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Maps as a visual language: A Chinese perspective

Zhaoyuan Li
Wilfrid Laurier University

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MAPS AS A VISUAL LANGUAGE: A CHINESE PERSPECTIVE

By

Zhaoyuan Li

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ABSTRACT

One primary goal of cartographic research is to improve cartographic communication. Psychophysical and cognitive research has assisted our understanding of the map use process. The present study is from a perspective of maps as a visual language. This study hypothesizes that 1) the map symbol system constitutes a visual ideographic language and 2) cartographic communication may be improved by applying the methods of teaching visual ideographic languages as a second language.

The thesis describes the evolution, units and structure of written Chinese, compares it with the map symbol system, then examines methods used to teach Chinese as a second language to suggest briefly ways that map use may be improved.

Chinese script originated in primitive drawings of concrete things--pictographs--and ideographs. These became stylized and combined, and were expanded greatly in number. Although the characters came to include phonetic symbols, the script can be used as a completely visual language and is not structured as a parallel to the phonetic language as are alphabetic languages. Furthermore, written Chinese is processed mentally much more holistically and requires more reader-origin organization than alphabetic languages. Maps have all the fundamental attributes of Chinese writing. Maps with their many non-phonetic symbols are essentially visual. Both cartographic symbols and early Chinese characters are often mimetic. To understand maps, symbols must be put into relation with other symbols that are not arranged linearly. Similarly, to understand Chinese, each character must be put into relation with other characters that can be sequenced vertically or horizontally and left to right or right to left.

Studies of teaching Chinese as a Second Language stress that a variety of approaches are necessary in teaching such a complex, high-level cognitive process. The basics of lexicon and syntax need rote learning, drill, substitution exercises and much experience. All these components and approaches could be applied to a map use teaching programme.

The thesis concludes that maps have a close parallel to written Chinese and that this parallel could well be applied to improving cartographic communication.

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Finally, I dedicate this work to my beloved parents, to my father, the late Dr. Lingfei Li and my mother Qingzhen Ouyang who provide for their faith and selfless supports in my life and work; to my dear wife Shuqin Luo, my lovely daughter Lilly who sacrificed much to allow me time to pursue my study. Their love, patience and encouragement sustained my determination to see this study to completion.

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CHAPTER ONE
INTRODUCTION

Cartographic communication plays important roles world-wide. The improvement of the effectiveness of cartographic communication, therefore, is the primary goal of a large proportion of the cartographic research endeavour. Cartographic communication is a highly complex cognitive process, influenced by not only how a map presents its geographical information, but also how map users take this information from a map.

Before the 1950s, cartographic research focused mainly on matters of improving the precision of representation of geographical relationships and on the techniques of making maps look professional; very little attention was given to the effectiveness of maps in the transmission of information and to the problems encountered by map users. Only in the past forty years have academic cartographers explicitly regarded the map as being a functional graphic display, considering how the efficiency of that functionality might be measured, experimented with and improved (Head, 1991:238). A broad variety of approaches have been taken, including psychophysical experimentation with individual map symbols, research in cognitive studies, and studies of maps as a semiotic system or a visual language.

Since the 1970s, a number of researchers (e.g. Pra/da, 1978; Guelke, 1979; Head, 1984; Lyutyy, 1984; Eastman, 1985; Head and Elgood, 1988; Saku, 1990) have argued that maps consist of visual symbols, that they communicate prolific amounts of

information, and that they may be thought of a language. Various studies using the language analogy have been conducted in order to understand and to improve strategies of map use. For example, some researchers proposed that maps may be considered part of the natural language system. According to Head (1984), there are basic underlying structures to our cartographic communication which are used by the experienced map reader. These structures include lexicon and syntax. Once taught formally, their use should lead to improvement in map communication. Arising from these studies are several questions in regard to the details of the concept of the map as a language, the significance and the specifics of map reading behaviour and of methods of teaching map reading. Therefore, a systematic investigation of each of these issues would provide fundamental knowledge for mapping, for map reading education, and for further understanding of the relationships between all the stages of map production and map use, thus enhancing the effectiveness of cartographic communication.

Although maps are used for communication, like a language, whether maps constitute an actual language or not has remained an academic debate with important implications. Some scholars think that maps can not be an actual language, because

1) map symbols comprise a non-alphabetic, non-phonetic communication system;

2) map symbols do not have their own pronunciation;

3) there is no fixed order of reading in maps; and

4) maps do not have a grammar system like English.

Other scholars, however, believe that map symbols are very much like a visual language, and that the language analogy may provide a very useful method for investigating the

map as a medium of communication. Most of the language analogy work has compared maps to Indo-European languages such as English, French, Russian, Polish and so forth -- all alphabetic languages[1]. A large part of the world's population, however, uses non-alphabetic languages. Moving our sights from the alphabetic language world to an ideographic language culture may reveal some important insights. The present thesis, therefore, proposed to compare the map language to written Chinese -- a highly significant human visual language.

Hypotheses

The hypotheses of this study are, therefore:

1) that the map symbol system constitutes a visual ideographic language, and
2) that cartographic communication may be improved by applying the methods of teaching visual ideographic languages as a second language.

Objectives

The specific objectives of the study are to provide reasonable evidence for the hypotheses posed above. The study will:

1) compare the map language to the written Chinese language -- particularly considering aspects of lexicon and syntax;
2) further explore the paradigm of map language, particularly examining the techniques of teaching Chinese as a second language as these can be applied to map reading education.

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1. In this thesis, "alphabetic languages" refer to Indo-European languages such as English, French, German, Russian, etc.

If the comparison of map language to ideographic natural language provides the same results as compared to alphabetic language, then the hypothesis of map language as a type of visual natural language is strengthened. If answers are different, this may suggest new concepts about the cartographic communication system. If the links between map language and ideographic language are close, then knowledge of methods of teaching Chinese as a second language may provide the basis for new methods of map reading education.

The Proposed Studies

To give some background in the evolution of map communication research, the literature review consists of two chapters. Two earlier methods, psychophysical experimentation with individual map symbols and cognitive studies, are reviewed in Chapter Two. Two later methods, maps as a semiotic system and maps as a language, are reviewed in Chapter Three.

In specifically addressing the objectives of this thesis, it is important to compare map language to written Chinese. To provide a basis for discussion, therefore, Chapter Four describes the origin, evolution, units and structure of the written form of the Chinese language. The next step, Chapter Five, is an investigation of the Chinese reading process. In particular, the relation between the hemispheres of the brain and the reading of written Chinese will be approached. Then the study will focus on how the reader recognizes and processes the characters, words and sentences.

With a basic understanding of written Chinese supplied, the study can then approach the problem of whether or not the map language is similar to written Chinese. If it is, then how closely does it fit? Chapter Six compares written Chinese to the map language -- from lower unit level to upper structure level, and from expression to content, and then discusses more the linguistic nature of maps.

Chapter Seven examines the methods that are used to teach Chinese as a second language, and then how these processes and methods might be applied to the teaching of map language.

A final chapter provides a general discussion and conclusion.

CHAPTER TWO
RESEARCH IN CARTOGRAPHIC COMMUNICATION: PSYCHOPHYSICAL EXPERIMENTATION AND COGNITIVE STUDIES

Introduction

Maps have been in use as communication tools for thousands of years. Even as cartography became considered as a science, its practitioners focused primarily on intuitive design concepts developed over long years of experience, giving little attention to communication theory and to the feedback from map users. They made their maps in a style that they personally felt to be "correct" and aesthetically pleasing.

From the early 1950s, cartographers began to take a specific interest in questions about how people perceive cartographic products. Arthur H. Robinson provided the modern theory of the map as a "functional graphic display" in The Look of Maps (1952). He claimed that the function of a map is to communicate geographical information. This theory was subsequently rapidly accepted as the dominant one within academic cartography. Based on this theory the field of study of cartographic communication, along with the study of the process of map reading and attempts to improve it, has been developed. A wide variety of approaches have been taken. Among them are two main ones: psychophysical experimentation with individual map symbols, and research in cognitive processes. These studies have provided important information to improve map making, and thus to improve the map reading process.

The present review examines each type of study. Psychophysical studies have

approached both quantitative and qualitative thematic map symbols to investigate the psychophysical functions associated with the perception of these symbols by users. Cognitive research examines the relationship between human cognitive processing and map reading.

Psychophysical Research

The field of psychophysics in psychology deals with how organisms respond to the energetic configurations of the environment. "Stimulus energy in many forms affects the organism through one or another of its specialized sensory receptors. Therefore, many of the problems of psychophysics relate to the operation and behaviour of sensory systems." (Eysenck and Arnald, 1972, Vol.3:81). In particular, much of the research in psychophysics has been directed toward identifying a 'psychophysical function' which "describes the quantitative relationship between the magnitude of a physical stimulus and the magnitude of the corresponding perceptual experience" (Gilmartin, 1981:10). The extensive psychophysical investigations of the graphic parameters of individual map symbols were largely done in North America. These studies built upon the work by American perceptual psychologists.

Even before much direct psychophysical testing had been done within a cartographic context, however, an integrated theory of the use of graphic elements within cartography had been proposed in France. In 1967, Jacques Bertin of the Laboratoire de Cartographie at the Ecole Pratique des Hautes Etudes in Paris published his Sémiologie Graphique. Not until 1983 was it translated into English. He did fundamental work in

which he strongly stressed the relations between the two sign components of "expression" and "content". The former is the sign's physical form, the latter the sign's meaning. He identified seven "visual variables" (Fig. 2.1). They are: position (the two dimensions of the graphic plane), size, value, grain (texture), hue, orientation and shape. He also proposed "manners in which a simple graphic symbol may be manipulated so as to clearly change perception and thus to allow the presentation of a clearly differentiated message item" (Head, 1991:241).

Bertin emphasized that each visual variable was either more or less suited to particular types of content. The variable "size" is the only one that he recommended to express interval-scaled or ratio-scaled quantitative data. The visual variables of size, value and texture can effectively portray ordinal data. All variables can be used for differentiation of merely nominally-scaled data, and all except shape can be used to create clearly-perceivable classes from nominally-scaled data. However, Bertin's list is not exhaustive; additional variables such as colour saturation have been identified by other researchers such as McCleary (1983) (DiBiase et al., 1992:204).

The visual variables of Bertin remain important. "They systematized much of the approach to cartography's content-expression link at the simple 'map symbol' level and set the psychophysical studies within a clear framework" (Head, 1991:242).

As early as in 1954, Mackay had presented the results of experimental work including dots, circles, spheres, cubes and isolines. The study was designed to investigate individual reactions on tests which were given to 300 college students in Canada and 120 students in Japan. In his study, students were asked questions pertaining to numbers, size

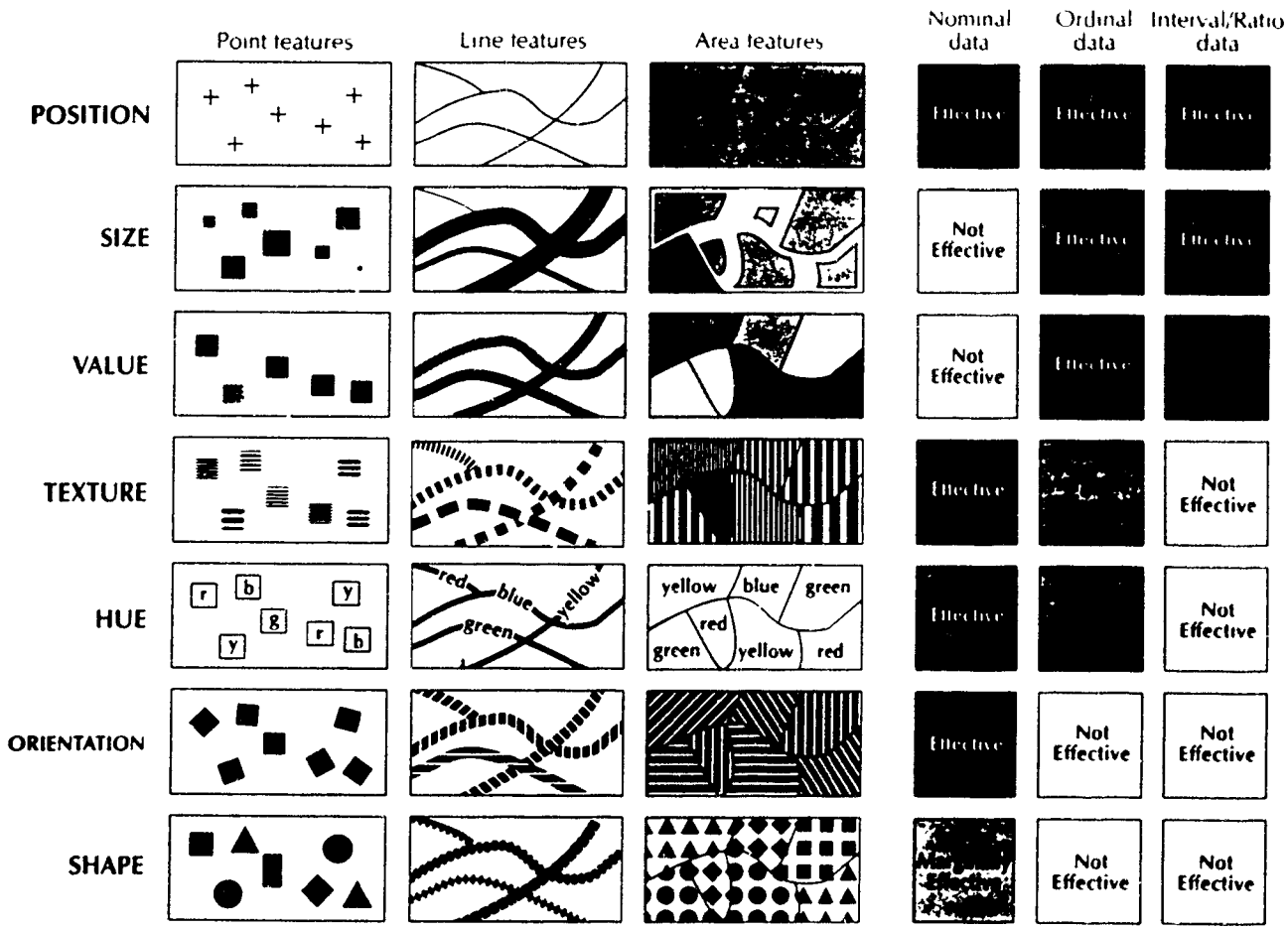


Fig.2.1 The visual variables and their effectiveness in signifying the three levels of measurement of data (after Bertin, 1983; DiBiase et al., 1992:204)

and personal preference. Several tests were used on equivalent projections by asking students to estimate areas of Australia and Greenland as they appeared on six different map projections. Each test was given to two groups of students, one with and the other without, laboratory instruction in basic cartographic symbols like dots, circles, spheres, cubes and isolines. He found that 1) map reading ability was greatly improved by laboratory practice in estimating and comparing numbers, areas, volumes and shapes; 2) subjects tended to underestimate areas and volumes when a large area or volume is compared with a smaller one; 3) most subjects, whether cartographically trained or not, experienced some difficulty in recognizing ten per cent or less differences in dot numbers and even higher percentages when area and volumes were involved (Mackay, 1954:226).

Further work was conducted by Flannery (1956), in his Ph.D. research under A.H.Robinson at the University of Wisconsin. He focused on circles and examined how the size of circles affected map users' perception. One thousand and forty students from five colleges and universities were used in the test. "Subjects were asked to make 46 individual judgments of the size differences of black circles on a white background in both a map and non-map context with areal size differences ranging from 2 to 1 to 32 to 1, and diameter sizes ranging from 3 to 24 millimetres" (Flannery, 1971:97-98). Comparisons were made with both larger and smaller circles serving as the standard stimulus and estimates recorded as size differences. The results showed that 70.5% subjects underestimated the sizes, only 16% estimated correctly and 13.5% overestimated. In another test which was primarily in a map context, a group of 200 college students were asked to make a total of 44 different comparisons. "circle size

differences ranged areally from 2 to 1 to 44 to 1 and diameter sizes ranged from 3 to 24 millimetres and subjects were requested to compare how much more crop was grown in one country than in another by estimating the size difference of the circles" (Flannery, 1971:100). Results indicated that 73.5% were underestimates, 19.5% overestimates and 7.0% were correct estimates. Thus, both studies clearly showed that when circles of graduated sizes were used as cartographic symbols, map readers consistently tended to underestimate their quantities. However, Flannery still thought that circles are good cartographic symbols when compared to other quantitative symbols (e.g. bars, triangles, etc.). In comparing the circle form of these graduated symbols to other forms, he claimed that:

1. it is relatively easy to convert basic quantitative data to circular form;
2. aesthetically, users prefer circles (62%) over bars (38%) and 60% ranked circles first over triangles, squares or rectangles;
3. circles can be placed on maps more rapidly than other types of symbols;
4. circles use space efficiently at least when compared to bars;
5. circles represent patterns of distribution reasonably well; and
6. when used as pie charts, circles more effectively communicate parts of the whole than do segmented bars. (1971:97)

We know now about the response of the average map user to variations in size of point symbols (especially circles) from Flannery's work. In the visual psychophysical world, the area of geometric figures is usually underestimated[1]. Because the areas of circles are not perceived linearly, Flannery has introduced a correction factor (data raised to the power of 0.57 instead of data raised to the power of 0.5), causing circle sizes to increase more rapidly than direct areal scaling would produce, thus compensating for the

1. Underestimation means that for every unit of physical stimulus perceived less than unity is reported in response (Dent, 1990:202).

perceptual underestimation. This is one of the most fundamental guidelines in the design of proportional circle (including pie) maps: the circle radii are scaled as data raised to the power of 0.57. This approach has been applied, for example, to the design of proportional circles in the three volumes of the monumental Historical Atlas of Canada (1987-1993).

Clarke (1959) expanded the concept of examining the effectiveness of circles as cartographic symbols into other forms of point symbols. These symbols were lines (bars), squares, spheres and cubes. He thought that the most common geometric forms were:

1. bars and lines, proportional linearly,
2. squares and circles, proportional areally,
3. cube and spheres, proportional volumetrically.(1959:98)

The reason that cartographers occasionally use pseudo three-dimensional symbols of cubes and spheres is that this type of symbol enables graphic representation of a greater numerical range before crowding occurs. To test the accuracy, error and variability in estimating the size of these symbols, Clarke conducted an experiment in which nine separate cards each containing three symbols were shown individually and at random to 33 second-year geography undergraduates. Each student was asked to compare the size of the smallest and largest symbols with that of the standard symbol. The results of the study showed that the more dimensions and the greater the difference between the symbol and the comparison target, the greater was the error and the less accurate the visual evaluation. Thus, cartographers should give attention to the fact that difficulty in visual evaluation of proportional symbols increases with the number of dimensions of the symbol; with data of a small numerical range, they are sometimes justified in using bars

(or lines) despite the problems these forms create for precise location of the item they represent. "Perhaps two-dimensional symbols meet all the conditions most satisfactorily, and so are valuable for general purposes" (p.103).

There were conflicting results from the study of graduated squares by Crawford (1973). Crawford hypothesized that the relative size (area) differences of graduated squares are judged on the basis of area, rather than on the basis of a linear dimension, and that the relative magnitudes are estimated accurately (Crawford, 1973:85). A total of 195 undergraduate students without prior cartographic training participated in the study. Subjects were asked to compare a numbered standard square and five lettered squares of variable sizes. The results of his study did demonstrate that subjects correctly estimated the relative area of graduated squares within a range of sizes appropriate for use on small scale thematic maps. Crawford admitted, however, that participants may have correctly estimated the squares because of the limited size of the test squares, and had larger squares been included in the study, the results may well have shown obvious underestimation of the relative size (p.88).

The results of this study raise questions regarding to the practical use of point symbols of variable area for particular cartographic problems. The graduated square has not been widely used by cartographers in the past because squares cannot be constructed and utilized in numerous mapping situations with the same ease as circles. On the other hand, there is extensive evidence that the average map reader cannot accurately estimate the relative size of proportional circles, though it is possible to adjust their sizes to compensate for perceptual error (p.88).

While many researchers continued to investigate the quantitative aspects of the psychophysics of map reading, other studies approached using qualitative thematic symbols.

For example, Head (1972) approached the problem of the symbolization of the important land-water differentiation. Head maintained that, in the map-reading process, the rapid, clear, and unambiguous interpretation of the dichotomy of land and water areas is highly important, for it is this differentiation that is most clearly related to readers' "mental maps" (Head, 1972:25). Twelve carefully-chosen samples from the broad variety of methods used were subjected to a test designed to determine the degree of subjective confusion between land and water areas (Head, 1972:28). The symbols represented a mixture of conventional symbols and those designed on various graphic perception principles relating to figure-ground discriminations and visual depth perception.

The test was conducted on 34 students enrolled in an Introductory Landform Geography course at the University of Wisconsin, Madison. A second test was conducted on 124 students enrolled in a second year cartography course at McMaster University, Hamilton, Ontario. The sample representations were printed on 3" by 3" cards, "randomized both in order and in orientation within test packets" (Head, 1972:30). Subjects were instructed to simply mark on the card the letter 'L' for land on the area they thought was land, and 'S' on the area they thought was sea.

The results from these tests indicated that the symbolisms produced different interpretations -- from misinterpretation to complete ambiguity to correct and

unambiguous interpretation. The study concluded that the most effective way to distinguish land from water is to keep all the labelling of land locations on the land and to use a "subtle" areal symbolization such a stippling to reinforce the land or water identification established by lettering.

Delucia (1972) conducted two experiments to measure the effect of shaded relief on map reading performance. The specific hypothesis being tested in two experiments was that the use of the shaded relief technique of terrain representation decreases the legibility of all other symbols appearing in the map, thereby making the information represented by those symbols less accessible to the map reader, and resulting in a significant increase in the time necessary to extract required elements of non-terrain information from the map.

The maps chosen for use in these experiments were the 1:250,000 scale U.S.G.S. topographic sheet covering Fairbanks, Alaska and the 1:62,500 U.S.G.S. topographic sheet covering Soda Spring, Idaho. There was a total of 32 subjects used in the two experiments, 16 in each one. All subjects were either undergraduate or graduate student cartographers who were familiar with maps utilising both shaded relief and contour line terrain symbolisation. In each experiment the subjects were equally and randomly divided into two groups with eight tested on the shaded relief version of the map and the other eight tested on the contour line edition. Results of the initial experiment conformed the hypothesis of the study. For cartographic designers the implications of this study are clear. From the point of view of the test hypothesis, the experimental results tend to indicate support for the notion that the use of shaded relief terrain symbology on a map

to some degree impairs the ability of a map reader to extract non-terrain information. Cartographers must also take into account the factors of map scale, symbol density, and density of the shaded relief background in making design decisions since all three have a definite effect upon the ultimate response of the map user to the map produced.

Considerable difficulties are encountered by researchers in attempts to assess the manner in which graphical information is used by map readers in route choice decisions (Gill, 1988:36). Most map users appear to believe that once a map's specific symbol set is understood, map reading is a fairly straightforward and self-evident procedure. Actually it is not easy for people to explain how they extract information from a map, though it seems such an obvious process. Much of the processing of the relevant map information and the assessment of its relative emphases is achieved subconsciously. As Dobson (1979) has stated, it is a fundamental assumption of map design research that design changes can attract the reader's attention and allow the cartographer effectively to choreograph the map reading process. Several studies have compared, and found considerable differences between, the routes selected for a particular journey by half a subject group who used one particular map, and by the other half who were shown a different map of the same scale (Sheppard and Adams, 1971; Morrison, 1974; Carpenter, 1979; Gill, 1986). Clearly, information on the road classification hierarchy is vital to such route choices. Particular differences in the line symbols could often be seen to affect the routes chosen in specific ways, the main graphical variables being width, colour and the presence/absence and nature of casing lines. As part of a linked program relating to the design of maps for route planning, Gill (1988) conducted two experiments. A

psychophysical test using line symbol segments found that the perceived prominence of the individual symbols in central vision could be predicted remarkably consistently by a combination of measures of line width, brightness and saturation contrast, and the effective value of the line colour. A second performance-based test of line symbol conspicuity suggested guidelines for a minimum colour difference to be used between line classes to prevent confusion in peripheral vision.

Any experiment is subject to different interpretations and no one or two experiments can be conclusive. There is a need to accumulate results and implications about a phenomenon over many experiments before laws or principles can be definitely asserted.

One of the very important conclusions from these studies is that we indeed learn that the average responses to particular simple map symbol parameters (size, shape, hue, etc.) can be very closely predicted. Therefore, it suggests that if we know how the average reader reacts to an individual map symbol or symbol component, we can better design the map to communicate specific data.

Cognitive Research

Since the 1970s, a number of significant theoretical shifts have occurred in disciplines influencing cartography, especially in the field of psychology. "The important shift that has occurred in psychology is away from an emphasis on strict behaviorism, and toward an emphasis on thought processes, toward what has come to be called cognitive psychology" (Petchenik, 1977:118).

According to Pettijohn (1991:53), "traditional classification in philosophy and psychology divides mental activity into three aspects: cognitive, involving perceiving, thinking, and knowing; affective, involving feelings and emotions; and connotative, involving acting, doing, and striving". Cognition may be defined as "every process by which a living creature obtains knowledge of some objects or becomes aware of its environment. Cognitive processes are: perception, discovery, recognition, imagining, judging, memorizing, learning and often speech" (Eysenck and Arnold, 1972:177). Similarly, Corsini (1984) maintains that "cognition comprises all mental activity or states involved in knowing and the mind's functioning and includes perception, attention, memory, imagery, language functions, developmental process, problem solving and that of intelligence" (p.228).

Petchenik (1977) argued that the psychophysical approach with its emphasis on the immediate perception of the map did not give the answers to how people read maps in the sense of learning, remembering, and making use of them. The psychophysical approach has ignored the higher mental processes which are required to understand a map She claimed :

> Map reading is more than just the cumulation of a number of simple perceptual comparisons of symbol size or value. Perhaps it is time, in recognition of this fact, to shift our thinking from the details of empirical research from psychophysical studies, etc., to a concern with the broader assumptions that underlie the conduct of such research, and to the possibility that certain shifts in those basic assumptions might be of some value to cartography. (p.117)

Other scholars (Olson, 1979; Gilmartin, 1981; Head, 1984; Taylor, 1991) presented similar opinions. They encouraged a more cognitive approach to research in cartography.

To them, map interpretation is a cognitive task.

Cognition is concerned with higher mental processes which people employ to acquire, store and use information. Taylor (1991) pointed out that "cartographic cognition is a unique process as it involves the use of the human brain to recognize patterns and relationships in their spatial context" (p.4).

One of the first cognitive studies related to map reading was conducted by Marino (1979). She chose to look at cognitive processes in the encoding stage of cartographic communication (map-making) rather than at the decoding (map-using) stage. In her study, she examined and compared the judgmental strategies used in the issue of the selection of characteristic points along a linear map symbols (such as shorelines or contours) by two groups of individuals: cartographers and non-cartographers. They were asked to determine which points along the line are crucial in the generalization of that line. The underlying assumptions were "1) that certain points (characteristic points) on a line must be maintained in order to communicate the character of the line, and 2) that lines symbolizing certain geographical features can and do have a different character from one another" (Marino, 1979:71). Lines representing geomorphological features of three types of rivers and three types of coastlines were used in this study. Subjects were instructed to mark those points on the lines which should be retained at three successively increasing levels or degrees of generalization.

These tests demonstrated the high degree of agreement that exists within as well as between cartographer and non-cartographer groups. Both groups thought that particular points along a line must be retained in order to preserve the character of these lines as

generalization occurred. The test results tended to support the idea that when people read maps, there is indeed a cognitive process in their minds. To use maps correctly, they have to understand and to memorize the characteristic features (e.g. the certain points for the lines).

There were two studies in which protocol analysis was used to identify differences between subjects with more or less cartographic experience (Thorndyke & Stasz 1980; Gilhooly, Wood, Kinnear & Green 1988). Both of these studies involved the learning of reference maps.

Thorndyke and Stasz were able to isolate 18 separate procedures used by subjects as they studied the map stimuli, and their 'good' learners selected more effective procedures than did their 'poor' learner counterparts. This was done through an experiment conducted on what the researchers considered to be "experienced" and "non-experienced" map readers by exposing them to two previously unfamiliar planimetric maps. (A planimetric map represents only the horizontal positions of surface features.) The maps used were 1) a plan of a grid-pattern city, with land-marks represented by labelled icons, and 2) a political map of some imaginary countries, with very few topographical features represented. "Experienced" map users were defined as those who frequently used maps in their jobs and "novice" map users were considered as those who have had little knowledge about maps. Each group studied the map for two minutes, then the map was removed and the subjects attempted to draw it from memory. Each subject received six trials on the same map. On the basis of the recall data, subjects were divided into good and poor learners.(Thorndyke and Stasz, 1980:146).

The Thorndyke and Stasz's experiment employed protocol analysis. This is a method of obtaining information from subjects by asking them to verbalize their thoughts as they proceed through the task (a "think-aloud" procedure) with later classification and analysis of the individual procedures employed. They found that the majority of good map learners frequently used what they called partitioning, encoding and evaluation. "Partitioning" refers to a technique for attending "selectively to well-defined portions of the map"(Thorndyke and Stasz, 1980:147). "Encoding" is the ability to recognize the spatial pattern and relationships among map components (p.147). And "evaluation" is regarding the methods to check the "learning process" to insure the effectiveness of learning (p.147). Poor learners frequently reported that they could think of no procedure for learning the spatial information; in general, their repertoire of spatial learning techniques was different from that of good learners. The best subject scored 100% and the worse subject scored 19%. Yet both had been classified on the basis of the experimenters' a priori criteria as experienced map users. Thorndyke and Stasz concluded that it is not map experience in general, but rather the types of encoding procedures that are used, that determine whether or not map elements will be learned. This suggests that the learning strategies used are more important than mere familiarity with map reading.

The Thorndyke and Stasz's study is opposed by some other researchers. Gilhooly et al. (1988) published a paper beginning by suggesting that Thorndyke and Stasz failed to reveal differences between experienced and non-experienced subjects because of the characteristics of the maps used in the study. They argue that the Thorndyke and Stasz maps are: 1) imaginary renditions which do not possess 'real world' validity, and 2)

simple planimetric representations which do not use or require cartographic expertise to learn (Gilhooly et al., 1988:87).

Gilhooly, et al., therefore, carried out two experiments. Experiment 1 began with selecting the subjects. A total of 262 undergraduate students taking first-year courses in Psychology or Geography at Aberdeen University were given a short (7-question) test of contour-map reading and a short (7-item) biographical questionnaire on the level reached in their Geography education at school and on their extracurricular use of contour maps. The test of contour map reading included the questions on spot heights, intervisibility, cross-section identification, directions of river flows, distances, etc. On the other hand, the biographical questionnaire included questions on any training received and the frequency of use of contour maps in activities such as hill-walking and orienteering. The former was scored according to the number of questions correctly answered. The latter was scored so that higher scores represented more formal training in geography or more extra-curricular use of contour maps. The scores on the map-reading test and the biographical questionnaire correlated 0.67 (Gilhooly et al., 1988:89). The high-skill group was drawn from the top 30% and the low-skill group from the bottom 30% of the distribution of scores. There were 40 low-skill subjects and 38 high-skill subjects from the selection. Therefore, a total of 78 subjects took part in Experiment 1. In both skill groups, males and females were equally assigned. The materials of Experiment 1 were two planimetric maps taken from Thorndyke and Stasz (1980) and two topographic contour maps.

Subjects were told that their task would be to try to learn all the information on

the map during five minutes so that they could re-draw the map and answer questions on it from memory. Subjects were allowed ten minutes to complete the drawings immediately after having studied the map. At the last step, they were presented with the multiple-choice memory test relating to the map they had studied and were given ten minutes to complete it.

The results of Experiment 1 were: skilled readers of contour maps showed advantages in recall of contour maps, but no advantage in recall of planimetric maps; skilled map readers had no advantage in drawing non-contour features of the contour maps from memory.

Although skilled map readers have an advantage in memory for topographic contour maps but not for planimetric maps, the encoding and retrieval processes underlying this advantage were not revealed by the techniques used. Therefore, Experiment 2 was devised with the aim of obtaining more direct information on encoding and retrieval in the map learning task. Twenty-one subjects took part including 11 high-skill subjects and 10 low-skill subjects. The subjects were selected from the same team as had been used in Experiment 1. Process-tracing techniques (thinking-aloud and pointer-using) were employed when the skilled and unskilled subjects studied, and then recalled, topographic contour maps. Objective measures of attentional and retrieval focusing revealed almost no differences between the skilled and unskilled subjects. However, analyses of verbal protocols showed that the skilled subjects made more use of specialist schemata by which the skilled reader analyzed the relationships among geographical units to build up the mental images of holistic structure, whereas the

unskilled subjects spent more time in reading place names. During recall, the skilled subjects made more use of both specialist and lay schemata, whereas the unskilled retrieved more place-name information.

Eastman's investigation (1985) about map learning indicates that spatial data are stored in the human memory as regionalized groups of features -- chunks. These in turn provide the units for higher-order chunks. His results showed the significance of a strongly-evident hierarchical organisation in a map and suggested its relation to the human hierarchical memory structure. The graphical design-variation of chunks, he found, are not so important as the hierarchical organisation.

Chang and Antes (1987) tried to find answers as to how the nature of map reading skills are influenced by environmental factors, culture, education and sexual differences. These researchers studied the map reading of reference maps, topographic maps and street maps in two cultural groups: students from the University of North Dakota (ND) and the National Taiwan University (TU), and with nearly equal numbers of males and females in each group. They found that: 1) males performed significantly better than females in reference and topographic map reading ; 2) TU subjects outperformed ND subjects in topographic map reading; 3) sex difference existed in both cultural groups and the cultural difference was significant among males as well as females; and 4) performance scores on different map types were significantly correlated (Chang and Antes, 1987:39).

To provide a more detailed description of the cognitive processing evoked when a map user matches a contour mapped landsurface against an actual viewed landsurface,

a cognitive experiment was carried out by Eley (1992) with map-skilled adults. He used contour maps and 3-D models of the same area to control the contour map perception. Thirty six adult volunteers (28 males, 8 female) were recruited from three populations in Hobart, Tasmania: public servants working as cartographers, skilled level participants in the sport of orienteering, and bushwalkers who frequently walked in the state's extensive wildness areas. The common factor uniting the three groups was that proficiency with topographic map was essential to their activities. Map users certainly seem to encode mapped features into mental images, manipulate those images, and match them, but they would seem also to engage processes extra to such a skeletal minimum. The findings indicate that processing is more varied and flexible than initially suggested.

The experimental results of Gilhooly et al. (1988) have been supported by the study of another research group. Kulhavy, Pridemore and Stock, (1992) used "think aloud" to evaluate the influence of cartographic experience on thematic maps. They selected the analysis of these verbal protocols as their primary data base.

Four high school seniors, two males and two females were considering as inexperienced map reading subjects. Four college seniors, two males and two females, completing their bachelor's degree with a major in geography were considering as experienced map reading subjects. In the experiment, they were asked to study a thematic map titled the Ancient Mayan World for 15 minutes. And the subjects were told to say whatever they were thinking from the point at which they first saw the map until the end of the 15-minute period. When the 15-minute period was ended, the map was removed from sight and the subject received a piece of white poster board of exactly the same size

as the map itself. Subjects were given a black-ink pen and asked to reconstruct the map as accurately as they were able.

An analysis of the verbal protocols yielded no salient differences due to sex of subject or instructions to learn the map. The experienced college subjects tended to emphasize theme information rather than geography, and to display wider scanning ranges during initial map viewing. During a map reconstruction task, college subjects generated more legend and orientation information, emphasized theme distributions, and used more grouping statements as a way of generalizing the theme information. They also embellished the map with additional content, and made more inferences about elements depicted within the map space. These results suggest that cartographic experience needs cartographic data on which to work. Apparently, most students are able to learn simple reference displays, so that cartographic knowledge has little, if any, influence on acquiring the information. However, when specialized data is added to the map space (e.g. contours, themes), there are marked differences between experienced and non-experienced populations.

Cartographers are interested in cognitive research to learn about maps and how they work as a research goal in itself, but they are in large part interested in the enhancement of cartographic communication by improving both map making and map using. The important questions are how people see and understand a map, and what kinds of factors affect that seeing and understanding. The answers to such questions will not come solely from psychophysics or cognition. New approaches have to be developed in the study of cartographic communication.

Summary

Research in cartographic communication has taken different forms. Much of the research work from the 1950s to 1970s in North-American was of a psychophysical nature experimenting with subject response to graphic parameters of individual cartographic symbols such as circle size and aspects of colour (Head, 1991:247).

During the past twenty years, some significant theoretical shifts have occurred in disciplines influencing cartography, especially in the field of psychology. The new approach is away from an emphasis on strict behaviorism, and toward an emphasis on thought processes, toward what has come to be called cognitive psychology. And more researchers have recognized that map reading is a skilled task in which the cognitive processes are strongly involved. In the last twenty years, some researchers have used cognitive research to approach the map reading processes from different perspectives. Among them, two new research approaches have emerged. One treats the map symbol system in the broader context of semiotics; another treats it within the context of human language. The following chapter will examine both of them in some detail.

CHAPTER THREE
RESEARCH IN CARTOGRAPHIC COMMUNICATION: MAP SYMBOL SYSTEMS AND LANGUAGE

Introduction

The history of mapping is probably at least as long as that of communication by written language (Robinson, et al., 1984:20). The map has been present in all human societies, and has played an important role in human activities throughout history. The concept of maps and mapping, whether as a mental constructs or physical products, is so basic that psychologists often talk of mapping strategies as central to the understanding of how the human brain functions (Taylor, 1991:3). Unfortunately, neither making nor reading maps effectively is as simple and straightforward as it may seem. Non-trained map users usually encounter problems in using maps. Most people understand little about how to use maps to extract information efficiently, and it is difficult for them to improve their map reading on their own. Even cartographic research on map communication has progressed slowly. This situation was summed up by Head (1991) as follows:

> The craft of encoding aspects of our milieu into map storage -- the art and science of cartographic production -- has ancient roots and is no stranger to technological innovation. Yet the understanding of the use of maps as a medium to facilitate human thought and communication about spatial relationships is a relatively recent concern and along this path we have made surprisingly little progress. To use a geographical metaphor: the path is not clearly cut, the night is dark, we have no torch, and we have no map. (p.237).

To resolve these problems, a number of researchers have proposed the application of models of the processing of visual language to the system of map symbols, analyzing

the system of map language in terms of such linguistic components as vocabulary, grammar and syntax. This concept, however, has been the subject of debate. Some scholars agree that a map is indeed a kind of language, while others say it is not. A.H.Robinson and B.B.Petchenik, two of the leaders in cartographic thought, in their landmark study The Nature of Maps (1976), stated:

> The differences between the discursive and the presentational forms of communication are so profound and fundamental as to defy any parallelism beyond that of simple sensory impression. Any attempt to apply to mapping the principles of operational structure out of which arise the grammar of a language is wasted effort. (p.67)

John Keates in his Understanding Maps (1982) also argued that the cartographic medium cannot be considered as a language, because it has no fixed alphabet of conventionally understood signs, and there is also no fixed order of reading (pp.109-113). Other objections to the consideration of maps as texts in a language come from Hansgeorg Schlichtmann. Schlichtmann has developed in detail the manner in which maps are a semiotic system; he considers the analogy with language to be imprecise and unnecessary.

Strong arguments in favour of considering map symbol systems as having linguistic features have come from other researchers, for example, Dacey, 1970; Ratajski, 1975; Pravda, 1978; Head, 1981, 1984; Eastman, 1985; Lyutyy, 1984, 1985/86. These researchers analyze the system of map language in terms of such concepts as lexicon and syntax and then further utilize the analogy between the language of maps and visual languages or other communication systems (Lyutyy 1984, for example, compared the cartographic language to the mathematical languages). Lexicon

is the vocabulary of a language, its stock of lexemes (or, in casual speech, "words"). Syntax is certain grammatical rules which govern the positioning of, and relationships between lexemes. In Cartographic Communication as a Natural Language (1981), Grant Head emphasized that

> to view cartography [maps] as a natural language will provide precisely the overarching theory that we are seeking. It will tie us to voluminous and extremely active research areas in both linguistics and information processing psychology and, importantly, will allow experimental testing of precisely-defined portions of the communication process. (p.2)

In 1990, Head reviewed twenty years of approaches to cartography as a language or semiotic system, published as "Mapping as Language or Semiotic System: Review and Comment" (1991). This chapter has benefited from that review, and follows it closely. For the benefit of the reader, however, most of this chapter's references are directly to the papers referred to by Head.

Formative Work in the Seventies

Michael Dacey of Northwestern University explored the concepts of an information system that provides a wide variety of geographical information to a diverse group of users (Dacey, 1970:73). His object in his "Linguistic Aspects of Maps and Geographic Information" was "to go beyond the bare observation that maps have a linguistic basis to clarify some of the ways in which maps and other formulations of geographic information constitute a language and then indicate how a linguistic approach contributes to description and analysis of the information content of a geographic information system" (p.72). Dacey maintained "all communication is by language and identification of the functions and properties of these languages are prerequisite to the

successful description of a geographic information system''(p.73). Beyond the traditional printed map, he was interested in all things that function like a map, such as textual material, systems of equations, sketches and drawings, that ''communicate information about location and a wide variety of areal relations'' (p.72). He felt that linguistic concepts were appropriate to all of these, ''because they take into account the meaning of geographical information but are largely unaffected by the structure and form of alternative symbolic expressions of geographic information''(p.72). Dacey recognized clearly the both content and expression components of sign, and he recognized it specifically at the morpheme level (p.73).

Dacey went further to recognize that language is ''an institutionalized collection of signs that have common designations to members of the community using these signs'' (p.73). The signs, Dacey goes on, are ''produceable by members of this community and they may be combined in some ways, but not in other ways, to obtain sign processes which also have a common designation to the users'' (p.73). The relations between sign, designation and user tend to produce three major fields of study. **Pragmatics** considers the interface between sign systems and their users. This largely empirical field emphasizes the origin, uses and effects of signs in processes of communication (p.74). **Semantics** concerns itself with the meanings of signs or the relationship between signs and the concepts they represent. The description or construction of a semantic system involves the classification of signs, the specification of rules of designation, the listing of rules of formation that govern the arrangements of signs that may occur in sign processes, and the identification of rules of truth that establish when a sign process is

true (p.74). **Syntactics** concerns the rules relating to the internal structure of the system of signs. The formulation of a syntactic calculus, as Dacey put it, uses a classification of signs for the identification of formation rules that determine the permissible arrangements of signs, and these permissible sign processes are called expressions of the calculus (p.74). This calculus also identifies transformation rules that determine expressions that are logical consequences of other expressions.

As Dacey has pointed out, the main difficulty in applying common semiotic or linguistic models to maps could be in the problem that "while the serial order of language is commonly contained within the ordering concepts of 'before' and 'after', the ordering of map symbols is multi-directional"(pp.74-75). A language for the transmission of geographic information, then, must be a two-dimensional language. An expression in a two dimensional language is called a picture or figure. A map is a collection of particular kinds of pictures. This two dimensional language concept had been recognized by other workers in several diverse areas (McCormick and Narasimhan, 1962; Narasimhan, 1964 and Ledley, 1966). Dacey suggested the application of certain linguistic models such as the "context-free phrase structure [grammar]" or "immediate constituent analysis"(p.76) and referred the readers to Chomsky (1962, 1965). Dacey noted that his work provided partial solutions to the problems involved in the definition of picture primitives, the expression of picture syntax and the generalization of the notion of concatenation to two dimensions, which confront the continued development of two-dimensional languages and their adaptation to the needs of geographic information systems. Problems yet to be explored included "the manner of describing the spatial

relations that obtain between expressions that are components of complex pictures'', and the procedures ''for conducting syntactical analysis of pictures'' (pp.77-78). Unfortunately, he does not appear to have published further along these lines.

Dacey also commented on the differing nature of geographic information as compared to the main information carried by most languages. Most languages make objects differ one from the other individuation in a variety of characteristics, these characteristics are not usually locational ones (p.78). A primary concern of geographic information, however, is the spatial attributes of the things occurring in a specified space-time region. Therefore, ''the theory of semiotics leaves open many problems concerning the specification of a semantic system for a language whose domain includes individuals whose positional attributes are as significant as the non-positional attributes'' (p.78).

Other researchers (Board, 1973; Morrison, 1974; Ratajski, 1975) continued to examine these problems raised by considering cartography to be a language. Ratajski observed that ''[Map] language belongs to the wide group of ideographic language'' (p.1). From the point of view of strict grammatical rules informing the receiver by means of a map, he reasoned that the map as a language expression is much more complicated than in the case of natural language, but that for a certain kind of communication it is much simpler, quicker and richer (p.1). He considered the cartographic marks which he calls ''signs'' as equivalent to word-size in the natural language hierarchy, and like words in visual languages, they can be subdivided into morphemes. In the cartographic signs, he uses primary and secondary morphemes to create the cartographic ''words'' (Fig. 3.2 on page 40).

While the focus of the above work, Head notes, had been "on lower-level cartographic symbols rather than higher-level complexes of map marks and the manners in which these complexes are achieved and used, certain significant aspects of the linguistic analogy were noted" (Head, 1991:244). Again, the problem was the linearity of natural language as against the two dimensional presentational mode of the cartographic system. This problem has been commented upon by all of Dacey (1970), Robinson and Petchenik (1976) and Ratajski (1975:76): the spatial arrangement of symbols on maps reflects closely the spatial arrangement of items on the ground. Therefore, it is easy to see the syntactic structure of the object language of maps as a mere reflection of a structure of concrete space (Ratajski, 1975:12).

Ratajski stresses how the geographical concepts may influence the map reading process. If the map user has developed from geographical experience the concept that "the source of a river is situated higher than its mouth", then as he/she uses a map that denotes a network of rivers, the map implies "the place situated on this river closer to its source is higher than the one closer to the mouth" (p.11).

From extended map use, "a whole atlas of mental maps is left in a map-user's mind", and this atlas enables the user to recognize on other maps the shapes of Europe, Great Britain and so on (Ratajski, 1975:13). These mental maps if used as part of the design of real map can play a key role in assisting the recognition of map syntax: "they play the same role in a map as punctuation, paragraphs, bold-face type or setting out in the written language" (Ratajski, 1975:13-14). At the last part of his paper, incorporating some lessons from experimental work, Ratajski suggested another significant aspect of

the map communication process : "A map is never read 'from cover to cover"'. Map reading is a cognitive process (Ratajski, 1975:16). Head (1991:244) considered this as a particularly important concept, since it runs counter to the widely-held generalization that maps are seen "all at once" and thus function in a manner fundamentally different from language (Robinson, 1978:5-7).

Pravda (1978) gave particular attention to the units of the map language and their ability to combine to form complex signs. Pravda defined cartographemes, cartomophemes and cartosyntagma as follows.

As is the grapheme in the visual languages, the **cartographeme** is the "...most elementary and visually perceivable graphic formation with a mainly graphic function, i.e. it has an individual graphic motive within the framework of a two-dimensional graphematic space and has also the ability to arrange into cartomorphemes. It is not a bearer of an independent significance /sensual, semantic content/ but only a material part /component/ of the cartomorpheme and together with it of the cartosyntagma" (Pravda, 1978:4).

A **cartomorpheme** is a "graphic formation which developed from the combination of cartographemes", "able to become a bearer of the significance component or of a part of the significance or even of a selective significance if the concept is complex" (p.4).

Pravda defines the **cartosyntagma** as "every independent cartographic sign","a graphic conventional or symbolic significate of an arbitrary /even abstract/ concept"; "it fulfils its full function only in a mathematically defined or otherwise logically defined

space of the map''(p.4).

Elaborations in the Eighties

Head (1984) presented the revisions to his 1981 discussion paper as: ''The Map as Natural Language: A Paradigm for Understanding'' (1984). The study recognized units in the map language, smaller ones of which can be assembled into larger. It recognized the content and expression components of signs, as ''concept'' and ''surface'' levels of language or ''meaning'' and ''form'' components of sign. Head insisted throughout the paper upon the important role of the map reader. ''The process of map reading, like the process of reading of text, requires the existence of structures in the reader's mind that are, at the least, equally as important as the marks on paper''(p.2). Head's paper gives much more attention than other language or semiotic papers to the process of map reading and to the reader's role in that process.

Although his paper does tend to present a case for upwards chunking of low-level signs into higher, it also points out that as the more efficient text readers ''... transfer into STM [short term memory] whole words, even phrases not just letters'' (p.4), so too do the more efficient map readers recognize and utilize larger map signs such as ''hill'', ''town'', ''valley'' etc., rather than using only the minimal signs such as one sinuous brown line (contour), one small black square (building), or one blue line (river). He presents a example: in the reading of a topographic map for landscape visualization, the user ''with a developed lexicon of geographic items -- 'drumlins, kames and outwash plains' -- will be better equipped to move quickly and effortlessly through the successive stages of the visualization process'' (Head, 1984:12).

Another way in which we can use the visual language analogy as a pathway to understanding map communication is to consider map messages at the level of texts, and to apply the human information processing and psycholinguistic notion of the proposition to the problem of syntax. The basic map communication is of the nature "what is where", with "what" including both geographic points such as a church or a library, and geographic patterns (Head, 1984:17).

In summary, Head makes three basic points. First he focuses attention upon the importance of message content, while many cartographers tend to focus upon expression. Secondly, he notes that the methods of teaching English as a second language might be applicable to the teaching map use. And thirdly, if cartographic communication is sufficiently similar to communication through natural language, one can transfer to cartography, fairly directly, much experimental work from other disciplines. (Head, 1984:19-25).

Schlichtmann, however, believes firmly that maps are better understood if they are studied in a semiotic framework. Semioticians, too, have developed models of the organization of our conceptual universe and of the processes of expressing and retrieving information (1991:28). His "Characteristic Traits of the Semiotic System 'Map Symbolism'" of 1985 is based upon the theoretical work of the semioticians Buyssens, Prieto and Eco. He presents to the cartographic literature the semiotic terminology that a sign is composed of two parts, one is a conceptual item, a meaning or content, the other is a perceivable item, a form or expression. These two parts, he notes, are linked by code: "a set of correlating rules or conventions" (Schlichtmann, 1985:23). For

instance, red lights and stop or danger may be considered the two parts of a sign. Schlichtmann points out that map symbols carry both locational information and substantive information. "Locational information is the location in globe space, that is, on the two dimensional, horizontal globe surface" (1985:4). Substantive information refers to other characteristics of the items signified such as magnitude or function. If the symbol had a shape that mimicked its geographic shape (e.g. the symbols for lakes), it would also be what he called plan information (p.24).

Schlichtmann deals with the units of content or expression starting with macrosigns. The macrosign is to maps just as sentences are to languages. In map symbolism, a macrosign is defined as a "complex which contains one location and one plan position"-- a localized sign (Schlichtmann, 1985:25). Macrosigns may be combined into complexes which he called texts, or can be decomposed into signs of a lower order, i.e. minimal signs. However, in this paper, Schlichtmann held that minimal signs cannot be broken down -- as they can be in natural language -- into smaller "distinctive" units on the expression side (pp.25-26). He thus did not recognize cartographic graphemes nor distinctive features below them (Head, 1991:248).

One important part of Schlichtmann's paper is his consideration of the syntax of macrosigns and their combination into texts. He identified two kinds of syntax. The local syntax refers to that which governs relations of the components of the localized sign. The second type of syntax he called supralocal which governs relations of localized signs within texts involving spatial arrangements. Although "the map arrangement of the expressions of localized signs in map space always models globe - spatial arrangements",

this is "not a sufficient condition for text constitution"(p.28). The reader has a strong role in creating chunks of text. The map marks alone are insufficient to create a text.

In 1987, Ronald Eastman provided an analogy between graphic language and natural language (Fig. 3.1). He presents the primary graphic variables (location, size, shape, hue, etc.) as the most basic elements of map symbolism. They parallel the phonemes (a small sub-meaning unit of spoken language, e.g. [æ], [b]) or graphemes (a sub-meaning unit of written language, e.g. a, b) in visual languages. Head feels that these units are missing from the cartographic language; "there is no equivalent to the phonemes or graphemes that are building blocks for morphemes" (1984:9).

GRAPHIC LANGUAGE	NATURAL LANGUAGE
Graphic Structure	Text
Graphic Syntax	Sentence Syntax
Graphic Symbols	Words
Graphic Signs	Morphemes
Graphic Variables	Phonemes

Fig. 3.1 The Strata of Graphic Language and their Natural Language Equivalents. (Eastman, 1987:89)

By linking a content to a graphic form, either by convention or by means of a legend, Eastman maintains, a graphic sign (Fig. 3.2) may be created. "Graphic signs are thus the minimal units of meaning in map symbolism, and would therefore correspond most closely to morphemes (minimal units of meaning) in natural language" (Eastman,

1987:90).

Graphic symbols (Fig. 3.2), then, consist of graphic signs and are the units that most closely correspond to the words of natural language. And graphic symbols are the materials from which the map is composed, "[They] are localized, compound signs -- 'words' on a graphic page" (Eastman, 1987:91).

In a natural language, we need the ability to create sentences to indicate our ideas. Similarly, by analogy to natural language, we require a graphic syntax -- a set of rules for combining graphic symbols into meaningful spatial "sentences" to indicate geographic patterns.

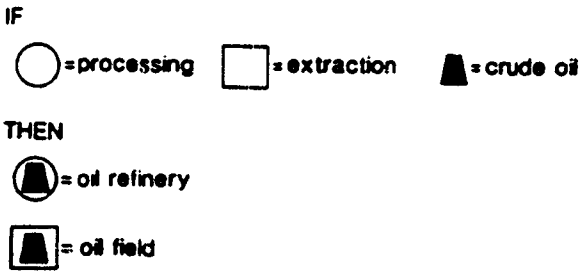


Fig. 3.2 Graphic Signs and Symbols (after Ratajski, 1976; Head, 1991:244)

Within a natural language, with the use of syntax people have the ability to construct sentences. Similarly, in a map context, with syntax there can be a meaningful graphic structure. And with structure, there can be an adequate understanding of the mapped material.

Conclusions

Since the 1970s, and particularly within the last decade and a half, a broad range of terminology and concepts has been drawn into cartography from semiotics and linguistics. The semiotic and language paradigms have certainly given new directions and potential to cartographic communication research. Much work remains to be done, however. One major problem is confusion in terminology and imprecision of concepts. Head suggests (1991:260) that progress may be hastened if we adopt more of the semiotic terminology and concepts. But, he maintains, language research is more detailed than semiotics in its consideration of process. And an understanding of process is crucial if we wish to explain the manner in which readers extract high-level meaning from maps. One further major problem, however, may be that little work has yet been done on applying to cartography the somewhat different forms and structures of non-alphabetic languages. The following chapters of this thesis begin this process.

CHAPTER FOUR
THE WRITTEN CHINESE LANGUAGE

Introduction

The Chinese language -- han-yu -- is used by more people than is any other language. The people who use the Chinese language live in almost every part of the world, and more than ninety-five percent of China's total population of more than one billion use "han-yu". No study that attempts to compare the map to human languages, therefore, can ignore Chinese. Like other written languages, the old Chinese characters evolved gradually from kinds of pictures. However, unlike English or other alphabetic languages, Chinese has evolved into so-called pictographs and further into ideographs. Indeed, in its essentially ideographic characters, Chinese may offer a closer parallel to maps than does the English language to which the map language has been compared. Thus, in order to systematically study the implications of the Chinese language for the map symbol system, the first step is to understand and analyze the Chinese language. To give a basis for discussion, therefore, this chapter focuses on the origin, evolution, units and structure of the written form of the Chinese language.

Written Form and Spoken Forms

Written Chinese consists of units. The basic small unit is the "radical" by which the Chinese characters can be arranged in the traditional Chinese dictionaries. A Chinese

stroke, on the other hand, is a dot, an L-shape, or a line (horizontal, vertical, or diagonal). The strokes are the building blocks of a character. They have no phonetic function and no meaning by themselves.

In China, there is only one written form of Chinese. Although its characters continue to evolve through simplification, the basic character structure of the simplified counterpart remains the same as its non-simplified partner. There are, however, seven distinctly different spoken forms of Chinese (Yuan, 1961, cited in Norman 1988: 181). The reasons for the many dialects are rooted in the history and geography of the country.

Before the Qin dynasty (221 BC - 206 BC), there were various local scripts. After Qin Shi Huang unified China and became the first emperor of the Qin dynasty, the Qin empire carried out a policy of standardization of these local scripts into what became known as the "Qin script". The clerks of the empire sent these new forms of script to north and south parts of China and it passed from one local government to another. For the local people, who may already have learned the written form of their first language, it was necessary to learn the Qin scripts. Since at that time it was difficult to transport the equivalent spoken form of this new script, the clerks of the local governments taught the people the Qin scripts using local spoken forms. The further the people were from the central government, the more different were local spoken forms. The written form of Chinese, now standardized in Qin script, became the common visual language of this vast country. Written Chinese enabled speakers of different dialects to communicate, using characters whose form and meaning remained the same even though their pronunciations varied across the dialects. Indeed, today, even speakers of different

languages, such as Japanese, Korean, and Vietnamese, can communicate to some extent through the written form of Chinese (Sun, 1992:19). The important point is that written Chinese is a working visual human language that can be used to communicate, quite independent of a spoken counterpart.

The Evolution of Script

The written Chinese is one of the oldest scripts in the world, its earliest written records going as far back as more than 3,000 years ago. During this long period of time, Chinese has seen constant development, but its grammar, vocabulary and writing system have in the main retained their original features. (Sun, 1992:10; Liu, et al., 1981, Book 1:9).

The Chinese system of writing developed out of picture forms that came to represent concrete things or concepts. The evolution of the Chinese language parallels that of the human being. During the era when there were no characters in China, there were basically two methods used for keeping records of events or for making memorandums. One was by using material objects. The other method was by drawing pictures.

Material objects used for keeping records of events came in various forms, i.e. tying knots, notching wood, or connecting beads. Tying a big knot symbolized a big thing or event; tying a small knot meant a small thing or event. Notching wood involved making signs on a piece of wood or a wooden stick. And connecting beads was done by using the thread or fibre of plants to connect beads or shells to indicate different

meanings. The Chinese abacus evolved from connecting beads (Sun, 1980:3). Tying knots, notching wood and connecting beads utilized material objects, but these material objects could not be developed into characters.

The oldest antecedent of script is the use of pictures. Drawing pictures could be used to help one's memory, but could also be used to convey information to other people. For instance, drawing a picture of a human could express something about humans, whereas drawing a tiger, a buffalo, a deer, etc. was used to keep records of hunting harvests. There is very little difference between ancient means of memorandum or indication by picture and today's advertisements or signs with pictures. Both of these function as forms of communication. Tang Lan (1965:24-30) was one of the first modern scholars to maintain that Chinese writing had its origin in primitive drawings. This has now become the prevalent view.

The main type of drawing from which written language is held to have evolved is the single picture (sometimes including several graphic components) which has particular meaning. The picture does not have any particular pronunciation. The more a drawing was used, the simpler the picture became. For the sake of convenience, the ancient Chinese began to attach a certain pronunciation to the simpler pictures. Therefore, these original drawings or pictures evolved into the origins of language -- pictograms.

The antecedents of writing, of course, are deeply buried in the past. Figures and scenes on clay pottery and rock faces, found in different sites six thousand years ago or perhaps even earlier, were probably forerunners of writing (Woon, 1987:80). In China,

most of the major sites are located in the country's central area, on the middle and lower reaches of the Yellow River regions. Although examples of these early inscriptions are very limited (Li, 1974:363-4), for the purpose of discussing the origins of Chinese writing and other related questions they are of high importance since these are the earliest sort of inscriptions discovered to date.

It is not certain whether all these drawings represented steps toward writing or were even intended for purposes of linguistic communication. Perhaps some of them were employed as a form of magic to guarantee a successful hunt or other benefits. Perhaps some of them were the product of religious activity, or even forms of aesthetic expression. Some illustrations, such as those depicting the phases of the moon, may have been part of some form of record keeping. Pictures from later periods, however, were clearly drawn for purposes of communication. These representations are generally referred to as pictograms or picture writing. Each pictogram had an image of the object that it represented, and, as far as we know, it offered no clues to pronunciation. Each situation depicted could be understood by the viewers. According to Anderson (1987:384), this kind of communication has also been found among people throughout the ancient and modern world, used by American native peoples, by African tribes, by natives of Siberia and by ancient people of the Middle East

The Evolution of Chinese Script

The most ancient forms of writing found in China are those on the shells and bones of the Shang dynasty (1766-1123 BC). These "Shang bone scripts" were followed

by the inscriptions on bronze and stone of the Zhou dynasty (1122-256 BC). In the Qin dynasty (221-207 BC), as we have seen, writing was standardized in what are now known as the "small-seal characters", still used on some seals today. The small-seal characters evolved into the calligraphy of the Han dynasty (206 BC - AD 220). This has been called "official script" or "clerical script", a simplified form of the small-seal characters. Since then, while the characters of this official script have changed in the style of component strokes, there has been no change in the basic characters themselves. The most commonly used form today is called the "regular script" or "model form", in which most books are printed. These stages of development will be described in some detail below.

The Chinese script appeared as a developed writing system in the late Shang dynasty (14th to 11th centuries BC). From this period there are abundant examples of script inscribed or written on bones and tortoise shells, mostly in the form of short divinatory texts, followed by a number of inscriptions on bronze vessels in the Zhou dynasty. The scripts of these periods had already developed as a writing system. The maturity of this early script has suggested to many scholars that it must have passed through a fairly long period of development before reaching this stage. The few examples of writing which precede the fourteenth century BC are unfortunately not enough to allow any sort of reconstruction of this development. On the basis of available evidence, however, it would not be unreasonable to assume that Chinese writing began sometime in the early Shang dynasty or even somewhat earlier in the late Xia dynasty, approximately in the seventeenth century BC (Qiu, 1978:169).

The earliest Chinese writing from late Xia shows that it had a basically pictographic origin. At the earliest stages of its development, it is quite clear that the chief device for encoding concepts was to draw a picture of what was to be represented. These pictures can be called "graphs". From its origins, therefore, a "graph" has been a morpheme. Each graph represented a single concept.

The chief sources of script remaining from the Western Zhou dynasty (eleventh century to 771 BC) and in the Spring and Autumn period (770-476 BC) are bronze inscriptions. These inscriptions range from a few characters up to several hundred. The script of this period is clearly derived from that of the late Shang but shows a general tendency toward a greater linearity and regularity of form (Fig. 4.1). A tendency to straighten out the strokes and to convert earlier rounded strokes to sharper angles can be observed. It is also obvious that the script becomes simpler, and loses some of its pictographic quality. This was due to a natural tendency to simplification through use, and to the need to simplify and rationalize the structure of the graphs as their use became ever more prevalent in an increasingly complex society.

After the Spring and Autumn period, the use of the script spread to all levels of society; this popularization of writing led to the development of many drastically simplified graphs. This development of what has come to be called the "popular" form of the script was especially widespread in the states of eastern China. The script of the western state of Qin, by contrast, generally tended to preserve more faithfully the earlier pictorial aspects. (Norman, 1988:61-62).

Modern graph	Early Western Zhou	Late Western Zhou	Spring and Autumn period
天 tiān 'sky'			
貝 bèi 'shell'			
火 huǒ 'fire'			
馬 mǎ 'horse'			

Fig.4.1 Graphic development in Western Zhou and the Spring and Autumn periods (11th century to 476 B.C.) (Norman, 1988:62)

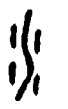
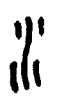
The two or three centuries preceding the unification of the entire country under Qin Shi Huang in 221 BC saw a rapid development of writing in virtually all areas of the country. The new Qin empire, as a part of a policy of standardization of such things as weights, measures and currency, also put into effect a policy of mandatory standardization of script. The various local scripts fell into disuse. Then new standard script was built on the Qin script forms, thus, reinforcing the pictorial character of script across all China.

The script which was adopted under the Qin dynasty existed in two different forms, a complex standard form and a simplified form. The former is known as a zhuan-shu or 'seal script' from its widespread use on seals. The Qin seal script is directly descended from the bronze inscriptional script of the late Western Zhou dynasty. In the course of its development, the seal script had taken on a more regular and balanced appearance and its pictographic origins had become obscured. The second variety of script used during the Qin dynasty was more important than the seal script in the subsequent history of Chinese writing. This latter form of writing came to be known as **lishu**, 'clerical script', from its association with various types of clerks employed by the government. In origin it was nothing more than an organic continuation of the old Qin-states popular script (Norman, 1988:63). The clerical script was highly evolved in its graphic form, and represented a much simplified version of the standard seal script. These forms of Chinese writing used until the end of the Qin dynasty are referred to as "ancient script" or "graph".

During the Han dynasty (206 BC), ancient script was replaced by the clerical

script for all purposes. By the first century BC the clerks and lower-level officials of the government archives had further modified it into forms which were rather more undulant and regular in their brushwork. This new script quickly spread to all levels of society and became the standard Han form of writing. This is the classic form of the clerical script -- lishu -- that is still widely practised by modern calligraphers. Figure 4.2 shows examples of the evolution of twelve characters from their earliest known forms until the clerical script of the Han dynasty.

The evolution from the seal script to the clerical script and the subsequent universal adoption of the clerical script in the Han dynasty probably represent the most important evolutions in the entire history of Chinese writing. This evolution marks the change from the ancient form of writing in which, despite a progressive tendency toward a more stylized and abstract representation, the essentially pictographic roots of the script could still be discerned. With the development of the clerical style in Han, significant changes took place in the graphic form of Chinese characters. The pictorial nature of characters was largely lost, the form of characters became square, and the graphic form became simpler. Rounded and circular strokes were linearized to make graphs easier to write. For example, the graph for the word 'sun' in the seal script was a circle with a short horizontal line through it ⊖; in the clerical style, it had become a small square crossed by a short horizontal stroke 日 , thereby losing its direct pictorial relation with the round sun. In other characters, strokes were simplified and consolidated or reinforced or standardized (Fig. 4.2). A number of strokes that were distinct in the seal script were merged, for example, ⌣ , ⌐ , – to — and ∫ , ⌊ , | to | . Commonly recurring strokes

	Shang bone 1600-1100 BC	Zhou bronze 1100-771 BC	Warring States 475-221 BC	Seal script 221-207 BC	Clerical (Han) AD 25-220
1. 'child'					子
2. 'cloud'					雲
3. 'water'					水
4. 'year'					年
5. 'silk'					絲
6. 'be born'					生
7. 'eye'					目
8. 'fruit'					果
9. 'tripod'					鼎
10. 'deer'					鹿
11. 'wise'					聖
12. 'buy'					買

were given variant shapes depending on what position they occupied in the whole character, such as — , | , ノ , 丶 . In the late Han period, the classical Han clerical script continued to evolve. Out of it came **kaishu** that has become the standard script of today. Kaishu has more straight lines and sharper angles than lishu. Kaishu forms the basis of all modern forms of writing in China. Thus, although there has still always been a tendency to simplification, for the last 1500 years, the written style of Chinese characters has remained basically stable.

The Number of Chinese characters

The overall number of Chinese characters greatly increased as the script became ever more widely used after the Han dynasty. There are several reasons for this. In earlier forms of the script it was quite common to use the same graph to represent two or more concepts, which carried the possibility of confusion. At the end of the Shang and beginning of Zhou (11th century BC), such characters began to be differentiated, generally by means of pairing them with a second character that either gave a more detailed meaning or related than to a spoken word that clarified the meaning. In the centuries of standardization following unification under the Qin dynasty, an ever-increasing number of new characters were created on the basis of the principle that each concept have its own separate character. It is estimated that at the end of the Shang dynasty there were approximately 4500 separate characters in common use. The Eastern Han dynasty (AD 25 to 220) had a dictionary - Shuowen jiezi - which contained 9353 different characters; in the late Qing dynasty (AD 1716) The Kangxi Dictionary was able

to bring together a grand total of 47,035 characters.

Surely of course, no one can remember the form or meaning of tens of thousands of different graphs. A study conducted by the Institute of Psychology of the Chinese Academy of Sciences in the 1960s showed that the average college-educated Chinese person who is not an expert in the fields of Chinese literature or Chinese history knows between 3,500 and 4,000 characters (Norman, 1988:72). A frequency study of the four-volume edition of Chairman Mao Ze-dong's Collected Works discovered a total of only 2981 different characters (Zhang 1980:196).

Another way to approach this problem of multiplicity of characters is to recognize that many characters recur in specific combinations with one other, creating "chunks" which may be easier to recognize. Guan and Tian (1981) in a preliminary survey found that in the Modern Chinese Dictionary -- Xiandai hanyu cidian -- there were 1,972 characters occurring in five or more combinations and 1094 occurring in two to four combinations for a total of 3,066. The statistics taken by the Research Centre of Language Reading, Beijing Language Institute from a corpus of 1.8 million characters show that the frequent recurrence of the first 1665 words counted in the corpus comes to 80 per cent and that of the first 4138 words 90 percent. These statistics suggest that an ordinary literate Chinese person knows and uses somewhere between 3,000 and 4,000 Chinese characters. Specialists in classical literature or history would know more, but it is doubtful if their active character vocabulary would exceed 5,000 or 6,000. (Stephenson, et al., 1990:226).

The Structure of Chinese Characters

There are six basic principles of Chinese writing. The theory of the six principles of writing was initiated in the Spring and Autumn period (770-476 BC), and developed in the Warring States period (475-221 BC). With the appearance of Xu Shen's dictionary -- Shuowen jiezi -- in the Han dynasty (206 BC - AD 220), China possessed for the first time a systematically elaborated theory of script development and analysis. Although there were some shortcomings from the contemporary view, "Xu Shen's work remains a remarkable accomplishment, whose principles have been to guide graphic analysis for almost two millennia, and whose relevance to contemporary research in this area is still considerable" (Norman, 1988:87).

In Shuowen jiezi, Xu Shen divided all characters into two broad categories - **wen** or simple non-composite characters, and **zi**, composite characters. The title of his dictionary reflects this important division, Shuowen jiezi meaning something like "explanation of simple characters and analyses of composite characters". **Wen** represents the characters which cannot be broken down into smaller components, e.g. 一, one and 水, water. **Zi**, on the other hand, refers to the characters which consist of two or more components each of which generally themselves are wen. For example, 李 Li (plums): the upper part 木 means wood; the lower part 子 means child.

Xu further classified all graphs into six categories. Of his six categories, only the first four are based directly on the structure of the graphs. The first two, **xiangxing** and **zhishi**, refer to simple graphs (wen) that are non-phonetic in nature. **Xiangxing** graphs are true pictographs: in one sense or another they are visual representations of the things

denoted. There are 364 characters in the xiangxing category in Shuowen jiezi. **Zhishi** characters generally refer not to physical objects but to various relational and abstract concepts. Examples are the graphs for numerals, position words such as above and below, and certain other words difficult to depict in a more concrete form. According to Shuowen jiezi, there are only 125 characters in this category.

The majority of Chinese characters belong to the zi or composite character category, and zi fall into two basic types, **huiyi** and **xingsheng**. The first category is non-phonetic: a **huiyi** (joined meanings) character generally has two graphic components whose meanings taken together suggest a concept distinct from the single concept of which it is constructed; for example, according to Xu Shen,  wu, the word for 'military', consists of two simple graphs,  meaning 'dagger-ax' and  meaning 'feet'-- the composite notion 'dagger-axes with feet'. Huiyi characters form a fairly large category: Shuowen jiezi contained 1,167 characters of huiyi. This method of creating characters has been employed in the formation of new characters throughout Chinese history and is still used today. For example, the relatively recent word for stove is  . The left part represents fire; the right part soil (originally, stoves were made from clay). Another example is  meaning dust; the upper part represents the concept small, the lower part soil.

The characters created with xiangxing, zhishi and huiyi methods are purely non-phonetic. They represent concepts directly, and could operate as components of a non-spoken language. But the largest category of modern characters have a component that relate to the spoken forms of the language. These are **xingsheng**, phonetic compounds.

A xingsheng character consists of two elements: one gives a clue to its sound; the other to its meaning. Xu Shen cited as an example of this category the character 河 (river) which consists of the component for 'water' 氵 on the left and a character 可 pronounced ke on the right; this right-side component is used to suggest the sound of the new composite graph which approximates that of the pronunciation of the character 'ke'. In modern nomenclature the semantic component is referred to as the **signific** and the part which concerns the character's sound is called the **phonetic**. There are around 7600 characters of xingsheng in Shuowen jiezi (Li 1977;41).

The compound xingsheng characters are derived from the simpler xiangxing, zhishi and huiyi characters. The signific components generally come from xiangxing, e.g. 口 mouth, 忄 heart and 衣 clothes. The phonetic components come from any of the three. For examples, in the compound character 沐 (wash one's hair), the 木 (tree) is a xiangxing character; in 忍 (endure), the 刃 (blade) is a zhishi character; and in 但 (only), the 旦 (morning) is a huiyi character. Thus, each compound character has the components that present both sound and meaning. Selecting a similar sound as the phonetic radical, and adding a proper graph as the signific radical, can create a new character. Furthermore, in xingsheng, the same signific component teamed with a different phonetic or the same phonetic component teamed with a different signific can produce a different character. For some examples, 方 (fang) it means square, as a phonetic component can be matched to different signific components, such as 訪 (fang) visit, 防 (fang) prevent, 芳 (fang) fragrant, 房 (fang) house, 放 (fang) release, etc... Other examples, 木 (mu) tree, as a signific component, can be matched by different phonetic

components: 柏 (bai) cypress, 机 (ji) machine or chance, 枪 (qiang) gun, 枫 (feng) maple, 架 (jia) frame, rack, shelf, or stand.

The remaining two categories of the liushu classification do not, strictly speaking, relate to the graphic structure of the character. **Jiajie** (loan characters) are graphs originally devised to write one concept which are later borrowed to represent the sound of another, often totally unrelated, concept. For instance, the modern 我 :I or me, was borrowed from the 𢦏 of shang bone scripts, where it represents a weapon. Another example is 会 ; originally it meant only join, but after being borrowed, 会 also means accounting. The principle of Jiajie does not create new characters. But it does link new concepts to existing characters, and is thus, in this sense, a method of creating new "symbols".

The meaning of the final category, called **zhuanzhu**, has been debated by Chinese scholars for many centuries, and its precise significance is still controversial. There are three conditions that zhuanzhu characters must meet: similar graph, same meaning and slightly different pronunciation. For example, 老 means old, in shang bone scripts as 耄 like a long haired, hunchbacked old person with a cane in his/her hand. Its pronunciation has been lao in the central regions of China around the Yellow River. However, in the other areas, its graph has been changed to 考 , the same meaning as 老 , with slightly different pronunciation: kao. 顛 and 頂 , another example, have the same meaning: peak or top. The former is pronounced dian, the latter ding.

In his Shuowen jiezi, Xu Shen arranged the 9,353 characters under 540 radicals (Liu, 1963:55). Today, we generally recognize only about 220 radicals. A radical is the

component which a number of characters have in common. They can thus be used as a means of classifying the thousands of characters, a necessity in a dictionary. Frequently, but not always, these radicals correspond to the character's signific. As he placed all characters under one of his 540 radicals, Xu Shen revealed that the great majority of Chinese characters were not mere arbitrary graphic symbols bearing little graphic relationship one to another, but rather were created from a relatively small number of components.

The Lower Level Units of Written Chinese

The grapheme. "Strokes" are the smallest units in the written language. These are the graphemes. Basically, all Chinese writing can be built up from the following eight strokes: 一 , 丨 , 亅 , 丶 , 丶 , 丿 , 𠂇 , 乀 . Each character consists of some, if not all, of them. Each stroke may occur in a different position from one character to another, and the length of the strokes may also vary from one character to another. Unlike alphabetic languages such as English, the Chinese graphemes do not have a specific phoneme. This is due to the evolution of Chinese writing from non-phonetic ideographs.

The radical. It is the smallest meaningful unit or "sub-morpheme" in written Chinese. It consists of one or more graphemes but it also carries some meaning. In order to make new characters to represent new concepts, the Chinese people had modified some characters from xiangxing, zhishi and huiyi. For example, 水(water) was modified to 氵, as a radical, with the same meaning. It could be combined with some other

radicals even other characters, to form characters with new meaning. For example, modified could be combined with at least 100 radicals or characters to form new characters whose meaning are generally related with water, such as 洪 (flood), 洋 (ocean), 泳(swim), 渡 (ferry), etc.

Understanding radicals, one really begins to understand written Chinese. Radicals are the basic drawings which the all characters are made of. Many scholars consider that the radical is the key into the written language. Wolff (1974:20) states:

> Why are the radicals the key to the language? They are the roots. To analyze the meaning of a character, break it down to its roots, into radicals. To find a character in the dictionary, break it down to its roots, into radicals. Every radical is a drawing of an animal, man-made object, nature object, or a simple symbol.

The character. This consists of one or more radicals, and it is generally considered as the smallest meaningful unit or "morpheme" in most grammatical analyses. In written Chinese, the overwhelming majority of characters are single morphemes. From the point of view of their tendency to combine with other morphemes, morphemes can be divided into two types; those that can be written independently are free such as 我 (I or me); morphemes which must occur in conjunction with another morpheme are bound such as 们 (a plural suffix) (Norman, 1988:154).

The word. As in alphabetic languages, the word in written Chinese is composed of one or more morphemes. Generally, there are two types of word: simple and compound. A simple word consists of a single free morpheme. For example, 人 (person); 打 (to hit); 最 (most); 重 (heavy). This class of words is very large and

contains many of the most basic elements of the lexicon. A compound word consists of at least two morphemes and can include free morphemes and/or bound morphemes. (Henne, et al., 1977:14). For example,书店 (bookstore) is a compound word consisting of the free morphemes 书 (book) and 店 (store);历史(history) is another compound word consisting of 历 (calendar) and 史 (history), both of which are always bound morphemes. Compounding is the main process in new word formation in the modern Chinese writing. Many new terminologies, especially of a technical or scientific nature, are almost all formed in this way. For example, 学 (learning) is used to translate -logy in such words as 社会学 (sociology), 心理学 (psychology), 人类学 (anthropology). (Norman, 1988:156).

The Chinese Sentence

Basically, the modern sentence delineated in written Chinese is presented with punctuation which is similar to written English. However, there is no equivalent of capital or non-capital letters in written Chinese as in written English. At the most general level Chinese sentences can be divided into primary and secondary types. The primary sentences contain both a subject and a predicate: 你问 'you will ask', whereas a secondary sentence contains only a predicate: 问 : '[You'll] ask.' The frequent omission of pronominal subjects is the main reason why secondary sentences are more common in Chinese than in English (Norman, 1988:166). Primary sentences can be subdivided into simple subject-predicate sentences and composite sentences. A composite sentence is formed of two or more simple sentences (either primary or secondary) in close

combination. If the components are in a parallel relationship, it is a compound sentence: 我来，我爸爸也来 (我 来 我 爸爸 来 也) 'I will come, my father will come too'. A complex sentence results when the component parts are in any of several non-parallel relationships: 若是他来，我就不来 (若是他 来 我 就 不 来) 'If he comes, I will not come'.

Many Chinese grammarians have remarked on the considerable semantic looseness that characterizes the relationship of subject and predicate in Chinese. Chao (1968:69) defines the grammatical meaning of subject and predicate as that of 'topic' and 'comment': the subject is that about which something is said (it is not necessarily the "actor" as opposed to "acted upon", more strictly called the "object".). Looked at in this broader way, the subject of a sentence may stand in a number of different logical relationships to the predicate. It may, for example, be the agent of a transitive verb: 他打我 (他 打 我) 'HE HIT-ME -- He hits me'; it may also be the patient or recipient of the action: 工作做完了 (工作 做 完 了) 'WORK DO-FINISH PCL[1] -- the work is already finished'. In other cases it may be merely an object about which some quality is predicated: 她的书法好 (她的 书法 好) 'HER CALLIGRAPHY GOOD -- her calligraphy is good'. It may also be an instrument: 大碗喝汤，小碗吃饭 (大 碗 喝 汤 小 碗 吃 饭) 'BIG-BOWL DRINK SOUP SMALL-BOWL EAT RICE -- the big bowls are for eating soup and the small bowls are for eating rice'.

Among Chinese grammarians, it is even common to consider place and time words at the beginning of a sentence as subjects: 明天会下雪 (明天 会 下雪) 'TOMORROW WILL SNOW -- it will snow tomorrow'; 屋里很冷 (屋里 很 冷) 'IN-ROOM VERY COLD -- it's quite cold in the room'. Many linguists would probably tend to reject this analysis in favour

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1. The following abbreviations are used in the literal renderings: NEG 'negative', PCL 'particle'.

of considering such elements time and place adjuncts. But such a distinction is more difficult to draw in Chinese than in English. A sentence like 多伦多没有地图博物馆
多伦多 没 有 地图 博物馆
'TORONTO NEG-HAVE MAP MUSEUM' can be translated either as 'Toronto has no map museum', in which case 'Toronto' would appear to be the subject, or as 'In Toronto there is no map museum', in which case 'Toronto' would seem to serve as an adjunct of place; but in fact such a distinction can be based only on the differing English translations. ''It seems quite doubtful that the Chinese sentence actually is ambiguous and represents more than one semantic structure. Even if it is possible to distinguish time and place adjuncts from subjects in such sentences, certainly the line separating the two analyses is much less distinct in Chinese than in English.''(Norman, 1988:167).

Summary

Written Chinese is an example of morphemic writing. Each symbol or character represents a morpheme or a minimal meaningful linguistic unit. There are copious examples to show that Chinese writing originated in primitive drawings or rough pictures. Based on these pictographs (xiangxing), the other categories of characters, such as ideographs, phonetic compounds etc., gradually developed. The Chinese script has been changing throughout history. In certain periods like the Qin and Han dynasties it underwent large-scale revision which gave it a new simplified version. In the Chinese writing system, morphemes (characters) are strung together one after another without any indication of word boundaries so that it is the reader who supplies the necessary meaning boundaries (Norman 1988:155). Although it is easy to identify words intuitively in

Chinese, it is difficult to define the concept rigorously. This is because the word is not a basic unit in the writing system, and it is not as easy to take for granted as it is in alphabetic writing systems. (Norman 1988:155).

CHAPTER FIVE
HUMAN PROCESSING OF WRITTEN CHINESE

Introduction

In the previous chapter, the written Chinese language has been described. However, how do the people read Chinese? What are the relations between the brain and this visual language? How do readers recognize the characters? And how do they chunk its units upwards into a sentence and then sentences into text? These will be the topics of this chapter.

The Brain and Written Chinese

Brain research has shown that the left hemisphere, which dominates the right side of the body, normally specializes in temporal relations, language, logical analysis, and verbal behaviour. It handles grammar, word recognition, abstract thinking, and it processes information sequentially in a linear, orderly fashion. On the other hand, the right hemisphere, which normally dominates the left side of the body, handles spatial relations, imagination, the synthesis of wholes, and the grasping of meaning-in-context. It perceives shapes, sizes, textures, colours and complex visual patterns. It processes information more diffusely and indirectly, integrating material in a simultaneous, holistic manner. (Klauser 1986:26)

In 1979, Tzeng et al. argued that "the reading and interpretation of Chinese characters called on the specialized functions of both sides of the brain, and that whether one or the other side dominated in a particular task relied on the balance of cognitive requirement" (p.501). These researchers conducted three experiments to examine the visual lateralization effect in the reading of ideographic symbols such as Chinese characters. The results indicated that recognition of a single logographic symbol tended to manifest a left visual field/right hemisphere (LVF-RH) superiority effect, whereas recognition of phonetic-based scripts (e.g. English alphabet) and Chinese two-character words showed a right visual field/left hemisphere (RVF-LH) superiority effect. In accounting for this, these researchers suggested that perhaps a single character is processed using a holistic pattern recognition process, while a two-character word is analyzed sequentially and analytically. Supposing that the sequential order between characters must be processed so that a two-character word could be correctly recognized, a RVF-LH superiority effect in the two-character word recognition might be attributable to the finer temporal resolving power in the left hemisphere. In another experiment conducted by Huang and Jones, Chinese subjects showed no significant visual field advantage for naming tachistoscopically-presented Chinese characters. However, both Chinese and North American subjects tended to discriminate characters presented in the left visual field more accurately. Therefore, the investigators also argued that recognizing required holistic processing, a task which was better handled by the right hemisphere (p.703).

The Chinese Characters and Words

It is inevitable to focus on single characters for establishing a context-free character recognition model when people learn the written Chinese. The character is the basic independent unit. As we have noted in the preceding chapter, the majority of modern Chinese characters are compounds consisting of one radical (i.e. signific) component (about 200 radicals in total) and one stem (i.e. phonetic) component. In most cases, the stem by itself can serve as a single character, whereas the radical is derived from a simple character but is no longer commonly used in isolation. A containing function can be seen among the Chinese characters. For instance, the stem component of a compound character is itself a compound character. That is to say, a radical-stem compound = radical + stem = radical + (radical + stem) = radical + (radical-stem compound).

For most alphabetic scripts, the word is composed of left-to-right letters. Word reading follows a unidirectional or one-dimensional scanning path. In written Chinese, although horizontal (AB structure) and vertical ($\overset{A}{B}$) configurations account for the largest proportion of characters, Huang and Wang (1992) identified more than 15 configurations such as A, ABC, $_{B}{}^{A}{}_{C}$, and $^{A}{}_{C}{}^{B}$, among others. This means that the majority of Chinese characters are assembled from sub-morphemes, i.e. radicals and stems. Figure 5.1 presents some selected configurations with examples. Character reading is therefore performed through a multidirectional or two-dimensional (2-D) scanning path.

Besides their possible containing structure and 2-D scanning configurations, Chinese single characters are inscribed in a fixed region, irrespective of the number of

Structural Category	Exemplar
AB	好 暗 封 獻
A B	否 音 異 幫
A	日 正 兩 為
ABC	測 假 辨 謝
A B C	森 嵌 箱 露
A B C	替 照 整 雙

Fig.5.1 Selected Chinese orthographic configurations with examples (Huang and Wang, 1992:6)

strokes in a character. Simple and complex characters, therefore, all occupy the same confined area in regular printed materials, e.g. 四 meaning four, 圖 meaning map.

It is also important to note that understanding the meaning of a Chinese character relies highly on its broader context. There are two main reasons for this: (1) many individual characters have several meanings and can be independently used as words in text; (2) single characters can also be used with other characters to form multi-character words with distinctively different meanings. For example, '生' has several meanings itself (e.g., "give birth to", "living", "premature", "uncooked", or "student"); it can also join other characters to form very different words such as '生長' meaning "grow", '生意' meaning " business", '生命' meaning "life", '花生' meaning "peanut", '卫生' meaning "health", and '接線生' meaning "operator". Thus, context is particularly important in helping to clarify the meaning of a character.

What is often considered the basic linguistic unit in alphabetic languages -- the word -- is expressed in Chinese script by a usual range of one to six characters. By far the majority (65.15%) of Chinese "words" use two characters (Huang & Liu, 1978:6). Each two-character word has its unique meaning, but the constituent characters also have separate independent meanings. A variety of compounding processes provide considerable flexibility in word invention (Fig. 5.2). English nominal compounds are similar, but account for a much smaller proportion in the English language than in the Chinese.

Although the meaning of a Chinese word is generally defined, the concept of the word remains fuzzy. Identifying words and segmenting word boundaries in written Chinese are not simple and straightforward tasks even for skilled readers. There are at

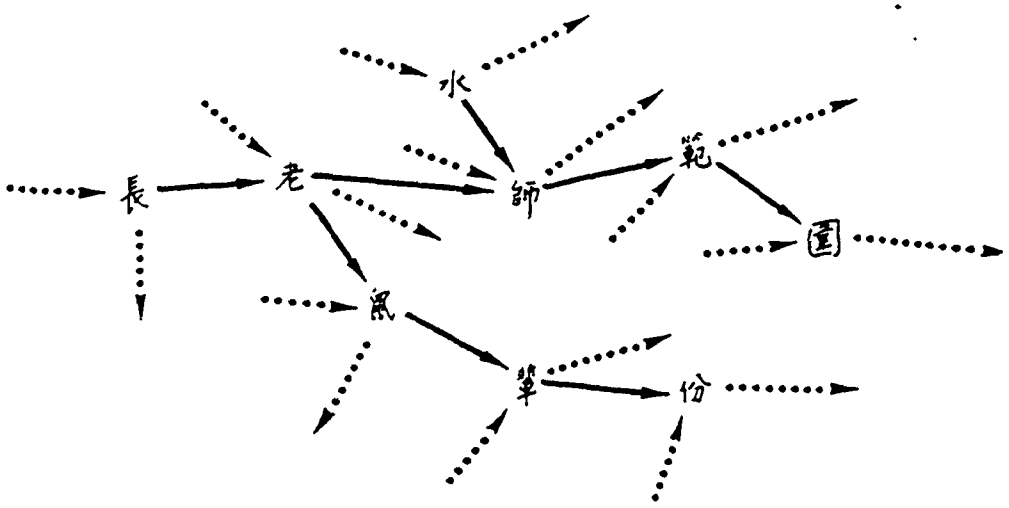


Fig. 5.2 Network of bimorphemic words. A solid arrow indicates an actual combination of characters forming a two-character word. A dotted arrow indicates that an indeterminate number of other combinations are possible. The words thus formed are: 長老 "elder", 老師 "teacher", 水師 "navy", 師範 "teacher-training", 範圍 "area", 老鼠 "rat", 鼠輩 "thief", 輩份 "generation" (Hoosain, 1992:114)

least two reasons for this. First, the size of a Chinese word is not constant and word boundaries are not marked by extra spacing. Secondly, many characters can be independently used as words in text, but they can also join other characters to form different words.

Chinese words, furthermore, generally have no inflectional markings to indicate the number and case for nouns or pronouns, or the tense, aspect and voice for verbs. For all these reasons, therefore, the chunking of simple characters into compound characters and compound characters into words becomes a very demanding process.

Grammatical Aspects of Chinese Sentences

A Chinese sentence does not require the verb of a sentence to agree with the subject. Furthermore, although different alphabetic languages vary to some extent in terms of their morphological complexity, words in most alphabetic languages generally have inflectional markings to indicate various grammatical attributes. In Chinese script, various forms of semantic and syntactic information are not provided by individual words. Rather, this information is usually carried by the context as a whole. Thus, in Chinese, the word in itself generally carries less meaning and structural information than it does in alphabetic languages.

A Chinese reader must thus rely very heavily on context. There are four major reasons for this: (1) the meanings of basic perceptual units in Chinese (i.e., characters) are generally not very precise and are highly variable; (2) Chinese words are not well defined morphologically (as expressions), partly because they do not have clearly marked

visual boundaries; (3) Chinese words do not usually contain explicitly marked syntactic information; and (4) sentence structure and other syntactic devices are not reliable sources to obtain precise and constant syntactic information. Thus, Chinese readers require a rather diffused strategy. They may pay very little attention to individual sentence units, characters or words (Chen 1992:175). Readers of alphabetic languages have a more focused strategy, paying considerable attention in the processing of the specific syntactic and semantic content of each word (Chen 1992:192).

One final feature of interest concerns Chinese word-order typology. In many grammars, word-order is the primary syntactic device for sentence interpretation. Some languages, for example, are characterized by SVO (subject + verb + object) word order (e.g. English), and others by SOV (e.g. German). The basic word order in Chinese is SVO. Since inflection is almost non-existent in Chinese, to identify the semantic role of various constituents one must rely heavily on word-order. Yet, when one examines Chinese word-order topology in detail, it becomes apparent that it contains features indicative of SVO language as well as SOV. For example, 大山賣了他的車 or Dashan 賣了 他的車 sold his car (SVO); 大山把他的車賣了 Dashan (BA) 大山 把 他的車 賣了 his car sold (SOV).

The literature suggests that reading words written in different systems activates different processing mechanisms (e.g. Chen and Juola, 1982; Chen and Tsoi, 1990; Hoosain, 1991). Such evidence is obtained mainly from studies using various lexical tasks (e.g. character/word recognition in visual-half-field experiments). This has lead to the suggestion that the processing difference due to variation in writing systems may be located at an encoding and perceptual level for simple lexical-processing tasks, but not

at higher levels of information processing, such as reading for comprehension.

However, there are some studies which illustrate that processing differences due to orthographic and/or language variation exist at higher levels of processing in complex tasks such as sentence interpretation and text comprehension. For instance, Chen (1992) conducted two experiments using a specially designed moving-window method to collect character and/or word reading times. In the first experiment, character reading times were analyzed in multiple-regression analyses to identify regression effects at various textual levels. In the second experiment, lexical, syntactic, and semantic information were separately violated at certain points in short Chinese and English passage (see Fig. 5.3 for a sample).

The results from the two experiments are compared to those obtained in studies of English using similar methods. Character reading times in Chinese were not generally affected by properties of characters or words, but longer pauses were often found at either syntactic or physical boundaries. Violation of syntactic information by modifying an important word did not produce a substantial disruption because syntactic information in Chinese is usually generated from the context. Similarly, embedding a semantic violation by replacing the critical word did not produced a significant disruption, because the Chinese reader would attempt to use contextual information to resolve the problems of violation. In contrast, both word-level and sentence-level effects were significant in English. These results suggest that Chinese and English languages activate different processing strategies for reading comprehension such that Chinese text induces a diffused strategy and English text a more focused strategy.

每月總有兩三次，全校學生列隊在圖書館集合，總有一個或兩個壞孩子，會給推進隔壁房間，鞭打（學裕，鞭打著，量度）得皮破血流，其餘的人坐在那裡，哆嗦著聽他們呼號尖叫。我恨透了這個學校，那兩年多提心吊膽的日子，真不知道是怎麼過的。

Two or three times a month the whole school was marshaled in the library, and one or more delinquents were haled off to adjoining apartment and there flogged (seprool, flogging, measured) until they bled freely, while the rest sat quaking, listening to their screams. How I hated this school and what a life of anxiety I lived there for more than two years.

Fig.5.3 An example of a Chinese passage and its English version. The critical word is underlined. The lexical, syntactic, and semantic violations introduced are indicated in parentheses (Chen, 1992:194).

Summary

In this chapter, we have seen that recognizing and reading written Chinese needs brain hemispheric cooperation. Recognition of the single character tends to show a left visual field/right hemisphere superiority effect, whereas recognition of Chinese words tends to show a right visual field/left hemisphere effect. The visual lateralization effect in reading Chinese characters is obvious. Furthermore, a Chinese character is a two-dimensional configuration. Thus, the recognition of each character is also a two-dimensional activity. Furthermore, understanding the meaning of a character usually depends upon the broad context. That syntactic information is also usually generated from the context has been confirmed by experiments that show that violation of syntactic information modifying an important word does not make a substantial disruption. Thus, Chinese reading appears to rely very heavily on broad contents, probably much more so than alphabetic languages. Likewise, it appears to involve the right brain hemisphere more strongly than alphabetic languages.

CHAPTER SIX
THE IMPLICATIONS OF WRITTEN CHINESE FOR MAPS

Introduction

Previous chapters of this thesis have outlined the variety of approaches that have been taken to attempt to understand and to improve map communication. These researches began with psychophysical experimentations with individual map symbols, continued with attempts to understand the more complex cognitive processes of map use, and now involve studies of semiotic systems and map language. It is a basic understanding of this thesis that map communication is a cognitive and more specifically, a linguistic process. To date, virtually all of the research into map language has been from the perspective of one type of language -- the alphabetic language. This research has recognized linguistic traits in the system of map symbols, and has concluded that maps can be analyzed in terms of such concepts as vocabulary, grammar and syntax. These researchers have found that the language approach can provide a very useful method for investigating the map use process.

Despite the positive results from the study of map communication from the perspective of alphabetic languages, some criticisms still remain. Specifically there are some concerns about the missing letter size unit in maps, about the lack of a spoken expression of cartographic communication, and about the lack, too, of a consistent format in creating a symbol-sequence from the page. Perhaps, however, some of these problems

arise only because of the narrow comparison of maps with alphabetic languages. Only cursory research has been done on the topic of map communication from the perspective of ideographic and visual languages such as Chinese. To provide further information, this study has been conducted from the point of view of written Chinese. In the preceding chapters we have introduced written Chinese -- its origin, evolution, units and structure -- and the Chinese reading process.

The present chapter will first compare written Chinese to the map language from lower level to upper level. Then, when the objections to the language analogy for maps are analyzed, the chapter will discuss the linguistic nature of maps in depth through a comparison to written Chinese.

WRITTEN CHINESE AND MAP LANGUAGE: A COMPARISON

There are six formal units in written Chinese. They are: stroke, radical, morpheme, word, sentence and text. Six formal units can also be identified in maps. Their names vary from researcher-to-researcher, but we can call them: segment, visual variable, sign, symbol, map syntax and map structure.

Strokes vs. Segments

The thousands of Chinese characters make use of only a small number of strokes such as hooks, lines, angles, and dots (Stephenson, et al., 1990:221). The strokes can be arranged in many different positions to create different characters (So, 1989:8). For examples, 末(last) and 未(no);陪(accompany) and 部 (ministry). In Chinese, the strokes

do not have a phoneme equivalent.

In map language, we have segments which may be thought of as the counterparts of the strokes in Chinese characters. The segments are the smallest units which can be detected on a map. The graphic segments are the most primitive element of map symbolism. Any variable in Bertin's visual framework (introduced in Chapter Two) can be broken down into segments. In other words, a variable is composed of segments. The segments usually have two forms -- dot and line -- but they can also cover area, with no internal differentiation, as with hue. Similar to the strokes, map segments when placed differently may show different meanings. For instance, ⊤ (a train station), + (a hospital).

Radicals vs. Visual Variables

In written Chinese, radicals are the basic meaningful units of the language. In a standard Chinese dictionary (for example, Xiandai Hanyu Cidian -- A Modern Chinese Dictionary), there are approximately 200 radicals. Most of the radicals are derived from pictograms (Xiangxing). A Chinese character may include one, two, or more radicals to form each individual character. The radicals have different shapes, sizes and orientations, etc.

In map language, there are seven widely-recognized visual variables. They are shape, size, orientation, texture, hue, value and saturation, all manners in which a simple graphic symbol may be manipulated so as to clearly change perception. Individual examples of these variables can carry certain assigned geographical meanings.

But as "sub-morpheme" units the visual variables also have interesting same properties. The Chinese radicals have origins in pictures, and thus must have meaning; with the visual simplification that came with the evolution of the language, they have lost much of their original configurations and are now used largely in conjunction with other sub-morpheme units to form characters, the morpheme-sized unit. Similarly, the visual variables in maps carry certain (usually sub-conscious) meanings. Hues have connotation (but varying greatly from culture-to-culture, even person-to-person). Some visual variables carry implications of "order", as do the varying shades of grey, darker often read as "more". Despite all these, both radicals and visual variables are most often considered as units below the morpheme in the size hierarchy.

Morphemes vs. Signs

The written Chinese system is basically morphemic. Each character, which is a sign or mark used in the system, stands for a minimal meaningful unit. The written Chinese system thus requires many characters. The morpheme of written Chinese is usually a character which is a component of a word. A morpheme is normally composed of radicals. There are about 3000 to 5000 characters used in day-to-day life. From these characters, a student of Chinese can be taught to learn the Chinese "words". Meanwhile, from Chapter Five, we know that there are more than 15 configurations in Chinese characters; simple and complex characters all occupy the same confined area; and character reading is performed through a multidirection or 2-D scanning path.

In map language, there are signs as a counterpart of the Chinese character. A sign

is an indication, a conventional or arbitrary mark or figure (Stein, 1973:1325). A sign is composed of visual variables, for instance, a piece of contour line in a map legend. Normally, a map legend has all "characters" applied on the map so that one can learn these and then read the map. Meanwhile, in map signs there are at least as many as the identified configurations of Chinese characters. Like the characters, there are simple and complex symbols in maps, and both of them can have the same size, e.g. ⊖ ⊗ ❂ ❀. And similar to the reading of Chinese characters, map sign reading is a 2-D process: "searching for geographic meaning" by assembling signs into larger sense units, no matter where the signs might be located. This contrasts to alphabetic languages, where the "next" letter is adjacent in only one of two directions.

Words vs. Symbols

In written Chinese the word configuration is not as clear as in English. As discussed in previous chapters, there is no space between Chinese words. One may ask how a reader of Chinese could recognize each single word. The answer is that the "boundary" of every word has been embedded in the reader's mind. They should learn "words" that are formed from more than one character even though they have learned the component characters in the Chinese classes. A Chinese dictionary usually can be compiled in the order of the characters instead of the order of the words in an English dictionary. Moreover, there are at least two methods to do so, one being by form or the number of radical strokes, the other by sound (e.g. pin ying) -- the pronunciation system of Chinese official language (Mandarin).

Similarly, in map language, a symbol concept sometimes is not clear. For instance, a set of contours could mean convex slope or concave slope, gentle or steep slope, spur or valley. In order to read a map, the reader must recognize each of these topographies before reading it, then identify the symbol correctly by using the already-learned topographic knowledge associated with the map context.

Sentence vs. Syntax

As noted in the previous chapter, the Chinese syntax is characterized by its lack of the inflexions employed by alphabetic languages in tense, aspect, person, number or case. For example, we have the following sentences in Chinese:

今天我是在家　　明天你是在家

今天 我是 在 家　　明天 你 是 在 家

"TODAY I BE AT HOME."; "TOMORROW YOU BE AT HOME.";

昨天他们是在家

昨天 他们 是 在 家

"YESTERDAY THEY BE AT HOME.".

Similarly, map syntax has the same attributes as Chinese. The basic sentence structure is subject + verb + object (SVO). For example, WHAT is at WHERE (and/or WHEN); but an alternative structure that also makes sense could be: there is (are) WHAT at WHERE (and/or WHEN) -- on an Ontario map (1975 ed.) (see Fig. 6.1 for reference), we can read a small map chunk (or a "sentence") that <u>THE METROPOLITAN TORONTO / BE / ALONG THE NORTH SHORE OF LAKE ONTARIO NEAR THE WEST END OF THE LAKE (1975)</u> or another "sentence" that <u>THERE BE / A CITY (WATERLOO) / AT AROUND 43°28' NORTH AND 80°31' WEST (1975)</u>.

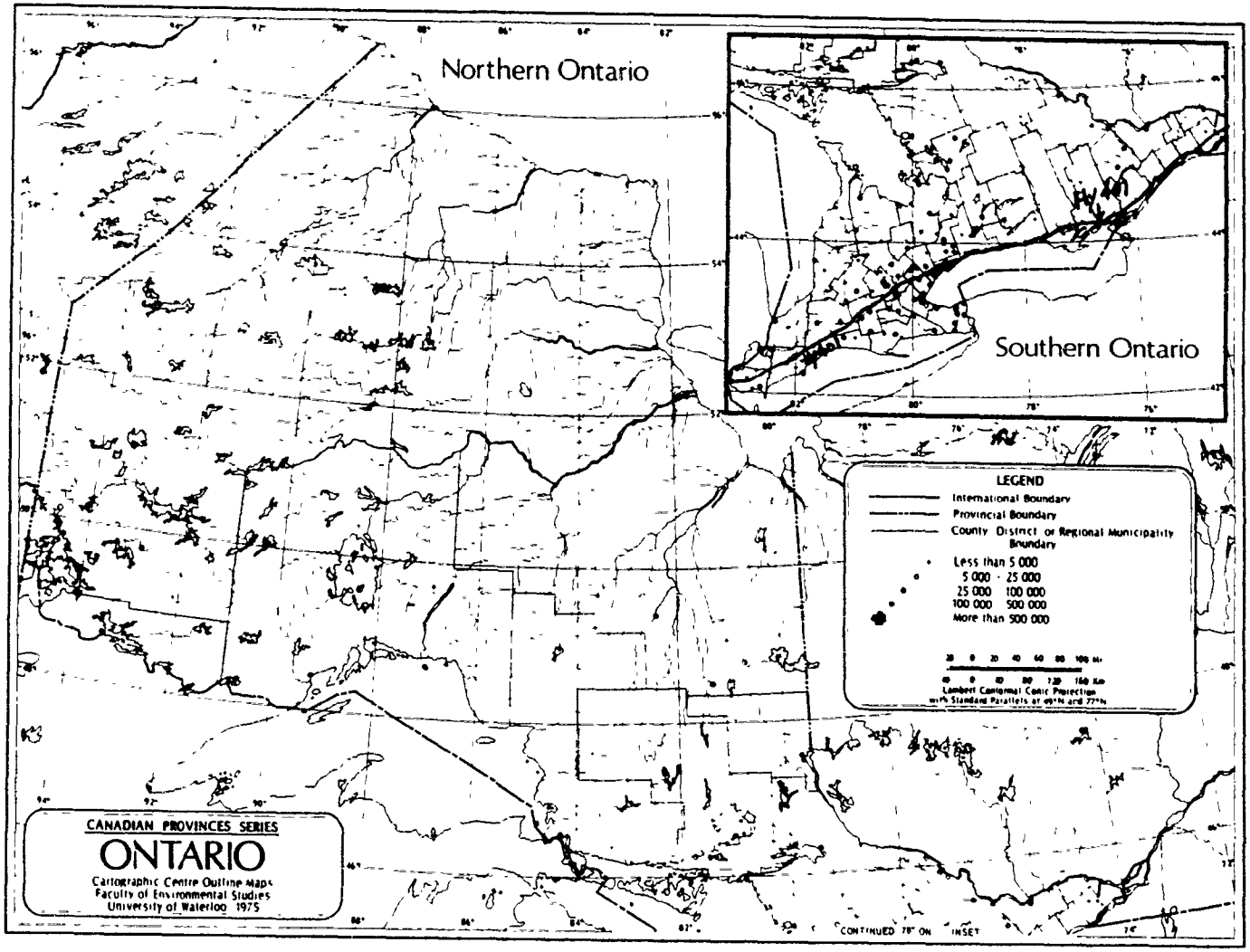


Fig.6.1 An Ontario map

Text vs. Structure

In the text, written Chinese can be understood as big chunks. It shows what is in the text. This includes the contents of individual lower-level units and all main propositions. But in Chinese reading, it includes even the author's feeling and probably the reader's feeling, *i.e.* you feel the text is good or bad for you.

The equivalent level in map language is map structure. The structure could be a whole map sheet or a part of a map. After reading a map, one should know not only each symbol's location but also the spatial relationships among these geographic configurations -- map words and map sentences. One should understand WHAT is WHERE during WHEN as well as ALL WHAT are WHERE during WHEN. For example, from the same map we build up a relatively large chunk after reading: MOST MIDDLE OR LARGE CITIES / BE / CONCENTRATED IN SOUTHWEST ONTARIO (1975), AND PARTICULARLY IN THE THREE AREAS. FIRST ONE / BE / ALONG THE NORTH SHORE OF LAKE ONTARIO; SECOND ONE / BE / ON THE NORTH SIDE OF NIAGARA PENINSULAR; AND THIRD ONE / BE / ALONG HIGHWAY 401 BETWEEN THE METROPOLITAN TORONTO AND THE CITY OF WINDSOR.

OBJECTIONS TO THE VISUAL LANGUAGE ANALOGY

The issue of whether map representation can be considered a language has been intensely debated. Robinson and Petchenik (1976:43-67), and Keates (1982:109-113) have argued that the map medium cannot be considered a language. They seem to find major problems in two areas: (1) it has no fixed alphabet of signs of which a language is built;

(2) there is no fixed order of reading as required by the syntax of human language. Of course, as has been stressed above, a number of researchers (Head, 1981, 1984, 1991; Schlichtmann, 1985; Eastman, 1985, 1987) have argued that the language analogy can provide a very useful means for organizing and investigating the graphic medium. Head (1980) has dealt with both problems mainly from an English perspective. Continuing this study from a Chinese perspective, we gain some new insights.

Fixed Alphabet of Signs

In The Nature of Maps, Robinson and Petchenik state firmly: "there is no analogue in mapping...[for the words] of discursive language" (p55). They have two reasons for the argument: first, maps have no strictly comparable visual units that are carriers of fixed meanings (p56). A map symbol -- a small circle, for example, can mean 500 kg of wheat on an agriculture map and 1000 people on a population map. Map semantics are far from standardized, but they are not completely haphazard. For instance, the contour line has become the world-recognized element for the mapping of topography. Even in written languages the word-sized units do not always have fixed meanings. For example, 行 (hang) and 行 (xing) in written Chinese are identical on the expression level. But they represent totally different concepts. Combined with some other characters, the former means 行业 occupation, 行家 expert, etc., and the latter means 行李 luggage, 流行 popular, etc. Robinson and Petchenik's argument that a map symbol may have different meaning from map to map does not, therefore, invalidate the whole concept of maps as language.

While there are thousands of characters in the Chinese system, the actual number of possible sound combinations is far fewer. Words which are pronounced the same, homonyms, are far more frequent in Chinese than in English; in other words, there is a looser relationship between speaking and writing in Chinese, than in English. Wolff compares English writing to written Chinese and states:

> English words are alphabet words. An alphabet is a set of symbols which indicates the sounds of a language, and in combination, the sounds of words. The Chinese language, however, is built on a totally different concept of symbol-making. It is ideographic language, it has picture-symbols for things and concepts. A Chinese word conveys the sense visually. Through the character, we arrive directly at the sense of the word. A Chinese word is to the eye what an English word is to the ear. (1974:9).

The pictographic nature of Chinese has special interest for scholars interested in cartographic language (Head, 1984:9; Taylor, 1987:2). Needham (1959, as cited in Taylor, 1987:2) has even argued that the pictographic character of the Chinese language encouraged mapping. Figure 6.2 illustrates some of the characters which have been used over the centuries in China. Taylor described some Chinese characters as below:

> The older characters for mountain, river, spring and farmland are especially interesting and characters are often incorporated and combined to form characters with new meaning. The earliest characters for spring, for example, incorporate the symbol for water. The symbol for water is also included in one of the symbols for river and the character for farmland incorporates the character for standing grain. The characters used for map are a combination of the character for picture and the character for the earth or land..... The earliest characters for picture incorporate the symbol for a well with a suggestion of a village and a boundary..... (1987, p.2)

In ancient times, Chinese people communicated using these pictographic characters. This shows that the Chinese characters were developed from some kind of pictures. The

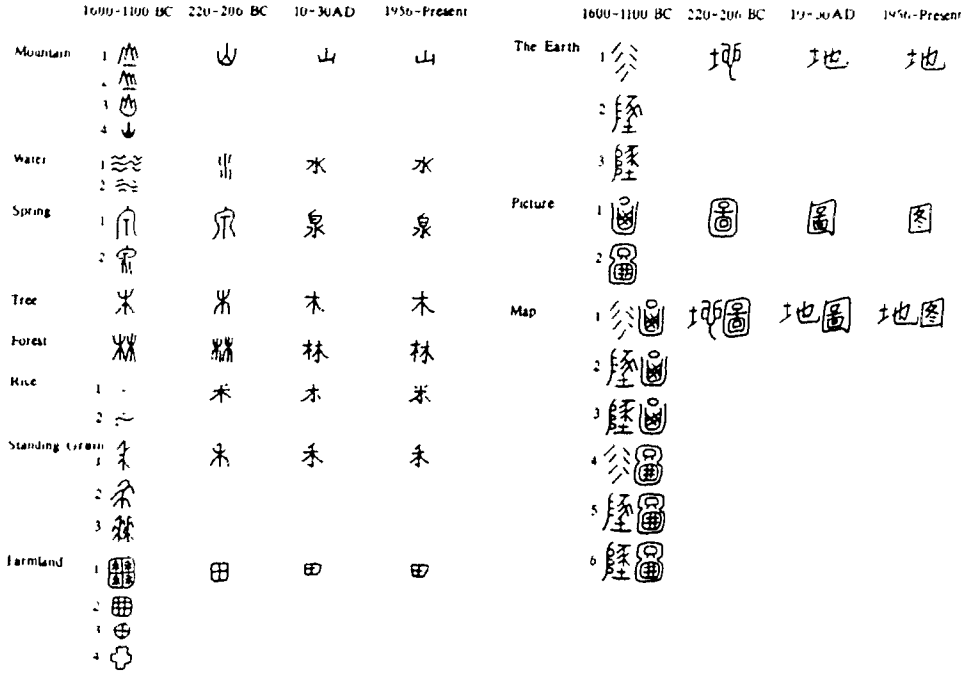
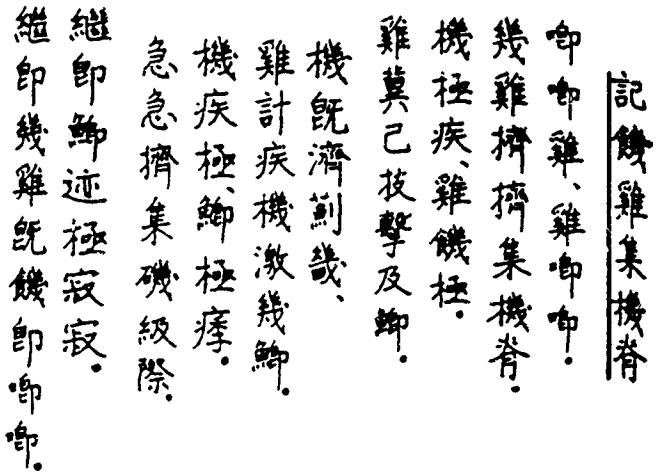


Fig.6.2 Chinese characters over the centuries (cited by Taylor, 1987:2)

pictorial nature of Chinese calligraphy has changed several times, with the most recent forms being very simplified for the convenience of application and education.

While the spoken and heard realizations are the same, however, each of the homonyms will have its own unique character. A common dictionary of Chinese, organized by sound characteristics, lists over 30 separate characters (and meanings) for the one sound "li" (Stephenson, et al., 220-221). Another example, a story like the following is quite a vivid Chinese poem. When pronounced in Mandarin, spoken by almost one quarter of the population in the world, the poem consists of nothing but a series of repetitions of the syllable: "ji" in the four tones (Britannica, 1970:634), see Fig. 6.3. It means that the pronunciation of this poem does not make any sense but confusion. It is important to realize that what is understood by the reader is derived not from the sounds, but from what is on the paper. To read it we will first orient the reading direction (here from top to bottom); we have brought some experience of Chinese reading to the task. Then, despite no space between each graph (i.e. character), we are able to identify the meaning of words , and then the meaning of each sentence. Thus, in Chinese, as Head has identified for maps, the process of assigning meanings to groups of lines (strokes) and graphs (characters), depends upon both perceptual and contextual clues (Head, 1984:7). Neither maps nor Chinese use an alphabet, and neither maps nor Chinese rely for meaning on simple spatial relationships of their morphological units.



Reminiscences of Famished Chickens Assembled on the Ridge of a (Flying) Machine

Chick, chick, chickens! Chickens, chick, chick!
Several chickens squeezed and assembled on the machine's ridge.
The machine was extremely swift; the chickens extremely famished.
The chickens surmised their skill was sufficient to strike some perch.
The machine having crossed the suburbs of Chi,
The chickens reckoned the swift machine should stir up several perch.
The machine was swift; the perch were extremely scared.
Hastily they squeezed and assembled in the interstices of stone steps.
Subsequently the perch's traces were extremely silent, silent.
Subsequently the chickens, since still famished, said chick, chick!

Fig.6.3 A vivid Chinese poem pronounced with only one syllable "ji" in the four tones(Britannica, 1970:634)

Order of Reading (Syntax)

Definitions of reading are generally divided into two major types: (1) those that can be considered "interpretations of experience generally", and (2) those that restrict the definition to the interpretation of graphic symbols. The first is a broader category and encompasses the second. Most reading definitions are related to one or both.(Dechant, 1991:3).

According to Dechant (1991), reading is a perceptual, an interpretative, and a conceptual, cognitive process (p15). Smith (1988) notes that reading cannot be separated from thinking. Reading is described as thinking through print. Conceptual thought is required to react with meaning. Reading requires higher-order thinking, in which readers interpret what they read, associate it with their past experience, and project beyond it in terms of ideas, relations, and categorizations.(p.55).

Some scholars (e.g. Robinson and Petchenik) appear to hold that map reading has nothing strictly comparable to human language reading. Maps, they state, belong more a class of symbolism called presentational -- a class that includes photographs and drawings and in this symbolic system there are no words. However, as we discussed in former chapters, there is no space between each Chinese character, and "words" are exceedingly difficult to define. This disadvantage can not stop the people reading Chinese in units (i.e. characters) and piecing them together sequentially to words, sentences and texts. Thus, both map reading and Chinese reading fit into the definitions of reading mentioned above.

While we continue to think of the map only as a set of graphic items on a piece

of paper or on a computer screen -- in other words, a mere graphic expression -- researchers may continue to agree with Robinson and Petchenik's second statement that "there is essentially no counterpart in mapping to the syntax of discursive language". They maintain "there is no syntax that is retained from one presentation to another". This is actually true with Chinese too. For example, the sentences 任何事情我都能做 (任何事情 我 都 能 做 ANYTHING I (DOU) CAN DO), 我任何事情都能做 (我 任何事情 都 能 做 I ANYTHING (DOU) CAN DO) and 我(都)能做任何事情 (我(都) 能 做 任何事情 I (DOU) CAN DO ANYTHING, (I can do anything.) are different at the expression level. The syntax of the first one is object + subject + verb (OSV), the second is SOV structure, and the third is SVO. These three sentences are, however, the same in content structure. Moreover, as we discussed in the previous chapter, there are three reading directions in written Chinese (from left to right, from right to left and from top to bottom). Thus, in this example, we have nine different forms for only one meaning. As Head argues that "the essential point is that cognition is not purely data driven" (Head, 1984:10). When learning any language, Head stresses, we should always bear in mind that the expression of a specific concept may vary, but the concepts and the relationships do not. Similarly, a vast number of map forms may be underlain by a much smaller number of content structures, concept-level syntaxes, or schemata.(Head, 1984:10).

Even Schlichtmann (1985) who firmly rejects the language analogy in favour of semiotics, claims that ordinary maps have a definite set of ordering rules which are syntactically similar to the syntax of written language after the transformation from sequential aural utterances to strings of visual signs laid side-by-side in alphabetical

languages (p.28). The scale transformation and the projection transformation are the basic syntactic rules for all maps. In addition there are secondary syntactic rules, such as the way symbols are assembled on the map and orientation of the map.

Just as closely analogous is the micro-syntax by which strokes are assembled into word-like graphic units in the written Chinese. In maps, there are also micro-signs, involving generalization or assemblage of micro-signs into large chunks.

Maps have an iconic or pictorial component, unlike the modern written-forms of Indo-European languages. Chinese, however, has a strong iconic or pictorial component. No one denies that written Chinese is derived from pictures. In the more complex maps today, the pictorial quality of micro-signs is largely lost. So, too, in modern written Chinese.

Maps obviously are limited as to what they can communicate. This again, however, does not alter their linguistic nature. They are capable of generating an infinite number of messages within the universe of discourse involving macroenvironments. They are a linguistic system specialized for the communication of spatial information.

Summary

In this chapter, we have compared written Chinese and map language, from lower unit level to upper structure level, from expression level to content level. Considering the histories, configurations and reading processes for both written Chinese and maps, it is fair to conclude that written Chinese is closer to maps than are alphabetic languages. Up to this point, it seems clear that the analogy of maps as a visual language is

undeniable.

The present study demonstrates that written Chinese, using no clues to pronunciation and understood just by reading, is similar to the map language. Although map language does not have a parallel spoken form, this does not refute the concept that a map is a text in a visual language. Even among the human communication systems unquestionably identified as visual languages, there exist significant differences. Chinese is idiographic, English is alphabetic. "Sign language", developed to assist the communication of people who are hearing-impaired, despite the fact that it is not spoken, is still identified as a language. Map language is a means by which people can communicate large amounts of geographic information much more effectively than other human languages whether visual or spoken. Thus, in map language, the retention of the source of written Chinese -- the icon or ideograph -- has continued to be an effective component in a mode of human visual communication.

The map language, however, is also evolving. It is not as simple as people once thought. Like other languages it also requires special training and practice to be read efficiently and correctly. The evolution of human language -- a simplifying and stylizing process -- indicates the direction of evolution of map language.

Despite the superficial differences among the various human languages, maps, like these languages, use a system of formalized symbols and signs. Maps have syntactic structures and are used as a means of communication. A trained map reader can find in maps the units of increasing complexity -- grapheme, morpheme, word, phrase, sentence and text -- that exist in other human languages.

The present study shows that written Chinese and maps are essentially visual, and that the sound of each character or map sign is separated from its written expression. Both maps and Chinese can function as non-alphabetic and non-phonetic language systems. And, most importantly, both the map and the Chinese reading processes emphasize semantic or content-driven reading. Since written Chinese and maps have so many similarities, it is highly likely, therefore, that we can use the methods of teaching Chinese as a second language to facilitate map reading education.

CHAPTER SEVEN
SECOND LANGUAGE TEACHING: CHINESE AND MAPS

Introduction

It has been argued in the preceding chapters that maps are an important communication medium, about which there has been considerable research in order to improve the efficiency of communication. It has been further argued that maps and written Chinese have many similarities. They can both be considered a visual human language. It follows, therefore, that methods used to teach Chinese as a second language might also be usefully applied to the teaching of map use.

This chapter, therefore, examines the nature of the term "second language" and second language teaching and learning; the methods used to teach Chinese as a second language; and, finally, how these processes and methods might be applied to map language.

SECOND LANGUAGE TEACHING

Second Language Versus Foreign Language

The term "second language" is becoming increasingly used in North America and elsewhere. Some people prefer to use the term "second language" rather than "foreign language" because it is not as strictly defined as the latter term. Some people, however, use the two terms interchangeably. It would be appropriate to distinguish between these terms.

In the present study, second language is defined as the one which is not only learned after the first language, but also has some specific functions within a society or community (Faerch & Kasper, 1983:23). It may be used as a common language or lingua franca to permit communication between people with no common language and for neither of whom it is the first language. For example, in Canada and the United States, English is regarded as a second language to immigrants and ethnic minority groups for whom English is not a mother tongue. It is not proper, however, to consider English learned by students in China after their mother tongue, as a second language.

The definition of foreign language is relatively uniform. It refers to a language which is studied primarily to communicate with native speakers of that language and which has no internal function in the learner's country (Richards, 1978:40). For example, Chinese when used by Canadians doing business in China would be considered a foreign language; it would not be so considered when used as a common language or lingua franca to permit communication between Americans who speak some Chinese and Russians who do likewise. English can be called a foreign language in China when it is used not as a lingua franca, but for communication with foreigners who are native speakers of English.

Second Language Learning Processes

Before studying teaching methods for a specific language, we must understand the language learning processes in general. Three major approaches are generally recognized.

Classical Behaviorism. The oldest theory is the Classical Behaviorism which is

based on observable, explicit, external behaviours and rejects the concept of 'cognition' as too mentalistic, and too dependent on 'instinct'(Liu, 1985:52). It stresses that stimulus and response are two significant factors involved in learning. The theory assumes that learning is a behaviour under which one learns to form associations between stimuli and reflexive responses. In the array of stimulus-response connections, the stimulus is critical; the desired outcome is an automatic, correct response. In language teaching such a theory emphasizes repetition, habit-formation, the avoidance of explanation, and the attempt to eliminate error which would impact negatively upon learning. One problem of the theory, put forth by Osgood, is that it ignores the mental processes involved in the development of meanings which may be the most important aspects of language acquisition (1980:24-26).

Neo-Behaviorism. This theory dates from B. F. Skinner's experimental analysis in the 1930s. It agrees with classical behaviorism in that learning is a behaviour which can be controlled and conditioned into an expected result. Unlike classical behaviorism, however, it focuses on the consequences more than on the stimulus and emphasizes that the repetition of similar consequences to a given response strengthens the learned behaviour (Liu, 1985:53). Thus, the fundamental difference between classical-behaviourist and neo-behaviourist theories is that the neo-behaviourist believes that the increased recurrence of response-generated results, enhances learning, not simply the association of a stimulus to a response. Skinner thinks that the key of learning a language is practice, nothing special, and like many other human behaviours, language can be

practised until it is perfected. (Liu, 1985:54). This language theory and the conditioned reinforcement have been the basis for the audio-lingual method, a method which is widely used and accepted by second language teachers. Although this theory is popular, it has also been challenged by studies in clinical neurology and neurophysics showing that language acquisition is far more than just overt behaviour and may involve a cognitive process (Bryden, 1982:52).

Cognitive Learning Theory. The importance of cognitive learning -- dismissed by the classical behaviourist at the turn of the century as too instinctive -- re-emerged in the sixties. Cognitive learning theory has two parts: rote learning and meaningful learning. In rote learning, the mental storage of items have little or no association with an existing cognitive structure; in meaningful learning, the new information is related to pre-existing cognitive concepts. Retention of the meaningfully-learned material is influenced primarily by the properties of a 'relevant and cumulatively established ideational system in cognitive structure with which the learning task interacts' (Ausubel, 1968:108). This cognitive theory of learning highlights the significance of the semantic aspects of language learning, and has had an increasing influence on second or foreign language teaching methodology (Liu, 1985:57).

According to Liu (1985), the complex process of second language learning cannot be explained by just one theory. Effective methods for teaching second languages will involve components from each of these learning theories.

Factors Influencing the Teaching and Learning of a Second Language

A number of factors will help us to understand why levels of achievement in second language learning may be higher in one set of circumstances and lower in another. These include social, affective, personality, cognitive, biological aptitude, personal input, and instructional factors. The present analysis classifies them into three principal components: the environment, the teacher, and the learner.

The environment will have an obviously important affect on the acquisition of a language. Infants in a single linguistic community will acquire the language of their own community and no other. But if the infant is moved from one linguistic environment to another, s/he will acquire the language of the second environment just as easily as that of the first (Lu, 1987a:5). This phenomena provides strong evidence of environmental influences on learning.

The attitude of the community is also an important factor. It determines, in large part, which languages are available to learners. If a community has positive attitudes towards another language and another culture, second language learning is more likely to occur than if the negative views are held. With a positive attitude, the administration of the community is more likely to sense the public need and then provide, in a professionally understanding way, a helpful learning/teaching system (Lu, 1987a:51).

The physical distance from the target-language community is also one of the influencing factors (Walker, 1989:78). For example, teaching Chinese in Waterloo, Ontario, would be different from doing the same thing in China. When Chinese is learned close to or within a Chinese-speaking community, learners can not only study

Chinese in a classroom but can also practice with Chinese-speaking people outside the school, thus acquiring further learning opportunities. When the language is learned within the Chinese community, the learners are forced to use Chinese because it is the only way to communicate. What they read and hear is only Chinese. Continual exposure to the natural use of the language provides essential opportunities to practise what has been learned and to test new hypotheses, both of which will greatly enhance the process learning.

A second major set of influences on the learning process is related to the teacher. The teacher's level of training for this specific task may vary considerably, and affect the choice of methodology for promoting effective learning, of suitable materials, of principles for deciding what to teach, and in which sequence, of testing arrangements, and the strength of devotion toward the student (Liu 1985:57). The teacher may or may not recognize the significance of these differences in students' ages, motivation, or level of proficiency. Even in a uniform learning environment, studying the same second language and having the same native language, some learners will be more analytic in their approach to the learning task, while others will be more intuitive. Some learners will prefer to use written materials to access the language, while others will prefer to hear the language. An important role of the teacher, therefore, is to provide an environment which facilitates the identification by students of those strategies which work best for them, or to suggest alternative strategies for organizing and storing information.

The teacher also selects the textbook. The best book in one place may not be the best book in another. Good textbooks are often related to local daily life in both

vocabulary and patterns. After the students learn words and patterns, therefore, they can use them. Teachers can also adjust the content of the course by using what they judge to be the best parts of different books.

The learner, of course, is also an important component of the factors affecting second language acquisition. The learner's ability, intelligence, attitude, motivation, choice among strategies and personality all are factors influencing second language learning (Lu, 1987a:12). Individual variations play an important role. That is why there is always the case where some individuals are more successful than others in mastering the language. The learner's willingness, high expectations of success, realistic and attainable aims, sufficient time, great effort and high perception of the benefits to be gained are all common factors associated with high achievement (Lu, 1987b:9).

One of the fundamental factors influencing second language learning differently from first language acquisition may be the interfering effects of the learner's first language. Although a first language is acquired by all members of the human species almost without fail, a second language is frequently not learned efficiently. Some of the difficulties in learning a second language have been shown to arise from the interfering effects of the native language (Fries, 1945:25; Lado, 1957:33). Generally, the greater the difference between the two languages, the harder it will be to acquire the second. For example, the Chinese language, in particular its writing system, has a form quite distinct from western languages (Stephenson et al., 1990:229). Many of the western languages are closely related, as, for example, English, French, Spanish, and Italian. Chinese, by contrast, has almost no common stock of words that are similar in form to any of the

western languages, and it uses grammatical categories that are unfamiliar to speakers of most western languages (Wrenn, 1968:2). This may be the reason that many western second language learners feel that Chinese is the most difficult language to learn.

The preceding discussion further reveals that the learning process as a whole is complex. Mere attention in isolation to any of the factors discussed above cannot guarantee successful language learning. Although in some cases a shortcoming in one or more of these elements can be largely compensated for by unusual excellence in others, all factors must be taken into account.

CHINESE

Conditions for Learning

To develop an effective methodology for teaching, it is important to understand the processes involved in learning. According to Robert Gagne's study (1965), conditions for learning may be divided into two levels: low and high. Low level learning is mainly behaviouristic in nature, involving motor skills training, habit formation, and stimulus-response aspects that involve simple processes. High level learning, on the other hand, always involves cognitive processes which normally include chaining, multiple discrimination, concept learning, principle learning, and problem solving (p.11). Based on Gagne's framework, then, we should consider two processes in the learning of Chinese which will be relevant to the teaching of map language: lexical items and the structural system.

Lexical Items. There are two aspects involved in the learning of lexical items: semantic properties and usage. Learning the semantic properties of lexical items and learning how to use lexical items are both entirely cognitive. In order to use lexical items correctly, the student must: a) know the semantic properties peculiar to a given lexical item and be able to select which of these properties are operative in a given situation; b) know the grammatical functions of the selected lexical items; c) know all the semantic properties of a given lexical item in order to ascertain its proper application in a given context. In short, learning lexical items is a combination of conditioned behaviour and cognitive processes; cognition, however, predominates (Liu,1985:61). Thus, mere rote learning may be helpful for some lexical items, but when a word has several meanings, the student must know how to select from them by recognizing context.

The Structural System. Syntactic and semantic learning, as well as principle learning are involved in this type of learning. In the acquisition of the structural system, the student must learn how to string together several syntactic patterns and must understand rules, such as those of syntax. Principle learning is the extension of semantic learning to the formation of a linguistic system. In such a system linguistic rules are not isolated in rote memory but belong to a total system.

To explore the structural system I divide my discussion into two parts: expression and content.

It must be understood that there are separate -- but interconnected -- structural systems at both the expression and content levels of a language. The acquisition of the

expression structure of Chinese involves both cognitive and behaviour learning processes. Students have to learn the characteristics and understand the underlying meaning of all the basic syntactic patterns and certain particles in order to construct a sentence. Each syntactic pattern has its own characteristic and it conveys particular messages.

A great deal of repetition, substitution and other rote-oriented pattern drills may equip students with the mechanical side of a specific construction, the ordering of the constituents of the expression structure (Liu, 1985:65). To be able to apply the construction in the proper situation, students must know why and under what conditions the construction is used and the difference in the messages conveyed between the sentence which uses one construction and one that uses another. Although each syntactic pattern expresses a particular message, there are particular relationships existing between patterns. Once students acquire this knowledge, they can link related patterns to express their thinking. For example, using a sentence containing the aspect marker "了" one can convey a variety of information about a past event. For instance, 我吃饭了 (I have eaten the meal.); 她死了 (She died.). Students must understand the concept expressed by each individual pattern (Liu, 1985:66).

Cognitive processes or "meaningful processes" are crucial to the learning of content structure. The knowledge of content structure provides the student with an insight into how the language actually works. Such knowledge simplifies the learning task because it provides the key to the language (Liu, 1985:62). Many sentences are manifested as expression structure which have been derived from content structures. These sentences simply cannot be fully understood from the evidence of the expression

structures alone. For example, the two sentences 什么地圖我都收集 and 我什么地圖都收集 (I collect any maps) are the same in content structure, but students often treat them as belonging to two different syntactic structures, mainly because they learn the sentences by rote memorization of expression structure. If they learn by reasoning, they will find it easier to understand and be less confused.

Thus, in summary, in the learning of the Chinese language, a variety of processes play a role, but the cognitive process is crucial.

Teaching

Considering the complexity of learning Chinese it is clear that one single teaching method cannot be expected to meet all types of language acquisition requirements. An integration of teaching methods is required.

There are many methods used in such second language instruction, but they all combine in various ways and various proportions the three basic components of vocabulary, grammar and practice.

Vocabulary means lexical items and can also be considered to involve the smaller units from which these items are constructed. In learning Chinese, Chinese characters have been considered the most difficult because of the large number of nonphonetic, visually complex symbols, which seem to learners 'like graphs'. Therefore, there is a debate about the proper time to introduce Chinese characters. Some teachers advocate waiting until students have a strong foundation in speaking before teaching the reading and writing of Chinese characters. They feel the characters are too difficult.

Walker (1984:77) gives two reasons that the delay may benefit the acquisition of literacy skills: first, it follows the pattern of native acquisition of the writing system, since writing is acquired subsequent to speaking and reading; secondly, it allows the student to focus on orthography without having to worry about vocabulary and grammar. However, many students who learn the characters late do not have good results. Thus, the majority of teachers introduce Chinese characters early in the beginner's course, or no later than a month after the course begins. The assumptions are that: first, they are difficult, so we should start students learning them as early as possible; secondly, in the beginner's course, grammar is simple and the vocabulary is limited, and thus the students have time to learn them; and finally, beginning students are, in fact, eager to learn the characters.

Often, beginners have some fear of the difficulty in dealing with Chinese characters, different as they are from those of alphabetic scripts. At first glance they look rather complicated. However, compared with the written form of languages such as English, Chinese is by no means the most difficult to learn and use. It is true that the alphabet of English is not large in number, consisting of 26 letters only, but English word spelling does not always agree with the pronunciation. Large quantities of English words require mechanical memorization one-by-one, and learners will perhaps spend more time in memorizing these than they would the Chinese characters. In addition, Chinese characters have an advantage over the written form of English, that is, much time can be saved when they are learned. Reading materials written in Chinese takes less time than reading similar materials written in alphabetic languages even if they have the

same contents. (This trait of Chinese is of great similarity to map language.) Once familiar with a certain number of Chinese characters, the student will be in a position to learn more by way of taking the words literally according to the context, sometimes by looking up the dictionary (Lu, 1987b:2).

To determine the sequence in which characters are taught, teachers usually use what is called the "vocabulary selection method". This method involves careful selection and grading of words based on the number of strokes. Since the orthography and sentence pattern of Chinese is unique, great emphasis must be placed on the development of strong visual memory for the characters (Stephenson, et al., 1990:226).

Grammar or syntax is a second basic component in second language instruction. Students must learn the basic Chinese syntax, including both expression and content structure. For examples, the expression syntax is acquired: 我是约翰史密斯 (I am John Smith); 她昨天给我一本书 (She gave me a book yesterday); 北京位于中国北部 (Beijing is located in northern China). Meanwhile, the concept of stresses on semantic or content structure is introduced. For example: "He is happy now." is correct on both expression and content structure levels, but "This table is happy now." is correct on expression level but not on content level. The teacher also attempts to tell the students that one content structure may be expressed with different forms in some situations, as we noted in a previous section. Therefore, the teacher must let the students know that understanding the concepts is very important in the mastering of syntax.

Practice is the third basic component of second language instruction. One way to help students remember is to have them read as much as possible. Specialized "reading texts" are prepared to ensure the recurrence of some of the lexical items and sentence patterns already taught, and to develop the students' power of reading comprehension and writing. Teachers also prepare supplementary reading materials. Students need to read not just single characters but complete sentences and stories. Thus, after vocabulary and patterns are introduced, good exercises and examples must be provided to support the learning. If the teacher explains without giving practice or offers insufficient practice, the student cannot remember a pattern. The student will not be able to use the language. Practice is the best method for students to consolidate what they have learned. It is difficult for one to gain perfection in a language by interacting with it only once. Repeated exposure assists the instantaneous recall of a language when it is needed.

Thus, all these methods fit together. The structural method teaches the structures of the syntax. When one has learned the "frames" or "patterns" or "schemata" of the syntactic structure, one can fit words into them more easily. Both the structures and the words used in them are reinforced through practice. One particularly useful method is known as the substitution method (Hill, 1974:86), see fig.7.1. In the figure, one of the sentence patterns is: The weather in Beijing's autumn is good or not? (Zhen, 1988:61). With this method, the students may make up many sentences with different contents but one expressing form. They can use learned words to substitute the subject, verb, object, time and place in the learned sentence patterns in terms of the different semantic contents.

A. 组句： Sentence-buildin

暖和	热
不暖和	不热
暖和不暖和	热不热
春天暖和不暖和	夏天热不热
杭州的春天暖和不暖和？	青岛的夏天热不热？
好	长
不好	不长
好不好	长不长
秋天好不好	冬天长不长
北京的秋天好不好？	吉林的冬天长不长？

B. 替换： Substitution drills:

1

你	喜欢不喜欢	杭州	的 春天
		青岛	夏天
		北京	秋天
		吉林	冬天

2

杭州	的	春天	暖和	不	暖和
青岛			冷		冷
北京			长		长
吉林			好		好

Fig. 7.1 Two drills of practice. In drill A, each sentence is built with words such as `` The weather in Beijing's autumn is good or not?" In drill B, there are two sentence patterns: ``You like Beijing's autumn, don't you?" ``Hangzhou's spring is warm." (Zhen, 1988:61)

MAPS

Maps as a Second Language

Maps are a system of communicating geographic information. The map language is normally acquired after the first language. Map use is a day-to-day activity and thus has specific internal functions within each country or society. It can be used to communicate between people from different cultural backgrounds or with no common spoken language as long as they understand the map language: it can function as a common language or lingua franca. Thus, maps are seen here to be similar to a second language. Map language, therefore, must be teachable as a second language. Indeed, it has been shown that mere twenty-minute lessons in lexicons and thematic map syntax have, in controlled experimental situations, raised map comprehension levels dramatically (Head and Elgood, 1988:11; Saku, 1990:110). A better understanding of the second language learning process may help us to improve map communication and teaching processes, both in theory and in practice.

Factors Influencing the Teaching and Learning of Map Language

Different environments can provide an opportunity for people to use maps more or less frequently. People in larger cities usually feel very much in need of acquiring direction or spatial relationship and thus be motivated to learn effective map reading skills. If the adminstration provides a variety maps with effective instructions, it would most likely promote map language learning. The more people are exposed to the process of map use, the better they master map language. People who do a lot of travelling also

have more motivation to use maps, which surely develops their map use skills to high levels.

In the teaching of map reading, the teacher's training (especially in cartography), attitude to the students, and the approach and methodology employed, all determine the extent of the success of map language learning.

There are several characteristics of the learner that will influence the rate of acquisition of the map language. These include ability, intelligence, attitude, even culture. The student's willingness, high expectation of success, devotion of sufficient time, and great effort are all factors associated with high achievement. In societies using an alphabetic language, the first language may have an interfering influence. Map language is quite different from any writing system used for representing languages which are in large part based on sound-symbols. To some extent maps are more closely related to written Chinese. The implication of this is that it is possible to employ similar methods for teaching Chinese as a second language, to teaching map language.

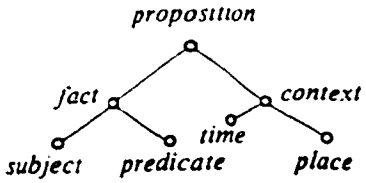
Methods for Teaching Maps as a Second Language

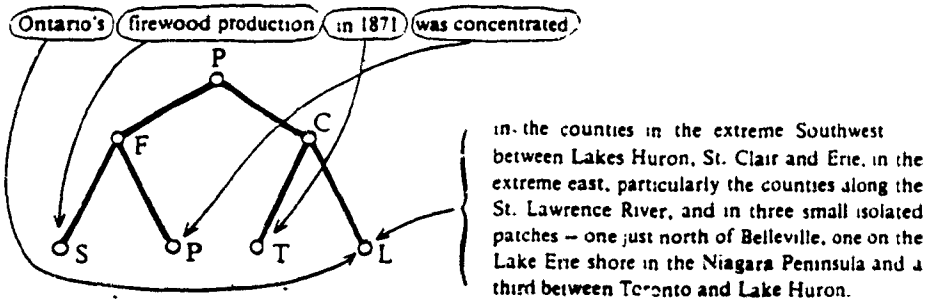
By analogy with the ideographic language, the system of map symbols might be called the basic vocabulary of the language of maps. Similar to learning Chinese, map use involves knowledge of cartographic vocabulary, such as conventional signs representing features like roads, rivers, lakes and towns. Without basic knowledge in these, it may be difficult for some people to use maps efficiently. The vocabulary should be introduced early. As with Chinese characters, frequently used symbols are of only a

limited quantity. Once a reader is familiar with a certain number of them, s/he will be in a position to learn more by way of "taking the words literally".

It is important to teach syntactic relationships between both geographic concepts (spatial relations at a concept level) and cartographic symbols (spatial relations at an expression level). It is also important that students are instructed on what types of cartographic features might appear together, so that they can associate one feature with another and consequently, to improve significantly their ability to build complex forms from simple forms. For example, valley bottom with winding river, or ox-bow lakes and backswamps, are grouped together because they occupy slots in a network of relations, just as the units make up a sentence. Contents as well as expressions of these features are linked by syntactic relationships. The syntagmatic order determines how units are combined. Instruction in syntactic relationships can help students to use the concept of spatial assemblages of the individual features to identify structured wholes, where each individual feature is represented by a "localized sign" or, in language term, a lexical item. (Schlichtmann 1985:6).

In teaching map reading, the students should learn how to understand spatial concepts and different forms of expressing them. For example, Head (1984:20) shows how three different cartographic presentations (Fig.7.2) can be used to express one proposition. The concept (expressed in written English) in the example is: Ontario's firewood production in 1871 was concentrated in the counties in the extreme Southwest between Lakes Huron, St. Clair and Erie, in the extreme east, particularly the counties along the St. Lawrence River, and in three small isolated patches - one just north of





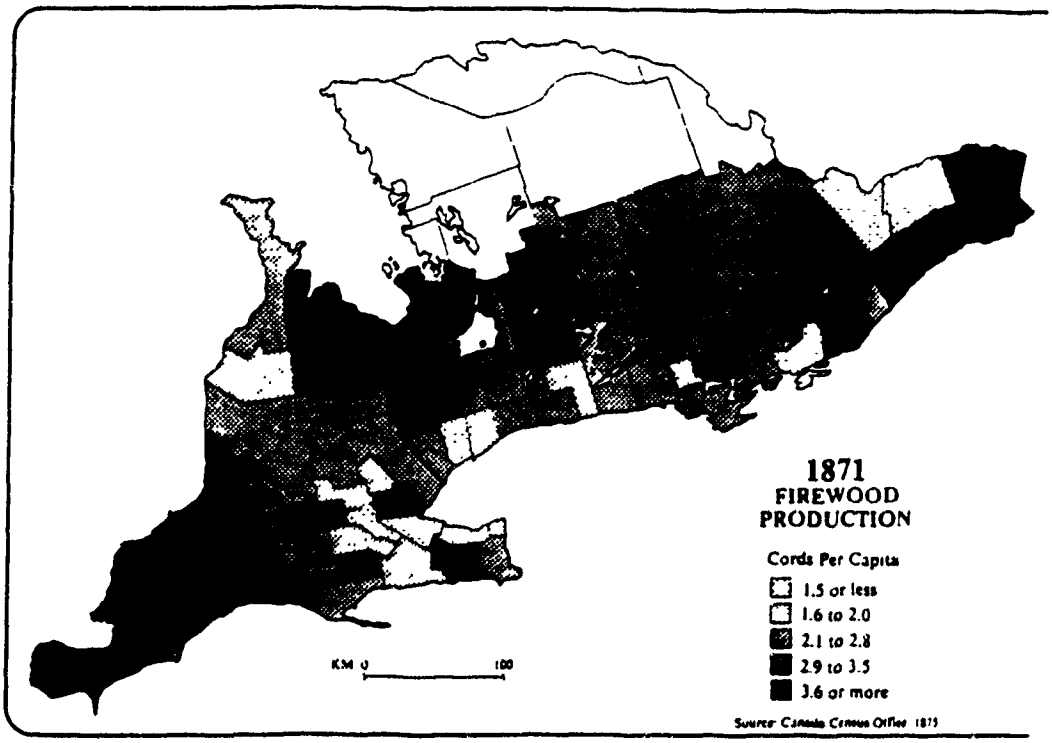
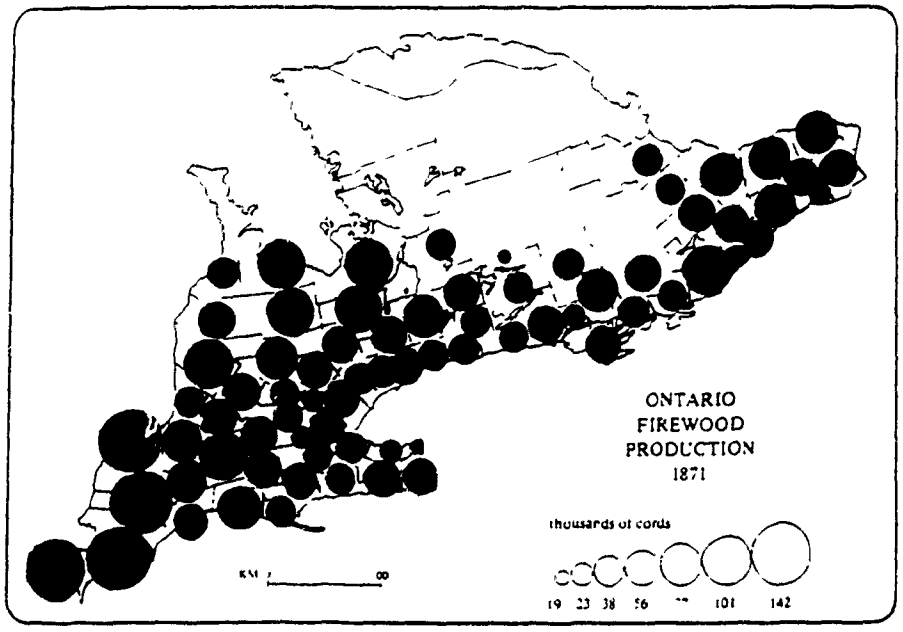


Fig.7.2 One proposition expressed in three different cartographic presentations (Head, 1984:20-21)


ONTARIO
FIREWOOD
PRODUCTION
1871
thousands of cords
19 23 38 56 101 142


little produced
heavy production
very heavy prodtn.
Light production
moderate production
very heavy production
Map shewing
FIREWOOD
produced in the
PROVINCE OF ONTARIO
according to the statistics
collected by the third census of Canada
1871

Belleville, one on the Lake Erie shore in the Niagara Peninsula and a third between Toronto and Lake Huron. One map in the example expresses the proposition by using different levels of shading; the second one by proportional circles; the third one by using English script notations in the different locations. There are three presentations with same basic contents. If students know different presenting methods (note: not making methods), they will have advantages in the reading of maps. In cartographic communication, students should be given the opportunity to make use of maps as much as possible. Frequent exercises relating to map use should be handed out to students. It is only through constant interaction with maps that students will become good map users. In short, the methods for teaching Chinese as a second language seem directly applicable to the teaching of map language.

CHAPTER EIGHT
CONCLUSIONS

Conclusions

This thesis represents as exploration of cartographic communication within the paradigm of the map as a linguistic form. Earlier map communication research focused of individual map symbols or their component parts, investigating their psychophysical attributes. More recent work considers the map communication process to be far more complex, engaging high-order cognitive processing. The paradigm of maps as a language form fits within this more recent approach, but certain objections to maps as language have remained.

Some of the objections to maps as a language are founded on the purported necessity for written human languages to have a phonetic counterpart. This thesis has demonstrated that written Chinese probably functioned historically as a primarily visual language. Today, the written form, which now has a phonetic component, can still be read by speakers of vastly different dialects of Chinese and even by speakers of related but non-Chinese language. Thus, if Chinese -- the natural language of around one quarter of the world's population -- can function as a purely visual language, there is no reason to deny on functional grounds the language analogy for maps on the basis of the lack of a non-phonetic counterpart.

A second major criticism of maps as a language strikes at the non-alphabetic nature of maps. Except with place-names, morphological units that appear and function

like alphabetic characters are not immediately evident on maps. Alphabetic units are not found in the Chinese language either, for these units are specifics of a phonetically-related language system. A comparison of Chinese and maps has shown that both systems do indeed have units at both expression and content level, and that at most levels of the size hierarchy these units are coincident. Certain problems of allocating small units of the map system to specific levels (particularly, is the visual variable a morpheme or a grapheme?) are illuminated when compared to Chinese. The Chinese "radical" is sometimes considered to be a grapheme -- with no specific meaning -- but in early Chinese script, as the basic pictogram, it did indeed carry meaning and was thus morphemic. Visual variables in mapping carry certain sub-conscious meanings of nominal, ordinal and ratio orders and can thus sometimes be considered morphemic, even though by most map users they are considered neutral in meaning unless otherwise invested through a map legend. The concept of sub-morphemic units -- units with sub-conscious or largely-lost meaning -- is reinforced from the consideration of the radicals of written Chinese and clarifies our linguistic concepts of maps.

The importance of the concept-driven, often widely-diffused reading strategy of Chinese also clarifies our understanding of the reading strategy of map users. A Chinese character is a two-dimensional form. Therefore, the recognition of each character carries a two-dimensional activity. Furthermore, Chinese reading appears to depend upon broad contents, probably much more so than alphabetic languages. Similarly, it appears to involve the right brain hemisphere more strongly than alphabetic languages. On maps, contour lines by themselves, for example, provide only limited clues to landforms, but

in the context of broadly-gathered readings of many contours and other map marks, a mental image of the landscape can be derived. Left and right brain hemispheres are shown to work together to process Chinese script, and it is likely that focused research would yield similar results in the examination of the map reading process.

In answer to our first hypothesis, then, the map symbol system does constitute a visual ideographic language. It appears to be closer in nature and in evolution to written Chinese than it is to alphabetic languages.

The second hypothesis of this thesis, that the methods of teaching second languages, specifically visual ideographic languages, is applicable to map use, has been investigated by examining methods used to teach Chinese. There are a number of points to be made in this regard. The teaching and learning of a second language involves the use of complex cognitive processes, and different people learn in somewhat different ways. Thus, a variety of approaches are necessary for efficient learning. Vocabulary and syntax, however, are basic components, and the methods of teaching these for Chinese seem directly applicable to the improvement of map use skills. Finally, extensive practice in substitution and in increasing complexity of expression is required. In short, the methods of teaching Chinese as a second language appear to be well suited to teaching map use.

Further Research

Cartographic communication efficiency should be improvable through further investigations of the methods of teaching Chinese as a second language adapted to the

map language.

1) A more in-depth study of teaching Chinese as a second language may provide more direct evidence to demonstrate how people learn the ideographic language as their second language. In this way, we may take advantage of some of the methods to apply to map reading education.

2) Since map language and written Chinese have so many similarities, we may investigate that whether non-trained people with Chinese as their first language read and understand map language faster and more efficiently than those with alphabetic languages as their first language.

3) Future study could pursue assessing, by experiments, the effects of new teaching methodology on map reading education. The experiments will reflect whether the methods are successful or not. If they are, the advantage and disadvantage of the methods can also be assessed.

4) Furthermore, drawing on the experience of the way of compiling the Chinese dictionary, the cartographic dictionary may find out its own way to be generated in the future.

In conclusion, the present study is an initial step in investigating cartography as a visual ideographic language from a Chinese perspective. There is no doubt that more and more research has been and will be conducted in the area of map language from different perspectives all over the world. Although many questions still remain, maps as a visual ideographic language continues to be an area of important research.

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