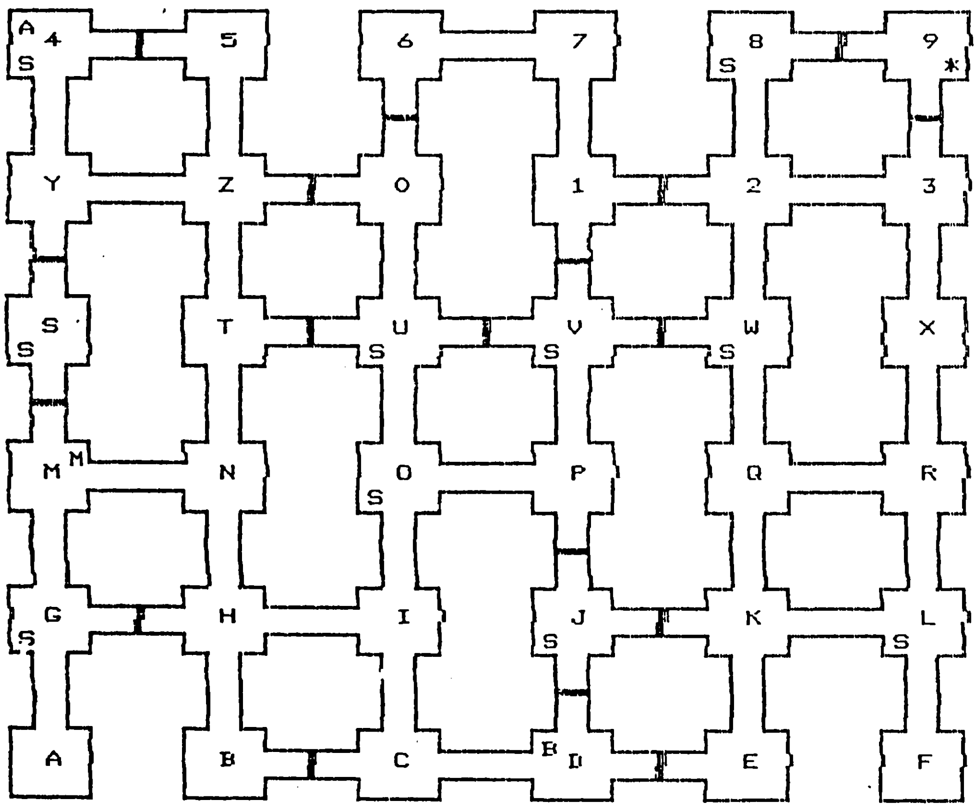
MAZEC4 : PLAYER A : GATE STATE 1



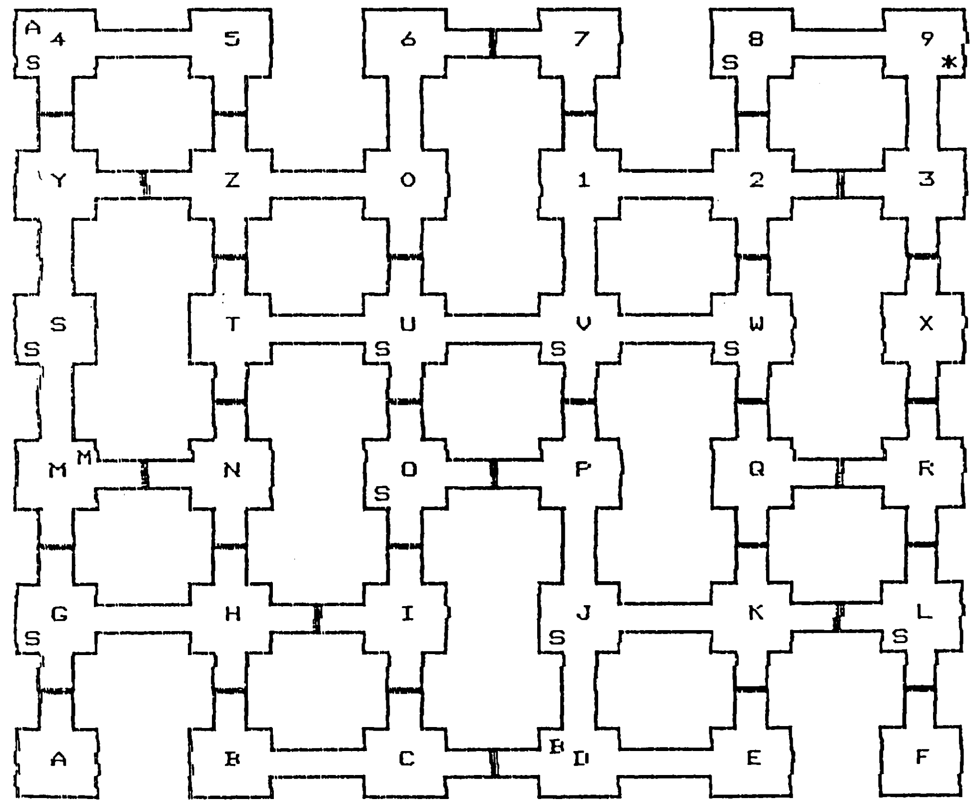
MAZEC4 : PLAYER A : GATE STATE 2



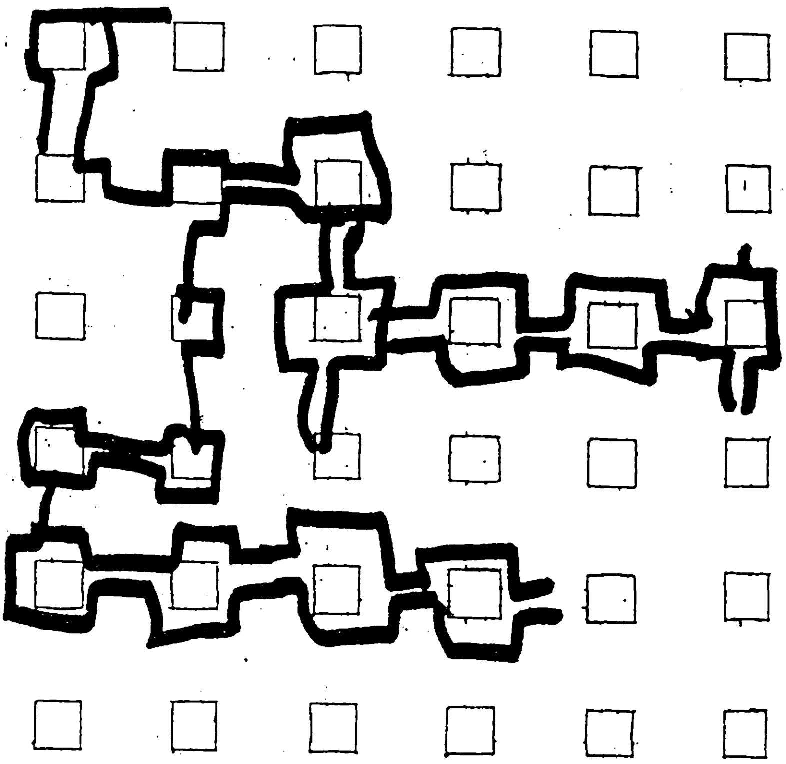
MAZEC4 : PLAYER B : GATE STATE 1

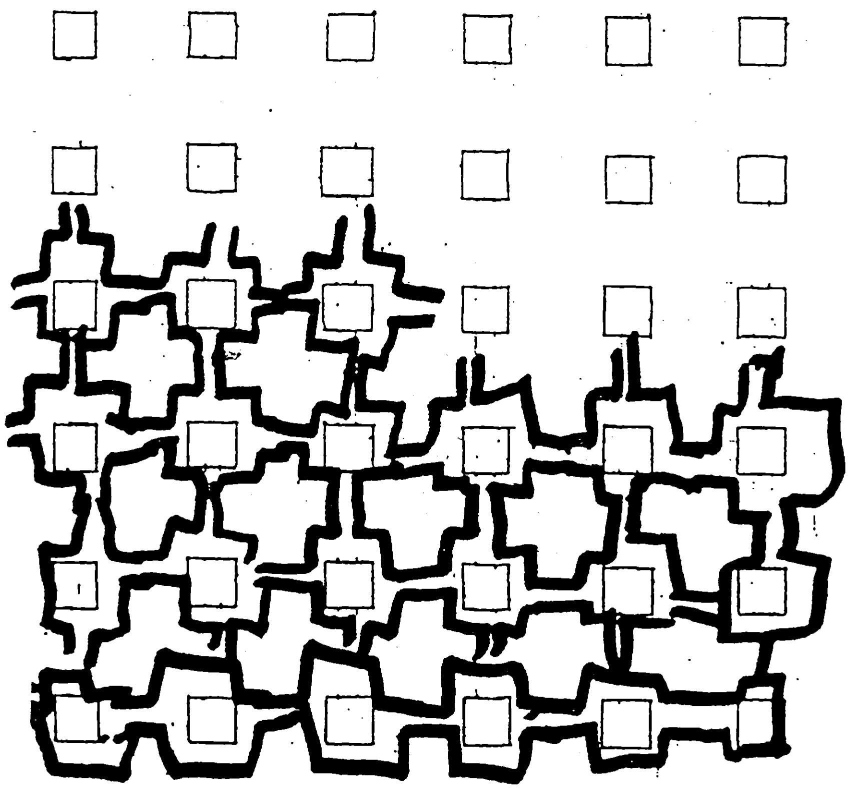


MAZEC4 : PLAYER B : GATE STATE 2

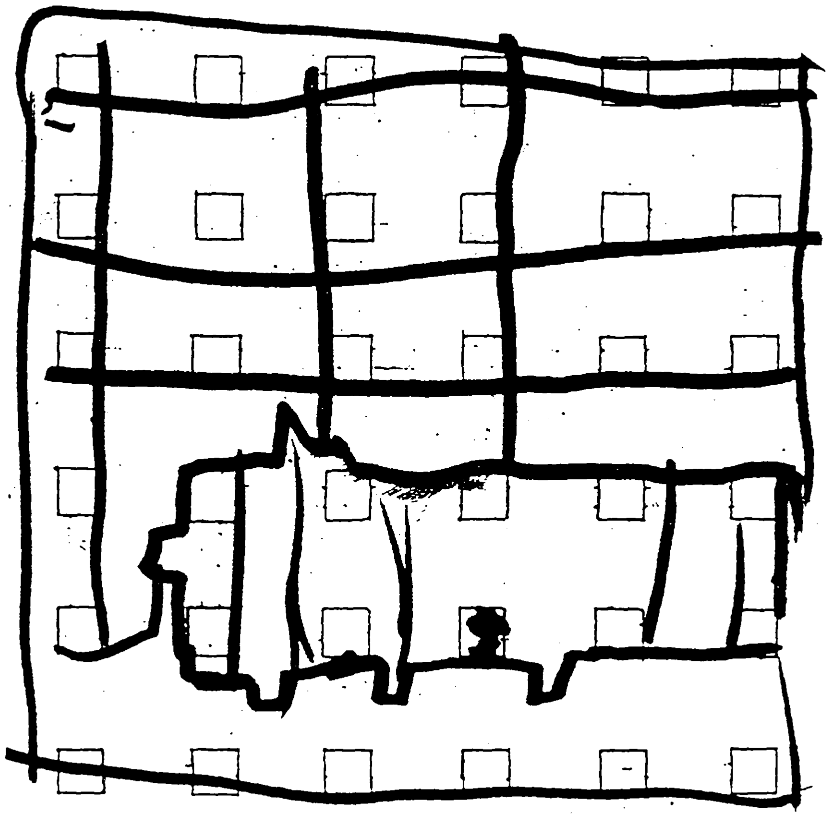


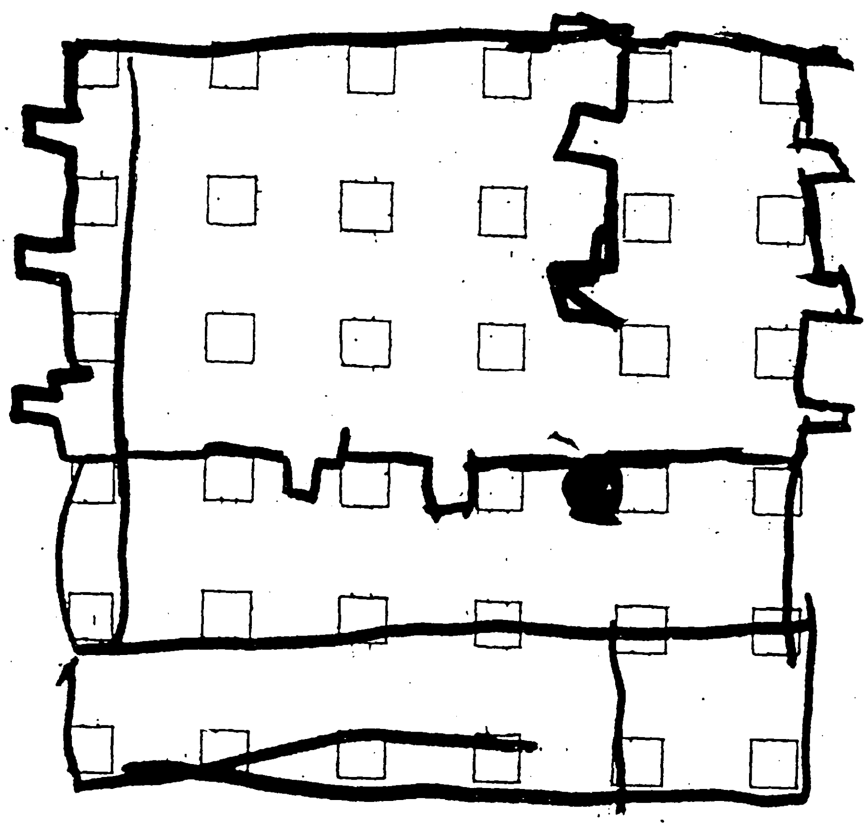
APPENDIX C: Some Examples of Children's Drawings from the Memory Test



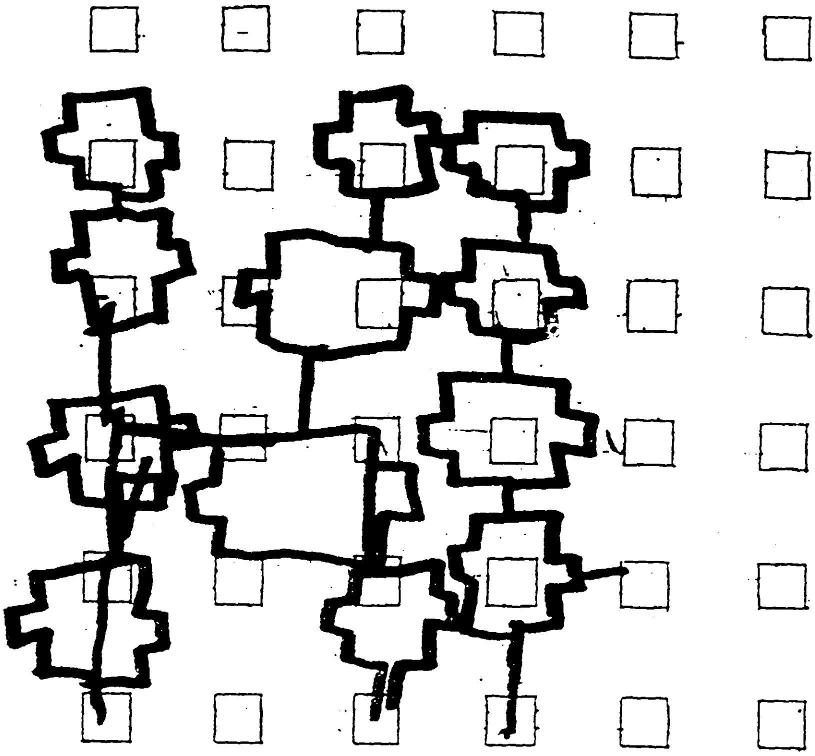


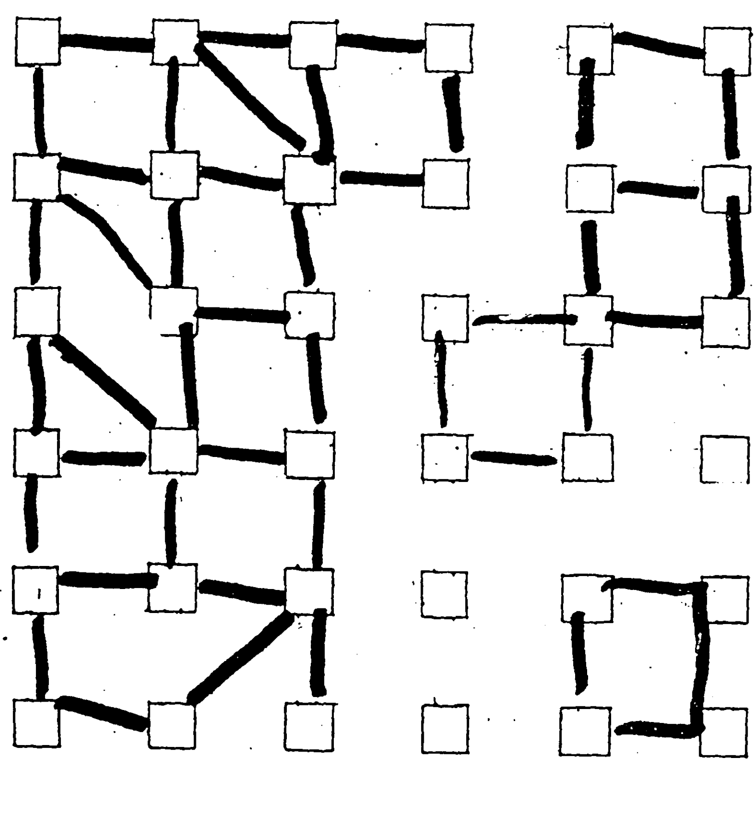
MEMORY TEST MAZES FROM 8 YEAR OLD CHILDREN





MEMORY TEST MAZES FROM 8 YEAR OLD CHILDREN





MEMORY TEST MAZES FROM 8 YEAR OLD CHILDREN

TABLE 1

ANALYSIS OF VARIANCE FOR SUCCESS OR FAILED GAME

FACTOR A = THE THREE AGE GROUPS OF SUBJECTS

FACTOR B = GAME 1, 2, AND 3

SOURCE	SS	DF	MS	F	P
TOTAL	26.135	125			
AGE	0.016	2	0.008	0.0568	NS
ERROR AGE	5.452	39			
GAME	5.73	2	2.865	15.138	0
AGEXGAME	0.174	4	0.044	0.231	NS
ERROR AXB	14.762	78	0.189		

TABLE 2

ANALYSIS OF VARIANCE FOR THE RATE OF MOVING

FACTOR A = THE THREE AGE GROUPS OF SUBJECTS

FACTOR B = GAME 1 AND GAME 2

SOURCE	SS	DF	MS	F	P
TOTAL	80.589	83			
AGE	2.41	2	1.2	0.877	NS
ERROR AGE	53.467	39	1.37		
GAME	0.36	1	0.36	0.6	NS
AGEXGAME	0.975	2	0.487	0.81	NS
ERROR AXB	23.38	39	0.599	0.81	NS

TABLE 3

ANALYSIS OF VARIANCE FOR THE MEAN NO. UTTERANCES BETWEEN MOVES

FACTOR A = THE THREE AGE GROUPS OF SUBJECTS

FACTOR B = GAME 1 AND GAME 2

SOURCE	SS	DF	MS	F	P
TOTAL	883.75	83			
AGE	66.03	2	33.01	2.67	0.078
ERROR AGE	481.398	39	12.34		
GAME	0.002	1	0.002	0.0002	NS
AGEXGAME	13.926	2	6.96	0.84	NS
ERROR AXB	322.39	39	8.26		

TABLE 4: ANALYSIS OF VARIANCE FOR THE RATE OF MOVING IN MONSTER GAMES AND ACROSS AGE

FACTOR A = THE THREE AGE GROUPS OF SUBJECTS

FACTOR B = SUCCESSFUL OR FAILED MONSTER GAME

SOURCE	SS	DF	MS	F	P
TOTAL	67.98	83			
AGE	2.75	2	1.37	1.029	0.3678
ERROR AGE	52.12	39	1.336		
GAME	0.92	1	0.92	3.073	0.0822
AGEXGAME	0.486	2	0.243	0.809	NS
ERROR AXB	11.7	39	0.30		

TABLE 5

ANALYSIS OF VARIANCE FOR THE MEAN NO. UTTERANCES BETWEEN MOVES ACROSS AGE AND MONSTER GAMES

FACTOR A = THE THREE AGE GROUPS OF SUBJECTS

FACTOR B = SUCCESSFUL OR FAILED MONSTER GAME

SOURCE	SS	DF	MS	F	P
TOTAL	431.27	83			
AGE	13.63	2	6.815	1.052	0.359
ERROR AGE	252.62	39	6.477		
GAME	0.088	1	0.0887	0.024	NS
AGEXGAME	21.247	2	10.623	2.884	0.0647
ERROR AXB	143.678	39	3.684		

TABLE 6

ANALYSIS OF VARIANCE ON THE NO. OF DESCRIPTIONS GENERATED PER GAME BY BOTH PLAYERS

FACTOR A = THE THREE AGE GROUPS OF SUBJECTS

FACTOR B = GAME 1 AND GAME 2

SOURCE	SS	DF	MS	F	P
TOTAL	7374.036	83			
AGE	1243.143	2	621.57	6.75	0.00313
ERROR AGE	3589.393	39	92.04		
GAME	20.012	1	20.012	0.327	NS
AGEXGAME	132.095	2	66.048	1.078	0.3509
ERROR AXB	2389.393	39	61.267		

TABLE 7

ANALYSIS OF VARIANCE ON THE MEAN NUMBER OF DESCRIPTIONS PER MOVE, PER SUBJECT PAIR

FACTOR A = THE THREE AGE GROUPS OF SUBJECTS
FACTOR B = GAME 1 AND GAME 2

SOURCE	SS	DF	MS	F	P
TOTAL	39.342	83			
AGE	3.578	2	1.789	3.117	0.0525
ERROR AGE	22.379	39	0.5738		
GAME	0.529	1	0.5299	1.76	0.188
AGEXGAME	1.115	2	0.5578	1.852	0.1672
ERROR AXB	11.739	39	0.301		

TABLE 8

ANALYSIS OF VARIANCE ON THE NO. OF WORDS PER DESCRIPTION ACROSS AGE AND MONSTER GAME

FACTOR A = THE THREE AGE GROUPS OF SUBJECTS
FACTOR B = MONSTER GAMES AND GAME 1

SOURCE	SS	DF	MS	F	P
TOTAL	4886.716	83			
AGE	548.015	2	274.008	3.487	0.03795
ERROR AGE	3064.671	39	78.58		
GAME	1.83	1	1.83	0.058	NS
AGEXGAME	36.322	2	18.161	0.573	NS
ERROR AXB	1235.878	39	31.689		

TABLE 9

ANALYSIS OF VARIANCE ON THE NUMBER OF DESCRIPTIONS PER MOVE FOR EACH DESCRIPTIVE CATEGORY

FACTOR A = THE THREE AGE GROUPS OF SUBJECTS
FACTOR B = GAME1, AND THE AVERAGE OF GAME 2 & 3
FACTOR C = THE DESCRIPTIVE CATEGORY

SOURCE	SS	DF	MS	F	P
AGE	.794	2	.397	13.409	.0000
ERROR AGE	2.398	81	.030		
GAME	.17	1	.017	.683	.4111
AGEXGAME	.054	2	.027	1.06	.3512
ERROR AXB	2.075	81	.026		
DESCR.	2.612	3	.871	21.78	.0000
AGEXDESCR.	.426	6	.071	1.775	.1049
ERROR AXDES.	9.716	243	.04		
GAMEXDESCR.	.075	3	.025	1.157	.327
A B C	.222	6	.037	1.714	.118
ERROR A B C	5.235	243	.022		

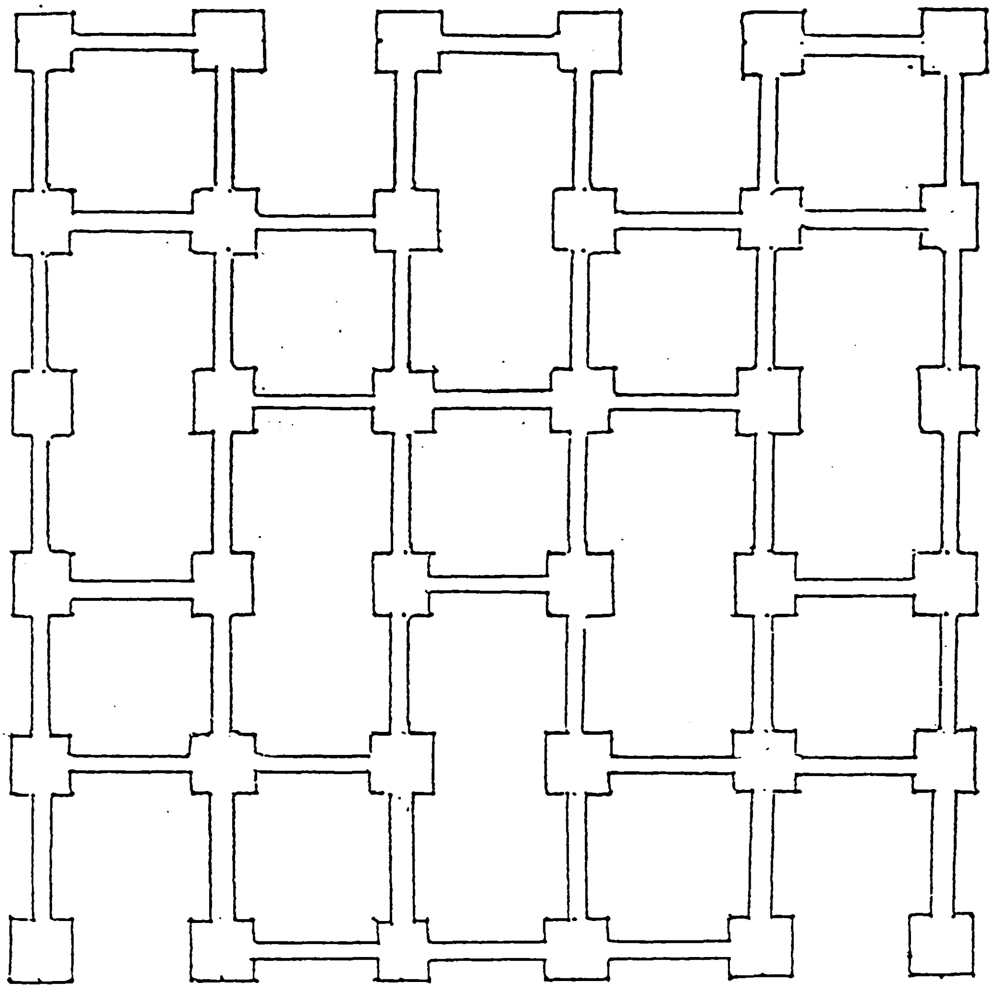
TABLE 10

ANALYSIS OF VARIANCE ON 'WITHIN' AND 'BETWEEN' DIALOGUE CO-ORDINATION ACROSS AGE AND OVER GAME

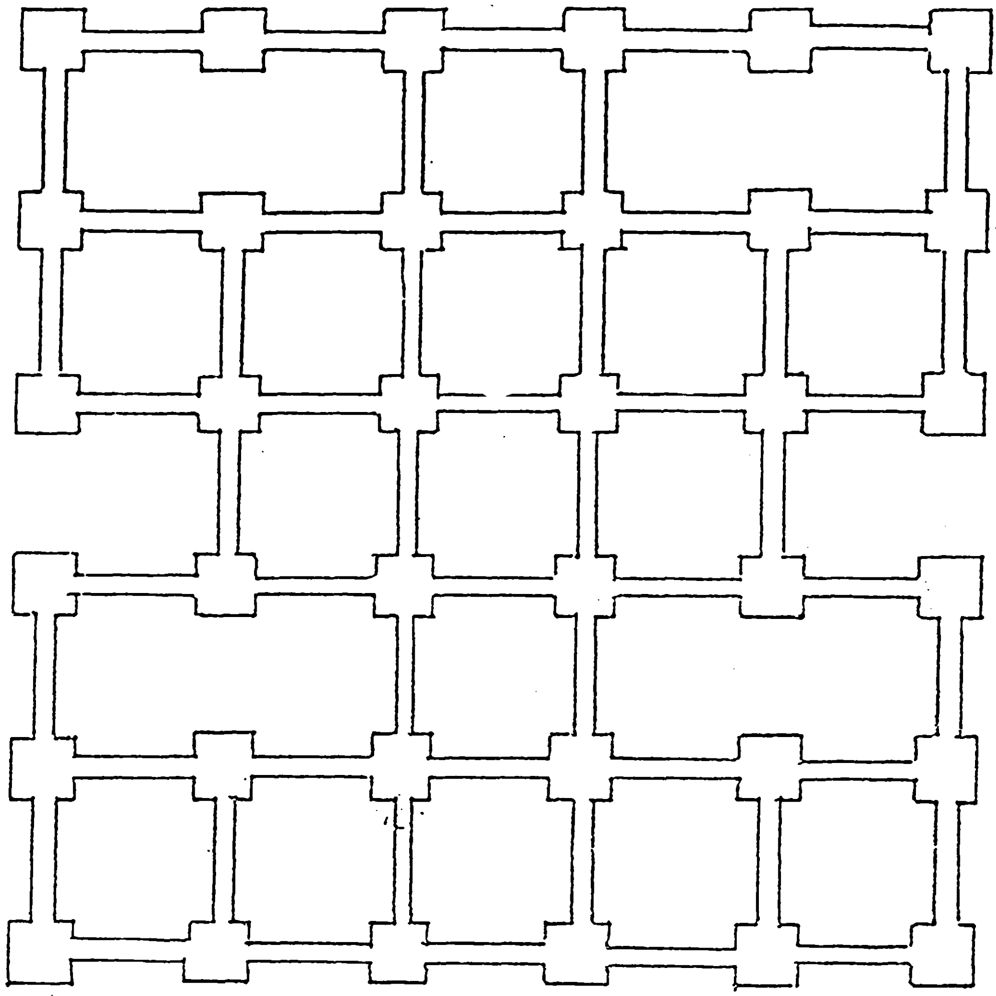
FACTOR A = THE THREE AGE GROUPS OF SUBJECTS
FACTOR B = GAME1, GAME2, AND GAME3
FACTOR C = 'WITHIN' AND 'BETWEEN' DIALOGUE CO-ORD.

SOURCE	SS	DF	MS	F	P
TOTAL	671.021	251			
AGE	5.664	2	2.832	1.0716	0.3532
ERROR AGE	103.068	39	2.643		
GAME	1.969	2	0.985	0.577	NS
AGEXGAME	13.99	4	3.498	2.049	0.0928
ERROR AXB	133.101	78	1.706		
'W' & 'B'	190.374	1	190.374	84.55	0.00000
AGE X C	6.776	2	3.388	1.505	0.23252
ERROR AXC	87.811	39	2.252		
GAME X C	3.167	2	1.583	1.029	0.36343
A B C	5.096	4	1.274	0.828	NS
ERROR A B C	120.006	78	1.5385		

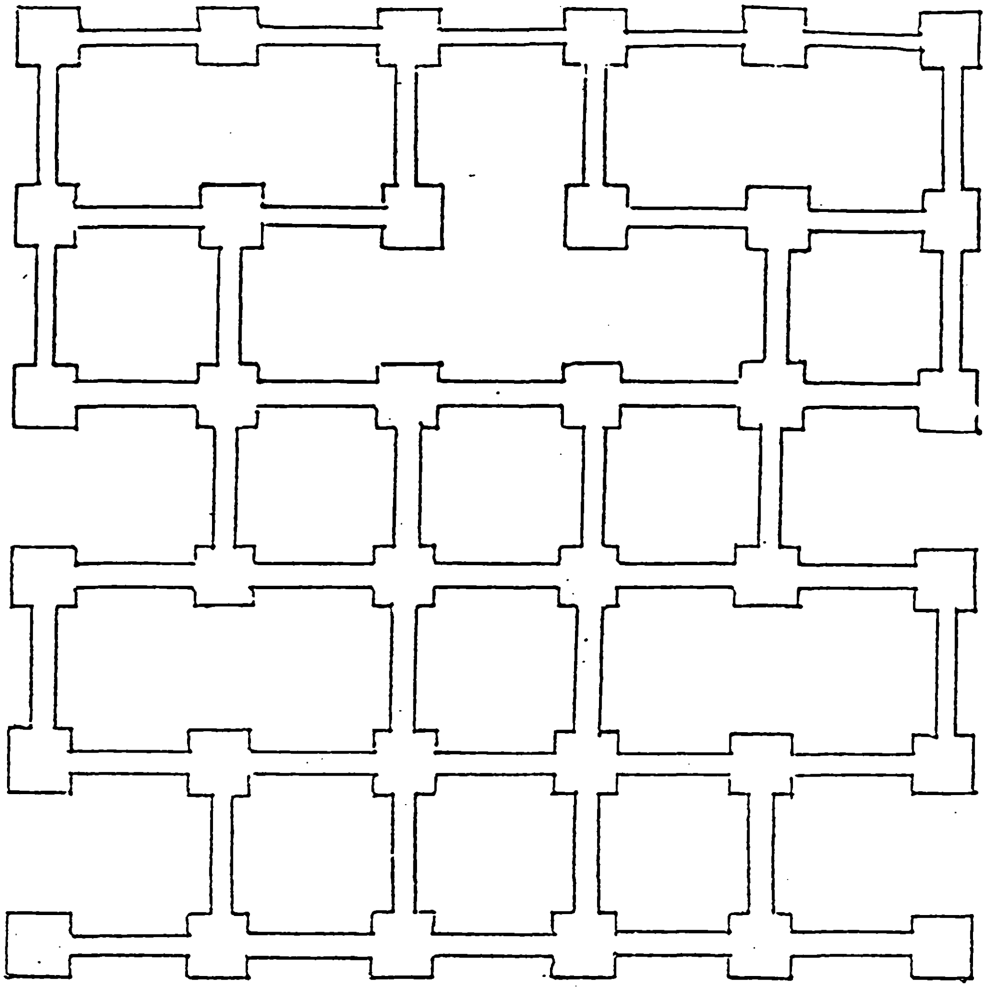
APPENDIX E: Mazes Used in the Pencil and Paper Study



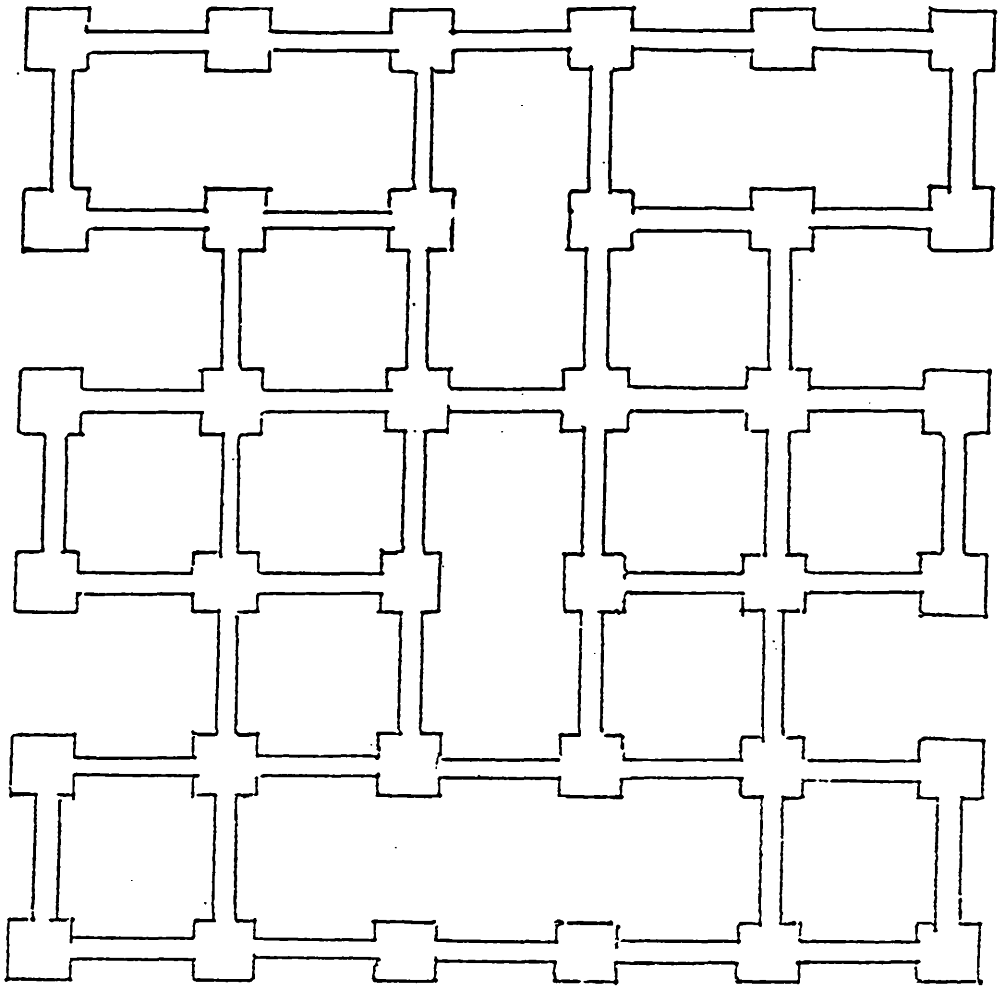
P&P MAZE 1



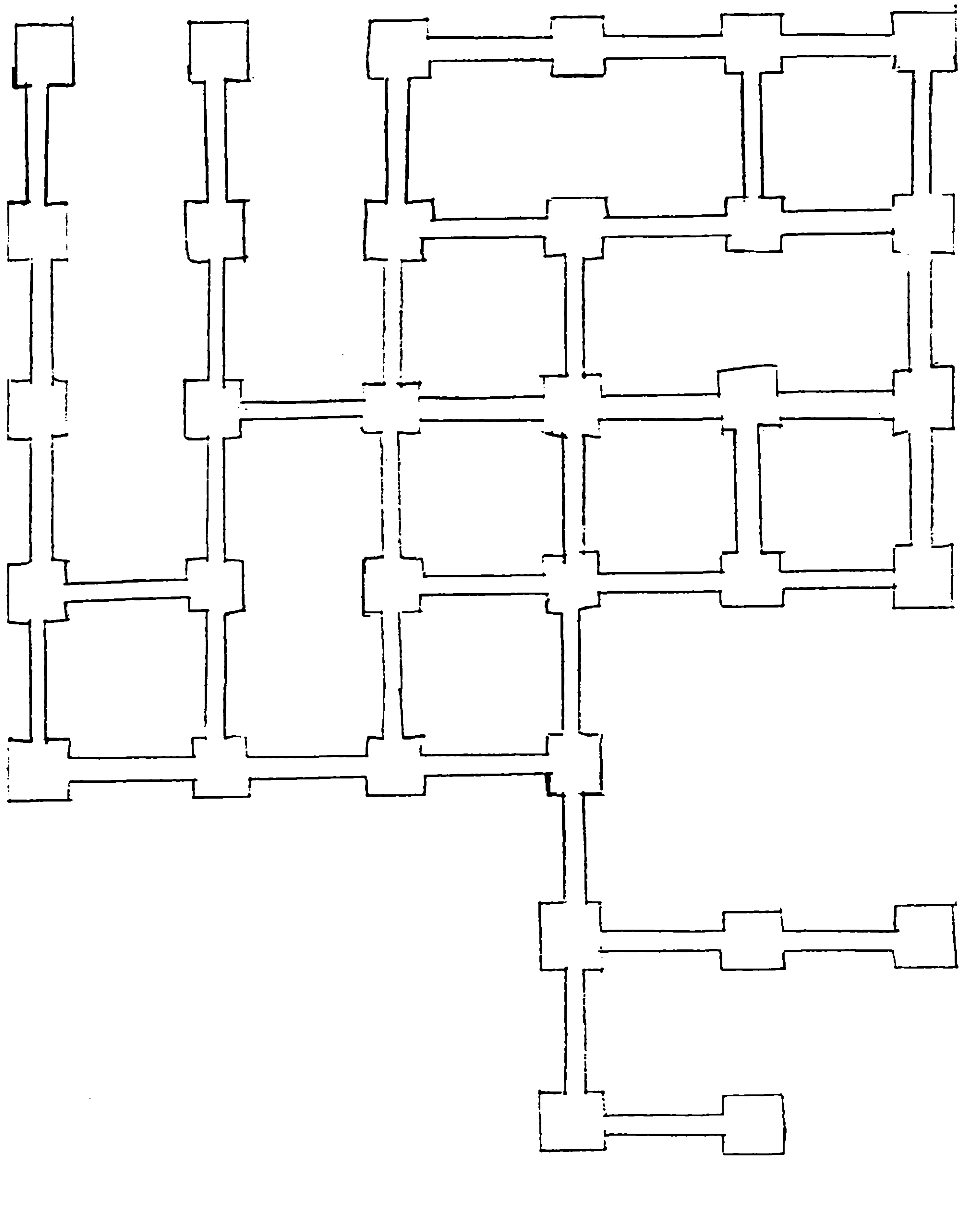
P&P MAZE 2



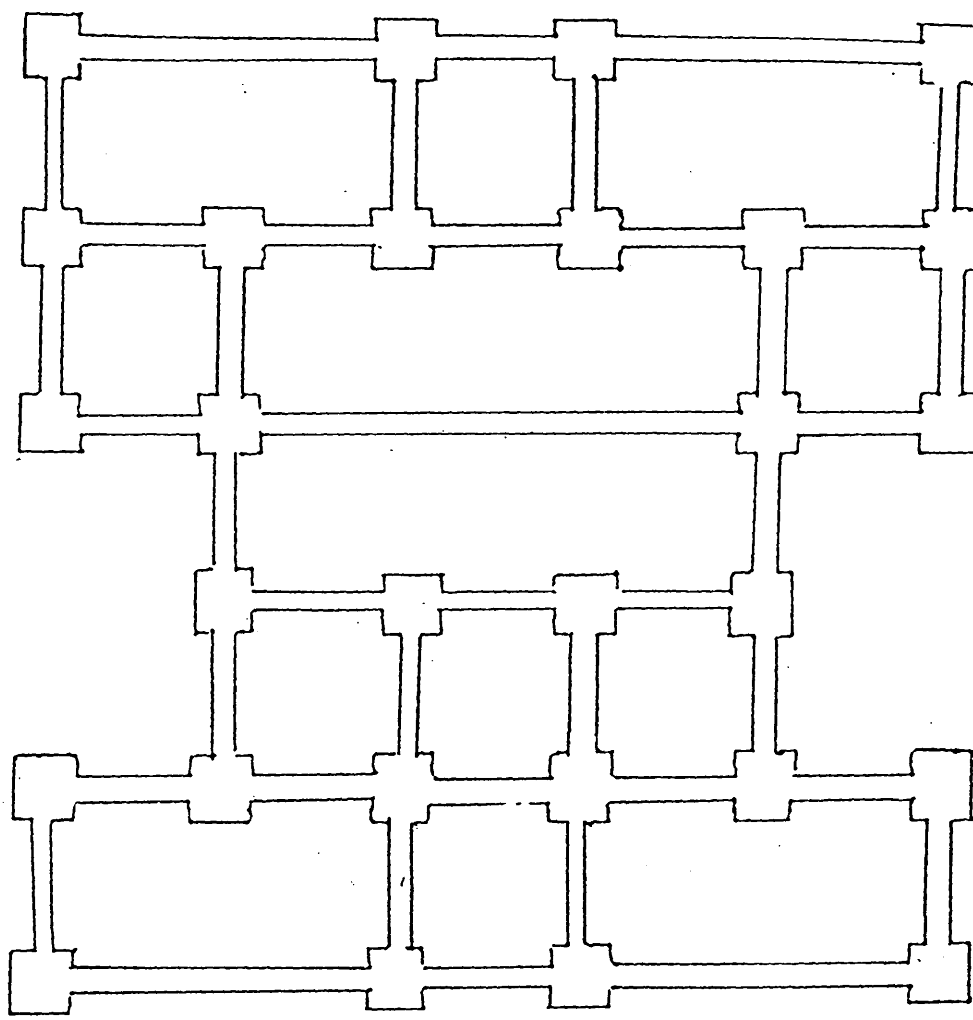
P&P MAZE 3



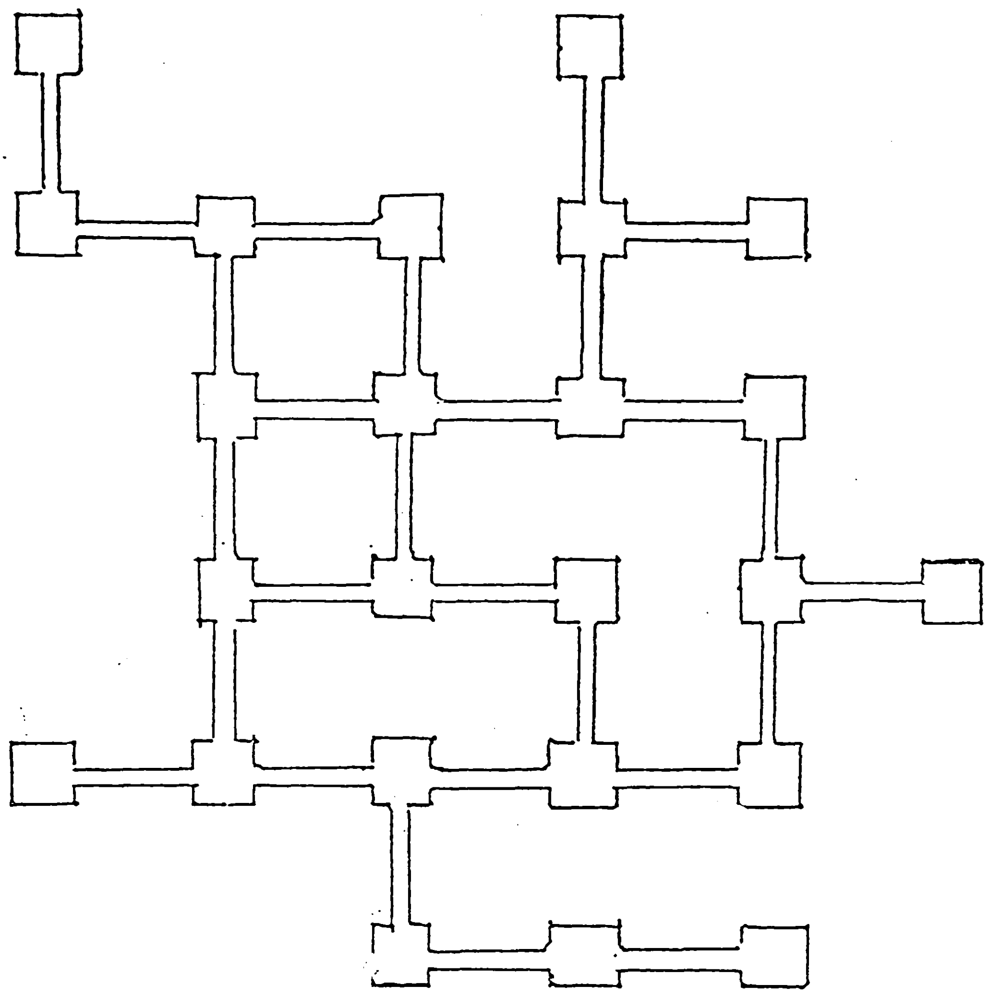
P&P MAZE 4



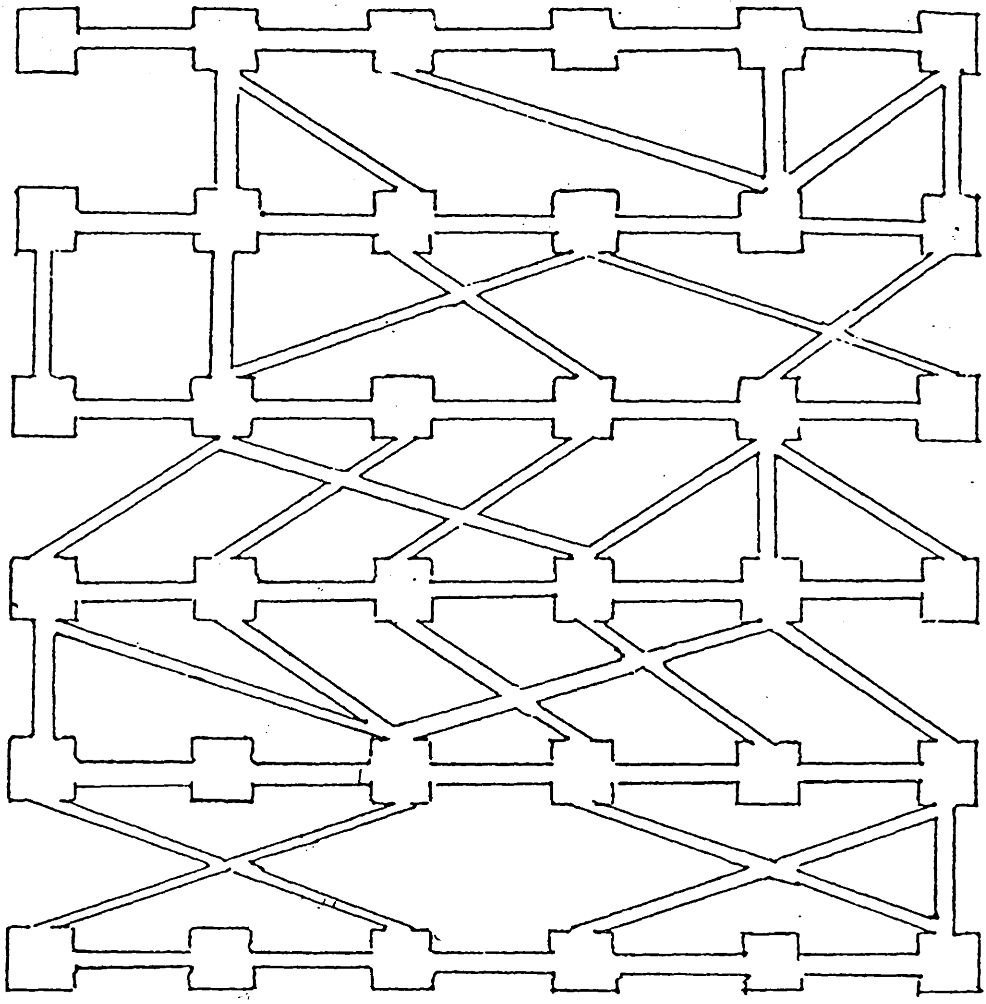
P&P MAZE 5



P&P MAZE 6



P&P MAZE 7



P&P MAZE 8

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