Visible Language 40.3

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Linda Reynolds, Sue Walker and Alison Duncan
Children's Responses to Line Spacing in Early Reading Books or 'Holes to tell which line you're on' **246-267**

Heloisa Moura
Analyzing Multimodal Interaction within a Classroom Setting **270-291**

Saad D. Abulhab
Typography behind the Arabetic Calligraphy Veil **294-307**

William Chiang
Comparison of Maya and Oracle Bone Scripts **310-333**

Index for volume 40

Line spacing

Very close (A)

space

2 amount of text

2 difficulty of words

1 clarity

1 no reason

7

Number of children

Close (B)

Number of children

Normal (C)

Number of children

Wide (D)

Most difficult

3 space

3 size of type

1 weight of type

Pr

1 spac

2 ease

1 attractiveness

1 no reason

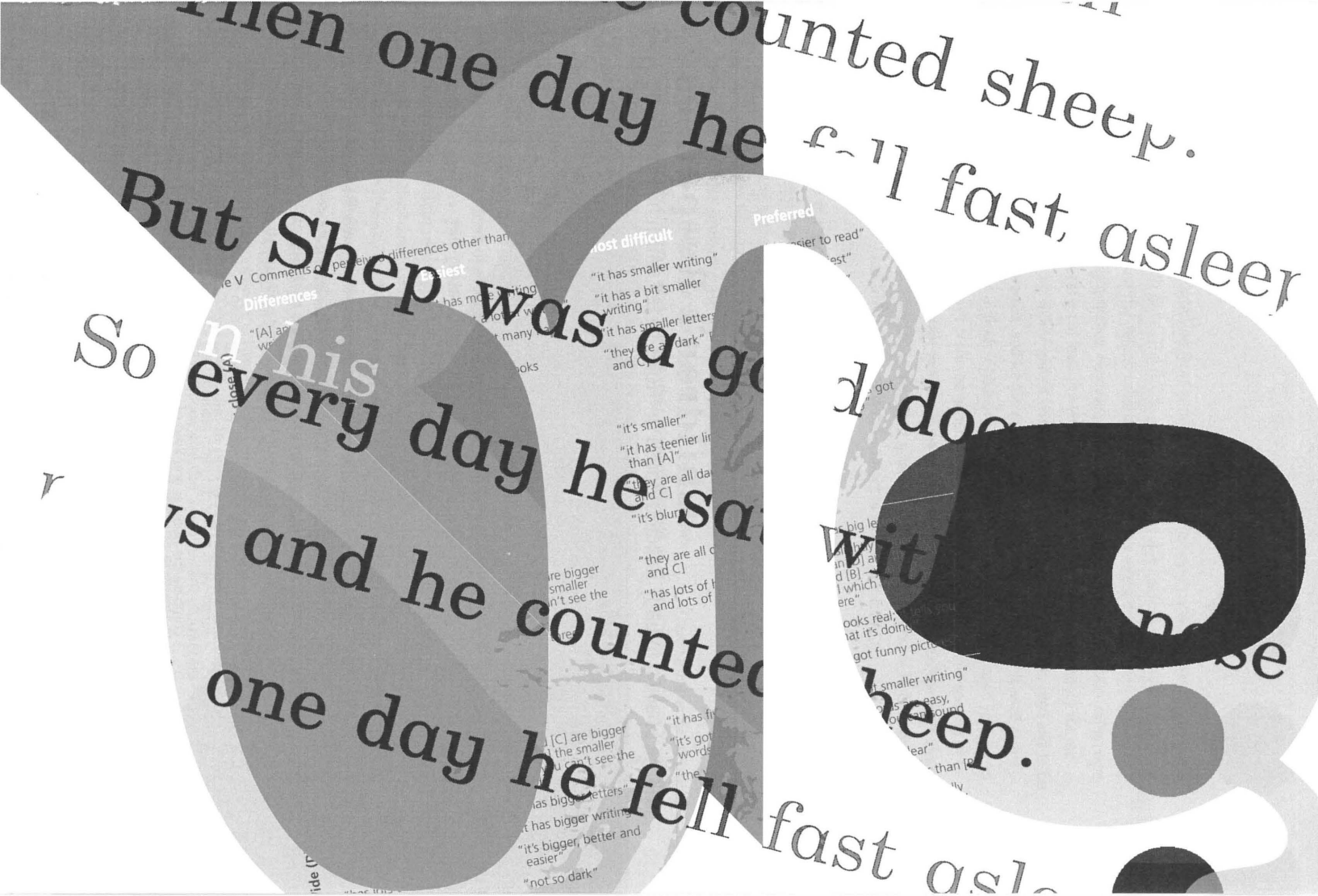
Number of children

Number of children able to make a choice

Number of children able to give one or more reasons

N = 24

* some children chose more than one version
** some children gave more than one reason


hen one day he
counted sheep.
But Shep was a
fell fast asleep
So every day he
his
and he counted
one day he fell
Differences
Easiest
Most difficult
Preferred
"it has smaller writing"
"it has a bit smaller writing"
"it has smaller letters"
"it's smaller"
"it has bigger writing"
"it's bigger, better and easier"
"not so dark"
"has lots of
and lots of
"it's got
words"
"it has fi
"has bigg
letters"
"they are all
and C]
"it's got funny pict
"it's smaller writing"
"it's easy,
"it's bigger, better and easier"

as line spacing, linefeed, inter-line space or leading. The term 'line spacing' is used throughout this paper and it refers to the baseline-to-baseline distance between successive lines of text. This distance is equal to the point size[2] of the type, plus any additional space (or 'leading') in points that is added.

In printed materials intended for adults it is generally accepted that, for type at sizes intended for reading at a normal distance, legibility is improved by the addition of two or three points of extra space between lines (Spencer, 1969). It is argued that the additional space makes it easier to follow each line, and facilitates an accurate return sweep of the eyes to the beginning of each successive line; it may also help with word recognition, as there will be less visual interference or 'contour interaction' from lines above and below that being read (see Hughes and Wilkins, 2002, 223). The optimum amount of space needed has been shown to depend on a number of factors. Tinker (1963) reports a series of experiments involving tests of silent reading speed with adults. He found that while line spacing greater than the point size of the type conferred a significant advantage with some type sizes and line lengths, this was not always the case and too much space could be detrimental. He concluded that optimum line spacing depends on line length, type size and typeface. The greater the line length, the more important it is to add extra space between lines (though very short lines were also shown to benefit from additional space between lines). The spacing also needs to increase in proportion with the size of the type. Tinker (1963), again referring to adults, advised that for optimal sizes of type (9-, 10-, 11-, and 12-point), an interlinear space of one to four points can be added in order to increase legibility. The

2 One point is equal to 1/72in or 0.35mm.

The greater the line length

influence of typeface was confirmed by Becker et al (1970) who found that, according to readers' judgments of attractiveness, sans serif and italic types are likely to benefit from an additional point of line spacing as compared with roman types. The relation between line spacing and word spacing is also important. According to the principles of Gestalt psychology, there is a tendency to group elements in the visual field on the basis of their proximity (Bruce and Green, 1985). Given that the typographer's aim is to group words into lines, the space between lines must therefore be greater than the space between words. If this is not the case, distracting vertical 'rivers' of white space may be created. Hartley (1994) argues that to avoid 'optical bridging' between lines, the minimum line spacing must be increased by an amount equivalent to the specified word spacing.

While research on the issue of line spacing in relation to adult reading material has led to useful insights, it cannot be assumed that these results can

be applied directly to material for beginning readers. It would seem reasonable to suppose that the same factors will operate, but to what degree? As Tinker (1968) points out, much of his work with adults involved tests of the speed of silent reading, which is of course not appropriate for beginning readers. There has been very little experimental work on line spacing in books for children who are learning to read, and the results have generally been inconclusive (Tinker, 1968). Nevertheless, Tinker argues that some level of additional space between lines is indicated for beginning readers because at that stage the return sweep of the eye from the end of one line to the beginning of the next has not been perfected, so generous line spacing 'will promote greater accuracy in doing this and thus reduce regressions of readjustment near the beginning of lines' (Tinker, 1968, 319). His recommendation for 'Grade 1' children (six- and seven-year-olds), based on legibility findings for older children, was 14- to 18-point type in relatively short lines of up to about 22 picas (3.7in or 9.3cm), and 6 to 8 points of additional line space (Tinker 1968, 320). Yule (1988) asserted that in books of the late 1980s the line spacing was usually wide enough to prevent most children's eyes slipping from line to line in reading.

In one of the few experiments conducted with children as participants, Hartley, Burnhill and Fraser (1973) asked ten- and eleven-year-olds to read aloud stories set in different type sizes and with different line spacing, but the same line length. They found no significant differences in terms of either reading time or errors. More recently, Rosemary Sassoon has been particularly concerned with type design and children's perception (Sassoon, 1993). She reports on a study in which one-hundred children, half aged between eight and

he more important it is to

thirteen with special needs, and half eight-year-olds in mainstream education, were shown text set in five differently spaced versions (which included two different line spacings) and asked which they preferred for reading. Sassoon concluded that where spacing is concerned, presenting findings as an average or norm is not always the most useful way to describe them, as children at different levels of reading have different requirements.

Hughes and Wilkins (2000, 2002) have conducted some of the most recent work on the legibility of children's books. They investigated the effect of type size and spacing on the ability to read at a distance, in order to help with the design of text in children's 'big books' (Hughes and Wilkins, 2002). They varied both letter spacing and line spacing in relation to type size, testing the visual acuity and reading speed of two-hundred children of six to twelve years of age. They concluded that 'children's reading would benefit by increasing the font size of the text and by expanding the spacing horizontally and vertically' (225).

However, they varied the letter spacing and line spacing in such a way that the effects of each cannot be isolated, and while their conclusion might also be valid for materials intended to be read at a normal reading distance, we cannot be certain of it.

Given the lack of experimental evidence on the effect of line spacing as a variable in early reading books, the study described here was intended to provide an insight into the effects of line spacing on children's reading performance and on their subjective responses to appearance of texts with different line spacing. In particular, the aim was to look at the effect of line spacing in realistic reading books when used in a realistic reading situation.

MATERIALS

Using realistic test material meant that the children's reading performance would be influenced by what Hughes and Wilkins (2000, 316) describe as the 'linguistic and semantic aspects of reading,' as well as the 'visual aspects.' In their studies of typography in children's reading schemes (2000) and 'big books' (2002), they used a Rate of Reading Test specially designed to minimize the influence of linguistic and semantic factors. The text consisted of fifteen randomly repeated common words, appearing as a paragraph but lacking any meaning. They found this method to be highly reliable, and in both studies it was sufficiently sensitive to pick up significant differences in reading performance as a result of variations in type size and spacing (letter and line). Our aim, however, was to examine the effect of line spacing in a normal reading situation. The

add extra space

testing was intended to replicate, as far as possible, a normal reading situation for children in Years 1 and 2 at UK primary schools. This would typically involve the child reading aloud to an adult on a one-to-one basis from an illustrated reading book produced to a high standard.

For this study, as for the previously mentioned work on typefaces and horizontal spacing, the text used was *A sheepless night* (Oxford, 1999), written by Geraldine McCaughrean and illustrated by Mike Spoor, part of the Oxford Literacy Web designed to fit the UK's National Literacy Strategy requirements in primary schools. It is part of the Oxford Literacy Web's Fiction Strand ('fun-

packed stories every child will love') and is aimed at children around six years old, likely to be in years 1 and 2 in primary schools. This relates to *Individualised reading* stage 7 (Moon, 2005), which is National Curriculum working within level 1, age 6-7.

In choosing the typographic variants to be tested, we were aware of the fact that there are complex inter-relationships between line spacing and other typographic factors. This was observed by Legros and Grant (1916), who discuss the many different factors affecting legibility, and confirmed by Tinker's (1963) extensive series of studies. Watts and Nisbet (1974), reviewing earlier work in this area, also argue that line spacing cannot usefully be studied as a variable in isolation from type size, line length and type weight, and that many studies that do isolate these variables are of limited practical value. However, testing different levels of several variables would result in a very large factorial experiment requiring large numbers of child participants. Our approach in this study, therefore, was to take into account the results of our previous experiments when selecting typographic variants other than line spacing.

In the typeface study referred to above (Walker and Reynolds, 2002/03), comparisons of reading performance revealed no significant differences between text versions in serif and sans serif types with and without infant characters. A previously-used version in Century Educational, a serif type with infant characters, was selected for use in this study because of the popularity of this typeface with publishers of early readers. The text was set in 19-point type (capital-letter height 5mm, x-height 3mm) with the following baseline-to-baseline increments:

between lines...

very close	17 points
close	21 points
normal	30 points
wide	38 points

The 30-point 'normal' line spacing (10.5mm from baseline to baseline) was the same as that used in the earlier comparison of typefaces; it was decided upon by a process of expert review (see Walker and Reynolds, 2004), taking into account the generous ascenders and descenders of the Century Educational typeface. A survey (by the authors) of line spacing, capital-letter height and x-

But Shep was a good dog.
So every day he sat with his nose on his paws and he counted sheep.
Then one day he fell fast asleep.

But Shep was a good dog.
So every day he sat with his nose on his paws and he counted sheep.
Then one day he fell fast asleep.

But Shep was a good dog.

So every day he sat with his nose on his

paws and he counted sheep.

Then one day he fell fast asleep.

height in twenty-two contemporary early reading books from seven different publishers indicated that the most frequently occurring values were 10mm line spacing with a 5mm capital-letter height and an x-height of 3.5 or 3mm (see table 1). Our material was therefore representative of books currently in use for five- to seven-year-olds. The 17-point line spacing gave negative spacing and was designed to represent an extreme, while the 21-point spacing was just sufficient to give clear separation of ascenders and descenders. The 38-point spacing was included to discover whether wider spacing than that typically used might be helpful to children learning to read. The four versions are shown

in figure 1. Four complete books were printed and bound, the text in each book being set through-out according to one of the line spacing variables under test. The cover and illustrations were the same as in the original OUP version of *A sheepless night*.

As each child taking part in the study was to be asked to read from all four line spacing versions, four different text passages were required. Four double-page spreads were selected for use, with lengths of 110, 99, 138 and 107 words. While four texts of the same length would have been preferable, it was felt that using a 'real' book rather than specially constructed and highly controlled text would offer benefits in terms of validity and child-friendliness.

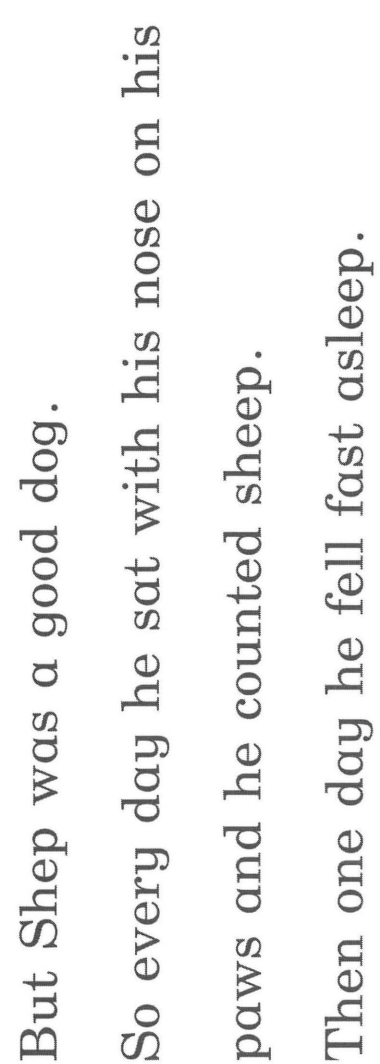


Figure 1 Examples of the test material. From the top, the line spacing values are: very close (17 points), close (21 points), normal (30 points), and wide (38 points). The type is 19 point Century Educational.

METHOD

PARTICIPANTS

Testing was carried out in a local education authority urban primary school in the south of England. Twenty-four children in Years 1 and 2 and aged between five and seven years took part. They were selected in consultation with their teacher who confirmed that they were of a comparable reading standard, able to read books from level 6 to level 8 of the Oxford Reading Tree, and from an appropriate National Curriculum-specified word list with an error rate of no less than five per cent and no more than twenty per cent.

PROCEDURE

Testing was carried out in a quiet area near the classroom, where the children were used to reading to their teacher or other adults on a one-to-one basis. The children were reassured that they were not being tested and that help would be given if necessary. Each child was first asked to read aloud from all four books (i.e., from all four line spacing versions), reading from a different double-page spread in each book as determined by the test design (*see below*). They were prompted only when they were unable to continue without help.

Each child's four readings were audio-taped for later analysis. When a child had completed the reading task, all four books were opened at the same double page spread (for ease of comparison), and laid out in the order in which the child had read from them. The following questions were then asked:

1 'Can you spot any differences in the way the writing looks in each of these books?'
If yes: 'What differences can you see? Can you tell me about them?'

2 'Do you think any of the writing styles is easier or more difficult to read than the others?'
If yes: 'Which did you think was the easiest?'
'Why do you think that was?' 'And which did you think was the most difficult?' 'Why do you think that was?'

3 'If you could choose one of these books to take home and keep, which one would you choose?' 'Why would you choose that one?'

If a child had difficulty in answering the first question, the texts with the widest and closest line spacing were placed together and the question was repeated.

Table I Linefeed, capital letter height and x-height in a sample of twenty-two contemporary early reading books from seven different publishers.

linefeed (mm)	cap height (mm)	x-height (mm)
7	4	3
7	4	3
7	4	2
7.5	4.5	3
9	4.5	3
9	4.5	3
9.5	4.5	3
9.5	5	3
10	6	4
10	5	3.5
10	5	3.5
10	5	3.5
10	5	3.5
10	5	3
10	5	3
10.5	5	3.5
10.5	4.5	2.5
11	4	3
12	6	4
12	6	4
15	7	4.5
single lines	6	4

TEST DESIGN

The particular combinations of double-page spread and line spacing seen by each child, and the order in which they were presented, were determined by a test design comprising six 4 x 4 Graeco-Latin squares, requiring twenty-four children in total. The design was balanced in relation to: the number of times each of the sixteen possible combinations of line spacing and double-page spread occurred (six times overall); the number of times each line spacing version was read first, second, third or fourth (six); the number of times each line spacing version was preceded by every other line spacing version (six); the number of times each double page spread was read first, second, third or fourth (six); the number of times each double-page spread was preceded by every other double-page spread (six). Children were randomly assigned to the twenty-four different reading sequences.

RESULTS

READING PERFORMANCE

The time taken to read from each double-page spread was not analyzed, as in previous tests in this series by the authors it had not revealed any significant differences as a result of typographic variants (Walker and Reynolds, 2002/03; Reynolds and Walker, 2004). With realistic test material we have found that children tend to pause in their reading to ask questions or comment on the story or the illustrations, making it very difficult to obtain accurate or meaningful timings.

The audio-taped readings were, however, analyzed for miscues. The miscues were categorized on the basis of standard lists used by teachers to assess children's reading (Arnold, 1984; Campbell, 1993). We have found it helpful to group the miscue categories according to their likely significance in relation to typographic features:

1 Errors that may be caused by confusion over word profile (which could, for example, be affected by the length of the ascenders and descenders or the confusibility of some letters with others)
   - substitution
   - omission of a syllable
   - transposition
   - hesitation
   - non-response
   - partial response
2 Errors that may be caused by confusion as a result of inappropriate horizontal or vertical spacing
   - omission of a word
   - repetition of a word
   - omission of a line

3 Errors that may result from a general uneasiness with the text and which may or may not be due to typography
   - insertion
   - change of word order [reversal]
   - self-correction

The miscues considered likely to be of most relevance in relation to line spacing were line omission and word repetition at the beginning or end of a line.

As the texts differed somewhat in length, the number of miscues per reading (a total that included all categories of miscue) was transformed into miscues per 100 words (number of miscues divided by number of words on the relevant double-page spread, multiplied by 100). The analysis of variance on numbers of miscues per 100 words did not indicate a significant difference between the four line spacing versions or between the four double page spreads, the average over the twenty-four children being around nine miscues per 100 words on each spacing. Line omissions and word repetitions at the beginning or end of a line were then analysed further, but once again there was no apparent relationship between the line spacing version and the number of miscues. However, although there were no statistically significant differences between the line spacing versions in terms of miscues, the qualitative responses given by the children are of considerable interest.

THE CHILDREN'S VIEWS

It is worth noting that each child had had the experience of reading from an example of each line spacing version, rather than having merely been shown the four different versions and asked to voice an opinion. Although the children had read from a different double-page spread for each spacing version, when answering questions afterwards they were shown four versions of the same spread.

Responses to Question 1: 'Can you spot any differences in the way the writing looks in each of these books?'

Responses to this question are summarized in table II. It may be seen that eight children could see differences when shown all four spacing versions together (though only one of these could distinguish between all four versions), a further ten could see differences when shown the two extreme versions together and six could not see any differences even when shown the two extremes. In other words, two-thirds of the children could not distinguish between line spacing versions that were only one step apart. This would seem to be in keeping with the lack of significant differences between the four spacing versions as a result of the miscue analysis of the children's reading. However, three-quarters of them could see differences when shown the two extreme versions together. Thus

Table II Number of children perceiving differences between the four line spacing versions.

nature of difference perceived	number of children perceiving differences when shown all four versions	number of children perceiving differences only when shown the two extreme versions	total number of children perceiving each kind of difference
line spacing	4	5	9
word spacing	1		1
type size	2	4	6
type weight	1	1	2
amount of text		1	1
other	1		1
Number of children perceiving one or more differences	8*	10*	

N = 24 (13 boys, 11 girls)
* Two children perceived more than one kind of difference

although there were no measurable performance differences given the material and measures used in this study, the majority of the children were nevertheless aware of differences in the typography between at least the extreme versions. Their perceptions of the nature of the differences were not always 'correct,' but are of considerable interest.

Ten children commented on the differences in spacing between the texts, though five of them could only identify these differences after being shown the two extreme versions together. Nine of the ten correctly pointed out differences in the line spacing, whereas one child perceived the words to be spaced differently. (The children's comments relating directly to spacing are summarized in table IV.) It may be seen that in general, in response to Question 1, the very close line spacing was regarded as 'squashed' and the wide spacing was regarded as 'spread out.'[5] One child was very specific, looking at the distance between the first letters of two consecutive lines in two versions; she concluded that the letter 'O' was further away from the 'l' (directly below) in the normal spacing than it was in the very close spacing. Another

3 One child compared the very close and normal line spacings, saying that in the former the 'lines are near to each other' and in the latter 'there are spaces between the sentences'. The perception of lines as sentences is interesting. Line breaks were often at the end of sentences, but each of the four reading passages included three or four sentences with a line break in them. These breaks were positioned so as to cause the least disruption of fluency, according to the principles recommended by Raban (1982).

child recognized that there were differences in the amount of space in each version, but thought that it was the amount between words rather than lines; she did perceive the very close line spacing as having the closest word spacing, however.

Six children thought that the four versions differed in type size. All of these children thought that the more widely spaced text had 'bigger writing' than the more closely spaced text, and three of them also described the very close and close spacing as having writing that was 'smaller' or 'a bit smaller' than the normal and wide spacing. The relation between line spacing and

Table III Numbers of children choosing each line spacing version as easiest, most difficult and preferred (bold type), and numbers of children giving each reason.

Line spacing	Easiest	Most difficult	Preferred
Very close (A)	1 *space*	3 *space*	1 *space*
	2 *amount of text*	3 *size of type*	2 *ease*
	2 *difficulty of words*	1 *weight of type*	1 *attractiveness*
	1 *clarity*		1 *no reason*
	1 *no reason*		
Number of children	**7**	**7**	**5**
Close (B)		2 *size of type*	1 *amount of text*
		1 *weight of type*	
		1 *other*	
Number of children	**0**	**4**	**1**
Normal (C)	1 *size of type*	1 *weight of type*	1 *space*
	1 *amount of text*	1 *amount of text*	2 *size of type*
	1 *no reason*	1 *difficulty of words*	3 *other*
		1 *no reason*	2 *no reason*
Number of children	**3**	**3****	**8**
Wide (D)	2 *space*	1 *space*	4 *space*
	4 *size of type*	1 *amount of text*	1 *size of type*
	1 *weight of type*	2 *difficulty of words*	1 *difficulty of words*
	2 *no reason*	1 *no reason*	2 *clarity*
			1 *ease*
			1 *attractiveness*
			1 *other*
Number of children	**9**	**5**	**8****
Number of children able to make a choice	**18***	**17***	**22**
Number of children able to give one or more reasons	**14**	**15**	**19**

N = 24

* some children chose more than one version
** some children gave more than one reason

apparent type size has been reported previously. For example, Hartley, Young and Burnhill (1975) carried out a small study using type sizes from 8 to 12 points and line spacing from 9 to 14 points. They found that half of a group of fourteen undergraduates showed a significant tendency to judge type size as larger when the line spacing was greater than the point size of the type.

A further two children described the differences they saw in terms of the weight of the text. Both commented that the more closely spaced versions were darker than the more widely spaced. One of the two thought that the very close, close and normal versions were all dark and the wide version light, without noticing any differences between the former three. The other perceived a difference after being shown the two extreme versions together; he also thought that the very close spacing had 'a lot of writing,' and the wide spacing did not.

Although only half of the children who noticed a difference between at least the extreme versions were able to correctly identify the source of the difference (9 out of 18), the fact that three-quarters of the group were aware that there was a difference of some kind suggests that typographical factors such as line spacing can affect the child's perception of text. If this results in differences in perceived difficulty or attractiveness, it could in turn affect the child's motivation to read.

Responses to Questions 2 and 3: Easiest, most difficult and preferred versions

When the children were answering these questions, the four books (representing the four line spacing versions) were once again open at the same double-page spread. Of those who made choices in response to the questions, most were able to give one or more reasons. These can be categorized as follows (see table III):

- amount of space on the page (space)
- apparent size of the type (type size)
- apparent lightness or darkness of the type (type weight)
- how 'clear' the text was (clarity)
- apparent amount of text (amount of text)
- apparent number of 'hard words' (difficulty of words)
- how 'easy' the text was (this may have related either to the appearance of the text or its content) (ease)
- how attractive the text was (attractiveness)
- miscellaneous comments, for example on illustrations (other)
- no reason given (this includes comments such as 'because I like it') (no reason)

Table III shows the number of children who chose each version (bold type), and the numbers of children who cited each of the above reasons for their choices. It may be seen that eighteen of the twenty-four children were able to identify one

or more easiest versions, and twelve (two thirds) of these chose either the wide or normal spacing. Interestingly, while nine children chose the wide spacing and seven chose the very close, only three chose the normal and none chose the close. It may be that when asked which was 'the easiest' it was natural for them to choose an extreme version. Fourteen of the eighteen children were able to give one or more reasons for their choice. Their comments are given in tables IV and V.

The reasons given for choosing the wide or the very close spacing are of particular interest (*see table III*). Two children chose the wide line spacing version explicitly because of the spacing. Four children chose the wide spacing because they thought the type looked bigger, a previously documented illusion referred to above. A further child chose the wide spacing because she thought that the type did not look as dark. These are all reasons that are either 'correct' or easily explicable. On the other hand, of the children who chose the very close spacing as easiest, two thought that the amount of text varied between versions, one saying that the very close spacing 'has got not a lot of writing,' and the other somewhat curiously remarking that it was easier because it had more writing. Two children thought they saw differences in the number of 'hard words,' even though the content of the four spreads they were shown when answering these questions was the same. Another reason given was that the very close spacing version was 'more clear,' which seems an odd choice as the lines are so close together. Only one child referred to the line spacing, arguing that the very close line spacing was easiest because 'you don't have to search for which line you're on.' By this she presumably meant that she did not have to scan so far to get to the next line. These comments may suggest that the children who chose the very close line spacing as the easiest were having some difficulty in finding reasons for their choice.

Seventeen children were able to choose one or more most difficult versions. Seven thought that the very close spacing was the most difficult, four chose the close spacing, three the normal and five the wide spacing (*see table III*). Fifteen children were able to give one or more reasons for their choice. The pattern of reasons given for these choices is again interesting. Space, apparent size of type and apparent weight of type were the predominant reasons for choosing the very close and close spacing as the most difficult. Those children who chose the wide or normal versions as the most difficult gave reasons such as the relative amount of text or the difficulty of words. Given that they were comparing double-page spreads with identical content, this might again suggest that having made a choice (which was in five out of eight cases the opposite of their choice of 'easiest'), they were looking for a reason. Only one child mentioned space, arguing somewhat surprisingly that in the wide line spacing 'lots of lines get muddled up, you start reading the same line again.'

More children were able to say which book they would choose to take home and keep than to identify an easiest or a most difficult version. Twenty-two children identified a preferred version (*see table III*): eight children chose the wide spacing, eight chose the normal spacing, one chose the close spacing and five chose the very close spacing. Thus more than two-thirds of the group of twenty-four children chose either the wide or normal spacing versions. Nineteen of the twenty-two children expressing a preference were able to give one or more reasons for their choice. Of the eight who chose the wide spacing, all were able to give at least one reason for their choice; among the eight who chose the normal version there was a little less certainty, with two children unable to give a reason. Once again the spacing and the apparent size of the type accounted for a substantial number of choices but this question, being less specific than

Table IV Words used to describe perceived differences in spacing.

	Differences	Easiest	Most difficult	Preferred
Very close (A)	"doesn't have spaces, [D] does" "is line after line" "pretty squashed, pretty close together" "squashed, [C] isn't" "together" "close together, and [D] is not" "[sentences] are near to each other" "the words are closer together"	"you don't have to search for which line you're on"	"it's quite squashed" "all squashed up together" "[A] has no gap, [B] is less squashed together" has "teenier lines" "it's all squashed up together"	"the writing is really near together"
Close (B)	has "little sized spaces" "close, [D] is not" "[D] is spread out and [B] is together" "has small spaces, tinier than [C]" "not spreaded, [D] is"		"[A] has no gap, [B] is less squashed together"	
Normal (C)	has "middle-size spaces" "there are spaces between the sentences" "has tinier spaces than [D]" "more spreaded than [A]" "the 'O' is further away from the 'I' [at the start of two consecutive lines] than in [A]"			"it's got the most spaces, I like middle-sized [spaces]"
Wide (D)	has "big spaces, [A] doesn't" "spreaded" "[D] is spread out and [B] is together" "those bits [lines] are apart" "not close" "there's a space between the words"	"it's more spreaded out" "there are holes to tell which line you're on"	"big spaces, so lots of lines get muddled up, you start reading the same line again"	"it's more spaced out than [B]; [B] is pretty close, [D] is pretty spaced out" "it has bigger holes" "it's the more spread one" "to see the pictures I only have to move my head that much; in [A] and [B] it's up and down, up and down"

perception of the

'easiest'or 'most difficult,' elicited several comments on less well defined attributes such as 'clarity,' 'ease' and 'attractiveness' (*see tables III, IV and V*).

Of the children who chose the wide version, three mentioned the spacing (*see tables III and IV*). One of them commented that she only had to move her head a little bit to see the pictures, because the bottom of the text was nearer the picture than in the more closely spaced versions. Unusually, the child who chose the wide spacing on the basis of apparent type size thought that it had 'smaller writing.' Two children liked the wide spacing best because it looked 'more clear' to them, and this may be related to their perception of the space or the size of the type even if they could not explain exactly why it was clearer. One thought that the wide spacing 'is really attractive.'

functionality and

Reasons for choosing the normal version included comments on spacing, apparent type size and illustrations. The two children who chose the normal spacing on the basis of the apparent type size did so because they thought the writing was 'slightly bigger' or had 'big letters.' Perhaps related to overall impressions of the attractiveness of the books was the choice of the normal spacing book because of its 'funny pictures,' and because it 'looks real.' The

attractiveness

former was a mistaken perception as all four books were open at the same double-page spread, but the latter comment is interesting. The normal spacing was the default version and perhaps more similar to the texts the child was used

of the text was

to reading, suggesting that some children may prefer what they are used to.

influenced by variations

Table V Comments on perceived differences other than spacing.

	Differences	Easiest	Most difficult	Preferred
Very close (A)	"[A] and [B] have smaller writing" "a bit smaller than [B]" "medium writing" "dark" [A, B and C] "darker than [D]" "has the most writing"	"it has more writing" "has not a lot of writing" "it's got not many hard words" "the writing looks easier" "more clear"	"it has smaller writing" "it has a bit smaller writing" "it has smaller letters" "they are all dark" [A, B and C]	"it's easier to read" "it's the easiest" "it looks good"
Close (B)	"[A] and [B] have smaller writing" "a bit smaller than [D]" "dark" [A, B and C] "has lots of writing" "seems different"		"it's smaller" "it has teenier lines than [A]" "they are all dark" [A, B and C] "it's blurry"	"it looks like it's got more writing"
Normal (C)	"big" "[C] and [D] have bigger writing" "dark" [A, B and C] "a bit scribbly"	"[D] and [C] are bigger – [with] the smaller ones you can't see the words" "it only has three sentences"	"they are all dark" [A, B and C] "has lots of hard words and lots of sentences"	"it has big letters" "it's slightly bigger than [D] and than [A] and [B] – you can tell which words are there" "it looks real; it tells you what it's doing" "it's got funny pictures"
Wide (D)	"big" "[C] and [D] have bigger writing" "bigger than [A]" "a bit bigger than [A]" "light" "has lots of writing" "the "O"s don't have flicks"	"[D] and [C] are bigger – [with] the smaller ones you can't see the words" "it has bigger letters" "it has bigger writing" "it's bigger, better and easier" "not so dark"	"it has five sentences" "it's got lots of hard words" "the words look harder"	"it's got smaller writing" "the words are easy, words you can sound out" "it's more clear" "it's more clear than [B]" "the writing is really attractive and good to read" "because you can see everywhere" "it has nicer pictures"

The one child who chose the close spacing claimed that it had 'more writing' and presumably saw this as an advantage. Of the five who chose the very close spacing, only one gave the spacing as a reason. The others gave less well-defined reasons such as 'ease' and 'attractiveness.'

CONCLUSIONS

The lack of significant differences in the number of miscues as a result of the four typographic arrangements tested here suggests that, with realistic reading

materials used in a normal reading situation, children's reading performance is unlikely to be measurably affected by variations in line spacing comparable with those used here. This is not to deny that differences might be revealed by more sensitive methods using specially constructed nonsense text (as used by Hughes and Wilkins, 2000, 2002)), but our aim in this instance was to gauge the effect of line spacing on children's reading in a typical school or home situation.

While the children's reading performance was not significantly affected by the four line spacing versions, the qualitative data indicate that around three quarters of the children were sensitive to the variations in spacing even if they were unable to correctly identify the nature of the difference. Overall the children's comments suggest that line spacing comparable with our normal or wide versions is likely to be the most acceptable for the majority. Given that the normal spacing was typical of that seen in contemporary reading schemes for beginning readers, it would appear that current practice is generally appropriate but that no harm would be done by using slightly more generous spacing. However, some of the comments made by the children in this study do suggest that line spacing can be too open as well as too tight.

Some children were able to relate their judgments and preferences explicitly to the differences in line spacing, particularly those who found the very close spacing most difficult and the wide spacing easiest and who

preferred the wide spacing; others referred to perceived differences in other aspects of the text and its content. Most children based their comments on what they thought made the text easier or more difficult to read, while others appeared to be more concerned with visual appeal in a more general sense. Whatever the children's reasons, the fact remains that their perception of the functionality and attractiveness of the text was influenced by the variations in

can affect

line spacing tested. This may have implications when considering how best to make books appealing and increase motivation. It was clear from the comments made by some children that young readers may associate appearance and content. If the content is perceived to be difficult because of the appearance

perception of

of the text, this is likely to reduce the initial appeal of the book and may discourage children who attempt to read from it.

It is interesting to speculate about the extent to which children's opinions and preferences may be conditioned by the books that are currently available to

results in

them. While there was the occasional comment that suggested that a child had a notion of what a 'real' reading book should look like, many of the comments were clearly spontaneous and reasoned responses to the experience of reading

in perceived

from the different versions. It is important that publishers and teachers should be aware of such responses so that appropriate and appealing material can be

attractiveness,

produced and selected for beginning readers.

affect the child's

to read.

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window


window
white board
Student 3
Student 2
Student 1
Instructor's tall support table & bench
ructor
multimedia projector
students' desks & chairs
students'
students' desks & chairs
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Student
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Instructo
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Heloisa Moura

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Visible Language 40.3
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Analyzing Multimodal Interaction
within a Classroom Setting

ABSTRACT

Human interactions are multimodal in nature. From simple to complex forms of transferal of information, human beings draw on a multiplicity of communicative modes, such as intonation and gaze, to make sense of everyday experiences. Likewise, the learning process, either within traditional classrooms or Virtual Learning Environments, is shaped by learners' perceptions of what is being communicated multimodally to them intentionally or not, and by the perceptible pedagogical affordances of the environment.

This paper examines the specific place of action and multimodal interaction within the learning process. It starts by defining learning and multimodal interaction. Next, it expands on an existing methodological framework for analyzing multimodal interaction in order to include affordances for learning and to visually map the central role of action to learning. Finally, it makes use of the reviewed methodological framework to analyze a video ethnographic study of interactions that take place within a graduate Design classroom.

INTRODUCTION

Any view of learning reflects its underlying theories. In the present study, it is assumed that learning is situated in particular sociocultural contexts, and it is the result of mediated experiences that are afforded (Gibson, 1986) or constrained by interactions with the situation (King et al., 2001). In this way, the possibilities and limitations for action in particular situations affect learning. Furthermore, learning takes place whenever and wherever the individual is receptive. It can have different purposes or intentions, which, according to King, Young, Drivere-Richmond and Schrader (2001), can be classified into: a) objective-driven learning, such as in instruction; b) non-objective driven learning, such as in exploration; and c) unintended learning.

With regard to the relation between learning and multimodal interaction, it is possible to affirm that learning is woven with multimodal interaction. Discourse analysis studies in educational settings (Cazden, 2001; Adger, 2001; Mehan, 1979; Gumperz and Herasimchuk, 1975) have been trying to uncover the way in which talk in school is unique, helping to explicate the actions in which learning is realized. The emphasis on the linguistic aspect of classroom interaction, however, fails to account for the multiple fused semiotic modalities that together, rather than separately, help extend the understanding of the learning that takes place.

Jürgen Ruesch and A. Rodney Prestwood were pioneers in bringing embodiment as communication into the applied arena of the human sciences (Lanigan, 1995). In early multimodal studies, "Anxiety: Its initiation, communication and interpersonal management" (Ruesch and Prestwood, 1949) and *Communication and bodily disease: A study of vasopastic conditions* (Ruesch and Prestwood, 1950), the authors affirmed that the whole body can be looked upon as an instrument of communication. In 1951, Ruesch and Bateson, *Communication: The social matrix of psychiatry*, examined the asymmetrical communication interactions between psychotherapy supervisors and supervisees, taking note of the embodiment applications to communication and the diagnosis of stressed embodiment. For instance, within a group of the twelve women and nine men who had undergone major operations (Ruesch and Prestwood, 1950), the majority had significant problems with human interaction and social process. The negative embodiment was manifest in a number of communication factors in the patients' comportment, such as inadequate gestures, poor system of codification and inability to consider the double meaning of communication actions.

Within educational settings, multimodal studies are more recent. Kress, Jewitt, Ogborn, and Tsatsarelis (2001a) conducted a multimodal study of school-based teaching in order to challenge the assumption that learning and

teaching are primarily linguistic accomplishments, and not visual and actional. The authors show that classroom texts are realized through the interaction of different modes of communication or organized means of representation. For example, the construction of the entity 'cell' in a year 7 Science classroom involved speech, action – in the form of experimentation and image. The process of construction also involved the transformation of information across modes, e.g., verbal analogy to visual analogy, and experimentation into written report. Here, communication is extended to refer to all meaning-making systems.

Bourne and Jewitt (2003), for example, took a multimodal approach to understand the ways in which the interpretation of literary texts is constructed through social interaction. The authors look at a year 10 English classroom, showing that higher-order literacy skills are realized and constructed through the configuration of talk, writing, gesture, gaze, movement and posture. An example is the use of a diagram by the teacher to talk about the abstract notion of gender and link the behavior of male students to the characters in the story and men in general. The authors show that the understanding of teaching and learning is facilitated and extended through the multimodal analysis of social interactions.

The present study examines the specific place of multimodal interaction within the learning process of a graduate Design classroom. It also seeks to identify the classroom affordances for perception and interaction, and to visually map the central role of action to learning.

A METHODOLOGICAL FRAMEWORK FOR ANALYZING MULTIMODAL INTERACTION AND LEARNING

In order to build on an existing methodological framework for analyzing multimodal interaction, so to include affordances for learning and the visual mapping of the significance of action, it is important to briefly discuss, first, the concepts of affordances, multimodality, interaction and communicative modes, then, to present a framework developed by Sigrid Norris (2004a) and to point to expansions made for the analysis of a graduate Design class.

AFFORDANCES

Traditional classroom communication is structured by bodily experience (Rohrer, 1998) and so is learning. And since learning is always situated, each situation places limitations on the interaction and makes some activities possible. Here, possibilities for action are understood as Gibson's notion of

affordances (Gibson, 1986). According to Gaver (1991, 2), "affordances per se are independent of perception." They exist whether attention is being paid to them or not, whether they are perceived or not, and whether there is perceptual information for them or not. For instance, an apple affords eating whether someone is hungry or not. Affordances, in this way, can be called perceptible or hidden, depending on whether there is perceptual information for them or not. Hidden affordances must be inferred from other evidence. If the information available to an individual suggests a nonexistent affordance, then the individual might mistakenly try to act on a false affordance. In addition, the individual will usually not think of a given action if perceptual information about the affordance is not present. In conclusion, separating affordances from the perceptible information about them allows making a distinction among correct rejections, perceived affordances, hidden affordances and false affordances. The analysis of affordances can directly suggest implications for design.

MULTIMODALITY

According to Kress (2004), multimodality deals with all the means human beings have for making meaning, referring to the modes of representation, such as drawing or writing. The author affirms that each mode forces individuals into making commitments about meaning, whether intended or not.

Multimodality is based on the use of sensory modalities by which humans receive information, such as touch, vision, audition etc. and requests the use of at least two response modalities regarding presentation of information, like verbal and manual activity (Baber & Mellor, 2001).

The prefix 'multi' literally means 'more than one' and the term 'modal' refers to the notions of 'modality' and 'mode.' Modality relates to the type of communication channel being used to convey or acquire information, and the individuals have access to a wide range of them through which they typically interact. Mode refers to a state in which the way a piece of information is interpreted or extracted to convey meaning is determined. Some examples are: gesture, movement, sound-effect, speech, writing and image.

Modes can be realized in more than one production medium. Media correspond to the material resources used in the production of semiotic products and events, including both tools and materials (Kress and Leeuwen, 2001), like printed books, CD-ROMs or computer applications.

In a communication act, whether between humans or between a computer system and a user, modality, mode and medium come into play. The modality defines the type of data exchanged, whereas the mode determines the context in which the data is interpreted and media gives the material support.

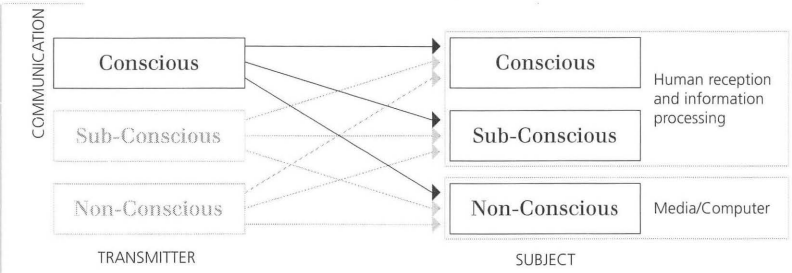
INTERACTION

According to Beaudouin-Lafon (2004), interaction can be viewed as a sensory-motor phenomenon, where the user input generates an output perceived by the user. According to Whittaker and Walker (1991), interaction can be seen as a negotiation process in which participants give and receive evidence for understanding in a manner that is incremental and concurrent.

Munck and Mayer (2000) describe interaction as a broader category within which communication is a specific type. It is the process of having a mutual effect, involving transferal of information with or without an intention behind it.

Interaction, in this way, can have nine forms of transferal of information — a conscious or intentional transmission of information that is received consciously, subconsciously or by a medium with no consciousness; a sub-conscious transmission of information, that is received in the same three ways; or a non-conscious piece of information, also received in the same three ways (*figure 1*). Communication, on the other hand, can have three of them — the ones where there is an intention behind the transferal.

Figure 1 Transferal of information (Adapted from Munck and Mayer, 2000)



By combining these views of interaction and communication, the authors conclude that certain types of perceived communication are not communication, but interpretation of signals and move to the re-definition of interaction. In this new approach, interaction is still rooted in the objectification of the subject, but instead of having a conscious human subject, it adopts a media with a faculty for being effected by the interaction. The interactivity of a situation, consequently, looks both at the ability of artificial or living entities participating in the interaction to objectify themselves as part of the exchange and the ability of the media to transmit this mutual effect, where purposes are mutually dependent.

According to Norris (2004a, 2), all interaction is multimodal and individuals' perception of everyday interactions is shaped by more than what is said. Human beings communicate through, for example, facial expressions, gaze, gestures, body posture and proxemics – or the distance between people. "All movements, all noises, and all material objects carry interactional meaning

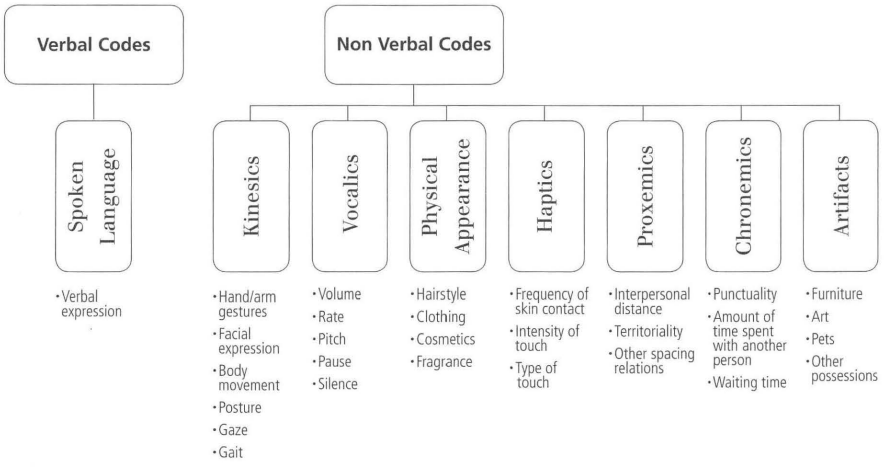
as soon as they are perceived by a person." Whittaker and Walker (1991) affirm that multimodal interaction should involve bidirectional communication through more than one modality.

COMMUNICATIVE MODES

Communicative modes, like head movement, gesture and spoken language are all systems of representation. Kress and Van Leeuwen (2001) affirm that a system of representation is a semiotic system that includes rules and regularities. In Norris (2004a), a communicative mode is never a static unit, but a heuristic unit, meaning that it can be defined in various ways and it has no clear boundaries. For instance, furniture can be a communicative mode or an element within the layout mode.

The behaviors that constitute nonverbal communication can be categorized into seven types of nonverbal codes, according to Ciccia, Step and Turkstra (2003), within which several communicative modes are found (*figure 2*): kinesics (messages sent by the body, including communicative modes such as hand/arm gestures, facial expression, body movement, posture, gaze and gait), vocalics (paralinguistic or vocal cues other than words, including volume, rate, pitch, pausing and silence), physical appearance (manipulable cues related to the body, including hairstyle, clothing, cosmetics and fragrance), haptics (skin contact cues, including frequency, intensity and type of touch), proxemics (spatial cues, including interpersonal distance, territoriality and other spacing relationships), chronemics (use of time as a message system, including punctuality, amount of time spent with someone and waiting time) and artifacts (manipulable objects in the environment that reflect messages from the user or designer, such as furniture, art, pets and other possessions).

Figure 2 Verbal and non-verbal codes



Blatner (2002) suggests thirteen categories of nonverbal communication: personal space, posture, gesture, pacing, eye contact, paralanguage, touch, adornment, physiologic responses, position, expression, locomotion and context.

Spoken language is a category from verbal communication that can be either heuristically defined as a communicative code or mode, including several sub-units, such as cooperative overlap (Tannen, 1984). Although usually sequentially organized, from smaller parts that add up to larger ones, it can also be realized simultaneously.

Proxemics refers to the ways in which individuals arrange and make use of their space. The distance individuals take from one another and in relation to relevant objects are both a focus of concern. Proxemic behavior is culturally conditioned and gives insight into the kind of social interaction that is taking place and the level of formality or informality involved. Hall (1966) distinguishes four types of distance: intimate, personal, social and public. This heuristic unit is sometimes defined as a communicative code and sometimes defined as a communicative mode.

Hall distinguishes four types of distance: intimate, personal, social and public.

Posture relates to the ways in which individuals position their bodies during interaction, including form of the body, such as open or closed arms and legs (Dittman, 1987) and postural direction taken by an individual towards others.

In the literature, gesture may refer to hand and arm movements only or include facial expressions and eye gestures. It is easier, however, to analyze them as separate communicative modes. According to Kendon (1978), hand and arm gestures are deliberately expressive movements with sharp boundaries of onset, including elements and a trajectory. According to Norris (2004a, 28), "hand and arm movements are often interdependent and concurrent with spoken language, slightly preceding the spoken discourse." Often, it is difficult to recognize the meaning of a gesture without language. The major types of hand/arm gestures can be classified into: iconic, metaphoric, deictic and beat. The face is a highly developed organ of expression. Facial expressions many times reveal feelings that the individual is not intending to communicate or even aware of (Ekman, 2002). Some examples are: pensive, amused, anxious or confused.

Head movement refers to the ways individuals position their heads, and can be distinguished between: rotational (shaking the head), lateral (tilting the head to the right or left) and sagittal (nodding movements).

Gaze relates to the organization, direction and intensity of looking, and it varies from culture to culture and subculture to subculture.

Other possible communicative modes are, for example: music, print, color, layout, dress, object handling and touch.

MULTIMODAL INTERACTION FRAMEWORK

Understanding the different communicative modes in isolation is the first step for understanding multimodal interaction (Norris, 2004b). One of the challenges for the analysis of multimodal interaction relates to the different structures of the various communicative modes, which may be sequential, globally synthetic, functional or appear randomly structured. Another challenge is the need to make clear links between the analysis of interaction and the analysis of a person's awareness, referring only to the awareness and attention that individuals express during interaction and to which others react (Norris, 2004a).

The methodological framework for analyzing multimodal interaction developed by Norris suggests that the communicative modes should first be defined and the actions, or interactional meaning units, identified next. The author classifies actions into: higher level (bracketed by an opening and a closing, such as a conversation and made up of a multiplicity of chained lower-level actions), lower-level (smallest interactional meaning unit, such as an intonation unit within a chain of units of intonation used during the conversation) and frozen (higher-level actions that are performed by an individual or group of people anytime before the interaction and that are entailed or frozen in the material objects, such as a magazine lying on the table).

Understanding the different communicative modes in isolation is the first step for understanding multimodal interaction.

Next, the communicative modes are analyzed separately. Then, the modes that are interdependent upon one another are analyzed in combination, with their hierarchical structure interconnected. Finally, all communicative modes are looked at together.

The analysis framework proposed here starts with the identification of the use of major patterns of time and space, which allows the visual mapping of the importance of action within the learning process. This step is followed by the selection of higher level actions for detailed analysis (for example, a conversation) and identification of the intermediate level actions (which are

smaller sequences of actions within a higher level action, for instance, 'Sally turns to John to ask what time they will need to leave, followed by John's reply') and lower level actions within each (such as an intonation unit); succeeded by the definition of the heuristic larger units or communicative codes of analysis (kinesics for example) and, within each, the heuristic units or communicative modes of analysis (such as facial expression), as well as the sub-units within each (like eye gesture). These steps are followed by the analysis of each communicative mode with all its sub-units separately, as suggested by Norris (2004a), then the communicative codes in combination, next the communicative code and, finally, the entire higher level action.

In order to include affordances for learning, the group of lower, intermediate and higher level actions are related to their affordances (Gibson, 1986) and perceptible affordances (Gaver, 1991) within a table.

LEARNING AND MULTIMODAL INTERACTION WITHIN A GRADUATE DESIGN CLASSROOM

This section presents a video ethnographic study of interactions that take place within a graduate Design classroom and the analysis of the multimodal interaction that takes place within it, as well as identifies the affordances for learning and maps the central role of action within the learning process. It starts by describing the classroom context and narrating the student demographics. The names of the instructor and students were removed; they are referred to simply as instructor and student A, B or C. The exact title of the class was also masked to protect the identity of the participants.

The class takes place in the evening, starting at 6:30 p.m. and ending at 9:30 p.m. The group of forty-four students is heterogeneous in relation to nationality, with thirty-three American students and the other eleven coming from countries such as South Korea, India, Thailand, China and Spain. There are equal numbers of male and female students. The age of the students varies from twenty-five to forty-seven. The educational background is also varied, with about half of the students coming from a Design background and the other half coming from many different fields, such as Engineering, Music, Physics, Mass Communication, Architecture, Psychology and Anthropology. According to the course plan developed by the instructor, "This foundation course takes us [the students and instructor] on a brisk journey to connect ideas ranging from the [class title] fundamentals, to modern frontiers of design and innovation [...]." The one page course plan includes a brief overview of the course, the format for the classes, grading opportunities, schedule and main topic covered and commentaries regarding class participation. The syllabus, however, lacks other common elements such as clear learning goals and objectives, a detailed course content structure, required readings, responsibilities, and grading standards.

The observed class was the second class in the a seven class sequence, following the introductory class where the students were presented with overall goals and structure for the course and were lectured regarding the fundamentals of the topic for an hour. Prior to the observed class, the students were instructed to form groups and work post-class on a presentation emphasizing strategies of the enterprise assigned to them, based on two articles given in class. As identified in the syllabus, the instructor for this course adopted a student presentation and discussion format. The affordances of this model will be discussed in the next section, which starts by discussing the use of time and space in the observed classroom.

USE OF TIME AND SPACE

The visual mapping and analysis of the use of time (*figure 3*) and space (*figures 4 and 5*) help provide a picture of the interaction that takes place in the observed classroom. In the same way, it assists in demonstrating the importance of action within the learning process. Figure 3 demonstrates how time is structurally used during the observed graduate Design class.

The class starts ten minutes late and ends thirty-five minutes after the scheduled time. In terms of chronemics, or use of time as a message system, this gives information about the instructor's position of authority, where students wait for the class to start and stay late until whenever the class finishes, instead of counting on a fixed schedule. The class is organized in clear blocks; it starts with announcements and attendance taken by the instructor and a short introduction to the topic, followed by ten student group presentations. Each presentation is followed by comments from the instructor and a brief question and answer session, open for the participation of the entire class. In between the student presentations, the class pauses for about ten minutes. At the end of the last presentation, the instructor closes the class with final comments.

The pedagogical choices made by the instructor regarding the structure of the class, created possibilities and constraints for learning (table 1). In addition to the affordances for learning available to students in face of the situation shaped by the instructor, it is also important to comment on the perceptible affordances, that is the affordances perceived by the students, or the ones they chose to make use of, for various reasons, within a larger set of existing possibilities.

The announcements and closing sections can be characterized as a one-way delivery of information (Oliver & Conole, 1999) by the instructor; students mainly listen to the messages and reply with answers that are directed to them individually or to the class as a group. All together, they take twenty minutes out of 3:25 hours. The announcement section sets the stage for what is going to happen in the entire class; this is where students get a big picture of how the

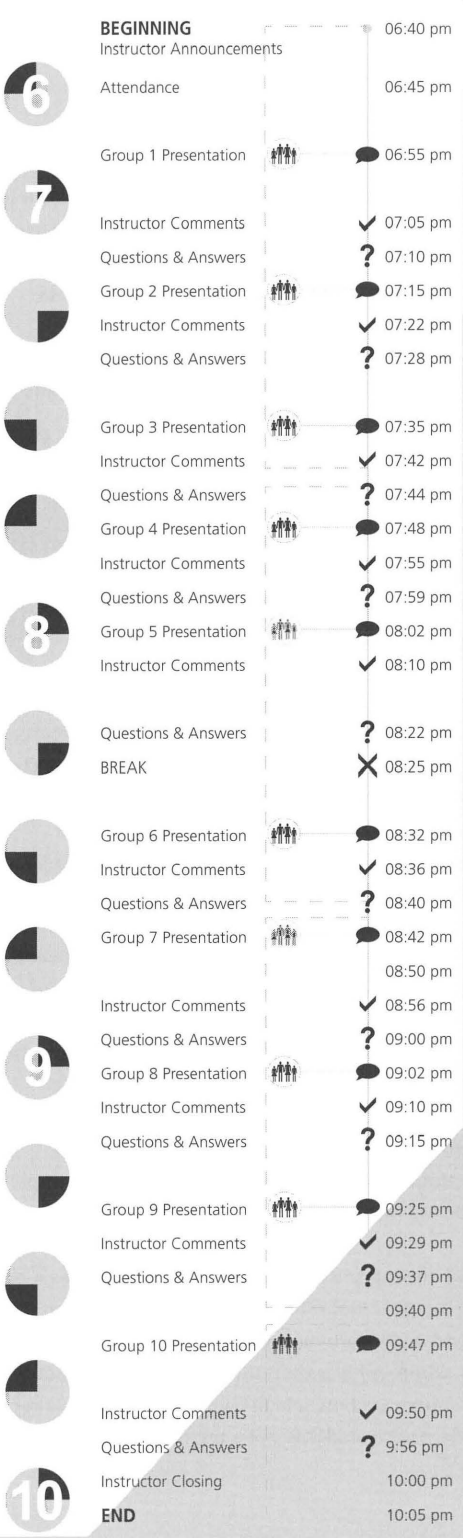


Figure 3 Use of Time

events will unfold. In addition, it also gets the different groups of students ready for their presentations, so they can flow from one to another smoothly. In this way, it is efficient in providing clear goals, which are, according to Laurillard, Stratfold, Luckin, Plowman & Taylor (2000), an important design feature that affords on-task talk, guiding the narrative and promoting the students' own narrative construction. An extract from the announcements section is: a) spoken language —"Did everybody get a copy of tonight's handout?" b) hand and arm movement —"raising paper with right hand above head and shaking it" c) deictic gesture after the hand and arm movement —"pointing to where the handouts are" d) head movement —"looking from one side to the other of the classroom, scanning to see if a student did not get the handout" and e)

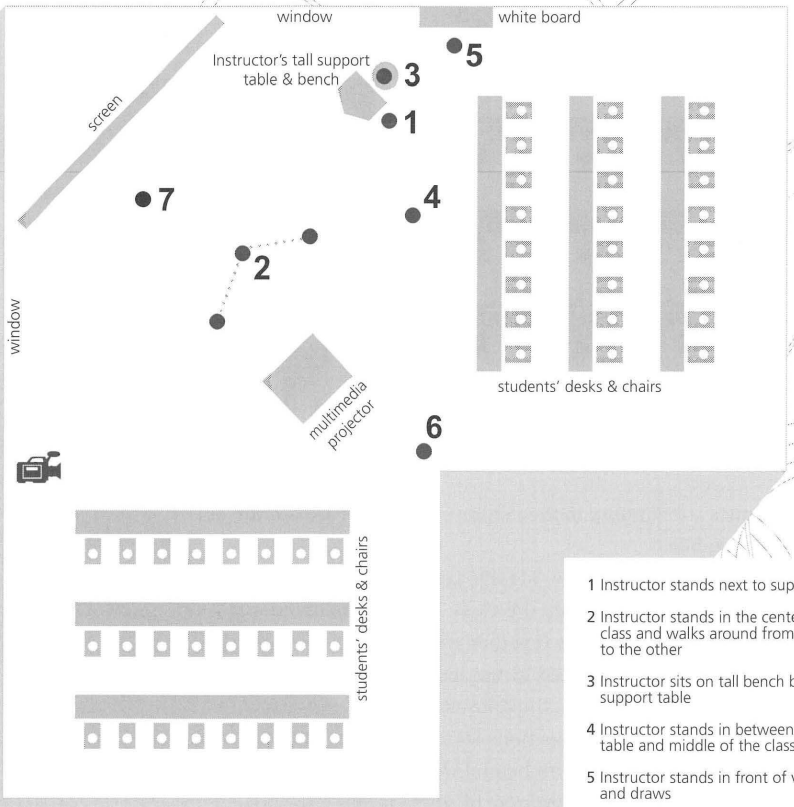


Figure 4 Instructor's Use of Space

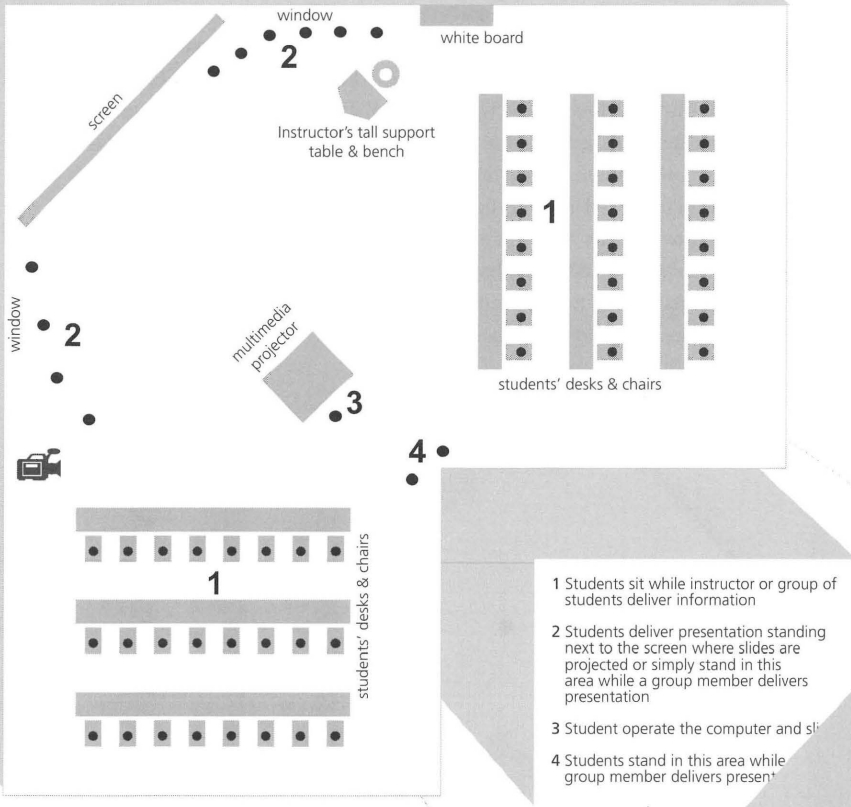


Figure 5 Students' Use of Space

proxemics —"standing in the center of the stage area of the classroom, with social distance."

The closing section, ideally, provides a space for systematization of the concepts viewed during the class. The systematization of the frameworks discussed during the class together with the goal of the presentations, however, were not provided by the instructor. Instead, the instructor made announcements related to the following class.

The presentation sections start with the indication of the deictic sign of the instructor, together with head movement, gaze and body movement. Groups one through ten, take an average of seven minutes to present, totaling 1:06 all together, despite being given only three minutes to present. At the start of each presentation, the lights are turned off, and, then, turned back on at the end. All student groups made use of the classroom's multimedia projector, showing both text, graphic and sometimes this activity can also be classified as one-way

delivery of information with limited affordances for learning, but in this case, the students are the delivers. One benefit of the group presentations, however, is that they presuppose a group interaction prior to the performance. And, in terms of affordances for learning, the group interaction indicates the prospect for hands on activity where the concepts taught on the previous class can be explored within a group, with opportunities for a two-way narrative construction among group members to emerge.

The instructor's comments at the end of each group presentation can be classified as assessment or feedback on performance (Oliver & Conole, 1999). It affords students the opportunity to reflect on aspects of their presentation, what went well and what did not in the application of the analysis frameworks. It also creates a space for asking questions and getting answers, which corresponds

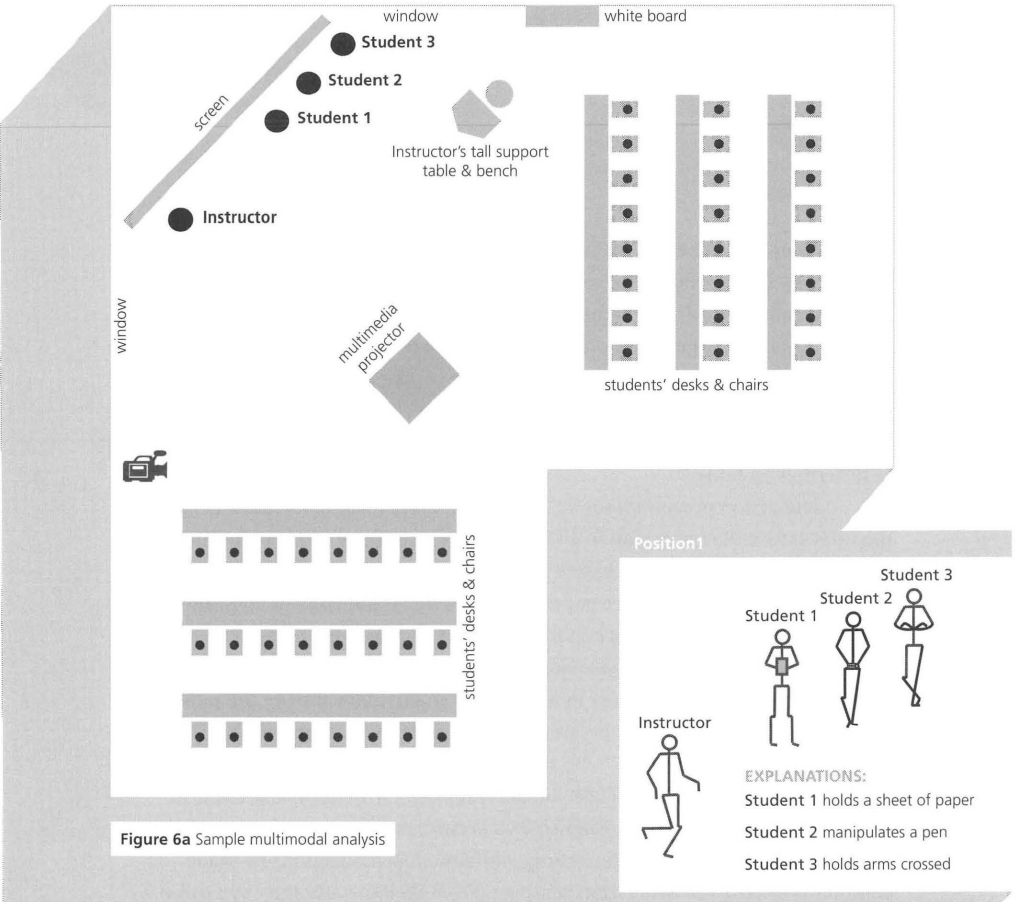


Figure 6a Sample multimodal analysis

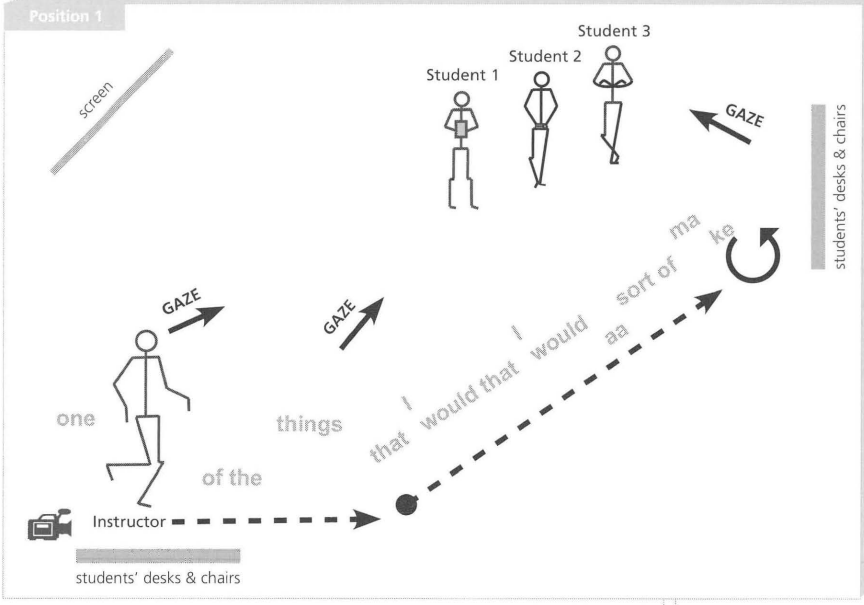


Figure 6b Sample multimodal analysis

to a two-way narrative construction (Oliver & Conole, 1999), with increased affordances for learning. The combined question and answer sections took forty-four minutes out of 3:25 hours. The group sizes ranged between four and five students. Not every student, nevertheless, had a chance to talk during the presentations. During these assessment sections, the instructor highlights both strong and weak points of the presentations. One example of this behavior is seen in the interaction between the instructor and one of the students from team A, described in table 2.

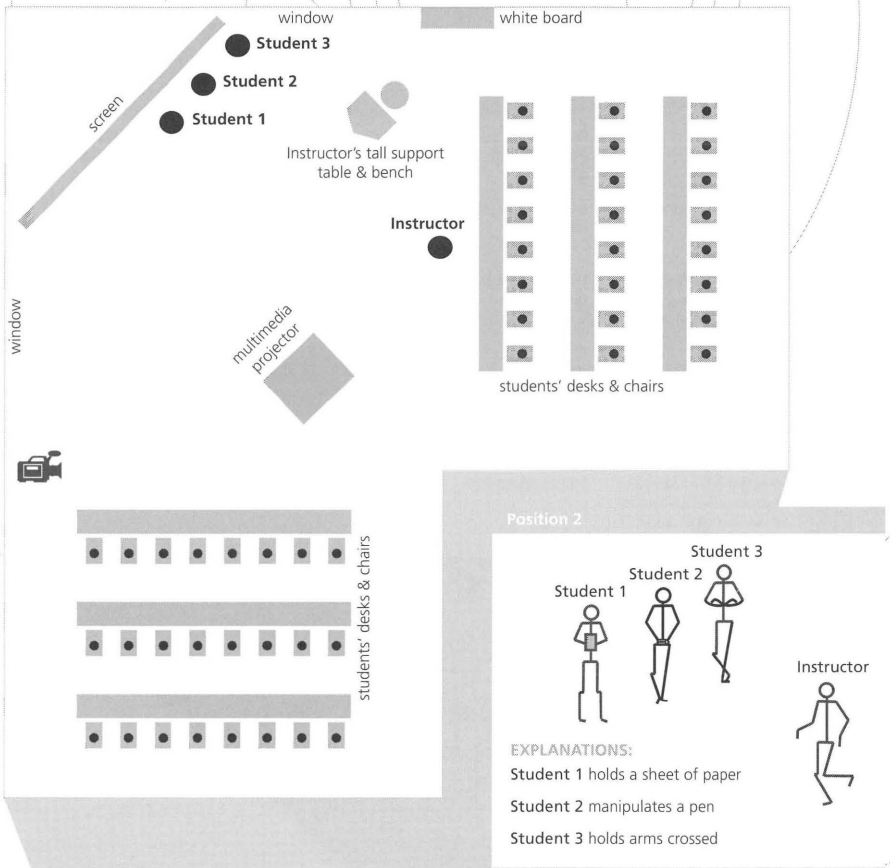
The group presentations vs. discussion class format, as described, takes the information delivery load from the instructor and places it on the students, which can be both good and bad. It can be good in the sense that it, ideally, empowers students to explore concepts and to be responsible to communicate them to a larger group in a professional way. It can also, however, lead to poor comprehension of the concepts explored, since there was no supervision during the exploration phase, and also to a feeling of inadequacy during the public evaluation of a presentation, in case it did not go so well. It certainly put students on the spot.

Considering that the class includes students from different cultural backgrounds and who speak English as a second language, it is important to point to the fact that no international student posed questions or made comments during the discussion sessions. Four US male students and three

US female students made comments and asked questions during the class, and two of these male students were the ones who spoke more frequently. So, the international students only spoke during their group presentations. Another interesting issue is the formation of the groups. There was little mixture of nationalities within the groups. So, seventy percent of the groups were either formed by US students only or international students only. And among the groups formed by only international students, some consisted of students of a single nationality. These behaviors indicate the inefficiency of the selected class format in terms of promoting a two-way narrative construction with the participation of the entire class, and of promoting the integration of students with different cultural backgrounds, once the instructor let the students pick the groups themselves.

In relation to use of space, Figures 4 and 5 illustrate the positions taken by the instructor and students during the class. Looking at the stage area, it is noticeable that the instructor explored the space fluidly, while the students

Figure 6c Sample multimodal analysis



remained at its borders, either near the screen at the corner of the classroom, next to the window, behind the multimedia projector or sitting at the student desks in the "L" shaped classroom.

Among the higher level actions taken during the classroom interaction, the one briefly examined on table 2 and figures 6a, 6b, 6c and 6d, when the instructor gives feedback on student performance, demonstrates how the analysis can be dynamically conducted, either through text or images (*figures 6a, 6b, 6c, 6d and 7*). This higher level action can be subdivided into several intermediate level actions — one of them was pointed out in the analysis in the table and figures just cited, when the instructor walked around the stage area while talking to the students. Among the lower level actions that composed the intermediate and higher level actions examined, one example was the instructor's eye gesture, when he looked upwards, reflecting about what he was saying to the group of students. Among the communicative codes of analysis examined in the example and earlier in the paper, the following are included: spoken language, kinesics, proxemics and chronemics. And among the communicative modes of analysis are: gaze, posture, gesture, hand and arm movement and head movement.

Table 1 Affordances for learning

	One-way information delivery	Two-way narrative construction	Hands-on Practice (in team)	Feedback on Performance
Affordances (Possibilities for action)	Listen, ask, reply, take notes	Communicate, ask, reply, listen, learn	Experiment, explore, learn	Reflect, review, reformulate, plan, learn
Perceptible Affordances - to anyone (Possibilities for action that at least one person notices)	Listen, ask, reply, take notes	Communicate, ask, reply, listen	(Not available to researcher)	Support criticism, clarification
Imperceptible or Hidden Affordances - to most (Possibilities for action that most people do not notice)	Ask, reply	Communicate, ask, reply	(Not available to researcher)	(Not available to researcher)
Selected Affordances - by most (Possibilities for action that most people make use of)	Listen, take notes	Listen	(Not available to researcher)	(Not available to researcher)

Table 2 Interaction between instructor and one team A student

Actor	Action	Verbal Communication	Non-verbal Communication	Space	Time
Instructor	A) Higher level action: instructor feedback on student performance, **A.1)** Intermediate level action: instructor walking around the stage area making comments on the group presentation, **A.1.1)** Lower level actions: spoken language units, and selected gaze, posture and head movement units	A.1.1.1.a) **Communicative code:** Spoken language, **Communicative mode:** Verbal expression: "One"	A.1.1.2.a) **Communicative code:** Kinesics, **Communicative mode:** **Gaze:** instructor looks at the three students being assessed, who are standing near the window, as illustrated in figures 6a and 6b	**Location:** Instructor at position 1, figures 6a and 6b	7:05:10
		Verbal expression: "of the things that I would that I would aah sort of make"	**Gaze:** looking to where he is moving to	**Location:** from the word "one" till "make," the instructor walks to the right side of the stage area, moving towards position 2, illustrated in figures 6c and 6d	7:05:11
		Verbal expression: "a point about"	**Head movement:** instructor turns face to three students being assessed; **Gaze:** instructor gazes at one of the three students	**Location:** position 2	7:05:17
		Verbal expression: "if it were me doing the kind of [class subject] you guys were doing"	**Posture:** instructor poses right hand under elbow and left hand holds chin, legs are semi-open with feet slightly pointing outwards **Eye gesture:** eyes look to ceiling, indicating reflection	**Location:** instructor reaches position 2 and turns his body back towards the three students being assessed	7:05:19
		Verbal expression: "One of the things that I would probably would have added is a North star through it"	**Gaze:** instructor gazes at three students being assessed	**Location:** position 2, towards the 3 students	7:05:26
		Verbal expression: "It is sort of the number of people using the various technologies"	**Gesture:** instructor moves hand from chin to the side, with the palm of the hand upwards and with a curved shape like a shell, representing the quantity he is talking about, and then moves hand back to chin	**Location:** position 2, towards the 3 students	7:05:35
Team A Female Student		**Verbal expression:** "That is something"	**Posture:** student stands with her arms crossed, in a closed and defensive position, plays with left leg as if dancing, indicating she is trying to relax, towards an open leg standing position, indicating she is ready for action	**Location:** Student at position 3	7:05:40
		Verbal expression: "that came through towards the end and we did not have time"	**Gaze:** Looking at the instructor	**Location:** Student at position 3	7:05:42
		Verbal expression: "to put it together"	**Head movement:** rotational head movement, indicating negative	**Location:** Student at position 3	7:05:45
Instructor		**Verbal expression:** "Yep"	**Head movement:** saggital head movement, indicating affirmation	**Location:** position 2 towards the 3 students	7:05:47
		Verbal expression: "it it it sort of fits."	**Gaze:** Looking at student 3, from team A (figure 6d)	**Location:** position 2 towards the 3 students	7:05:48

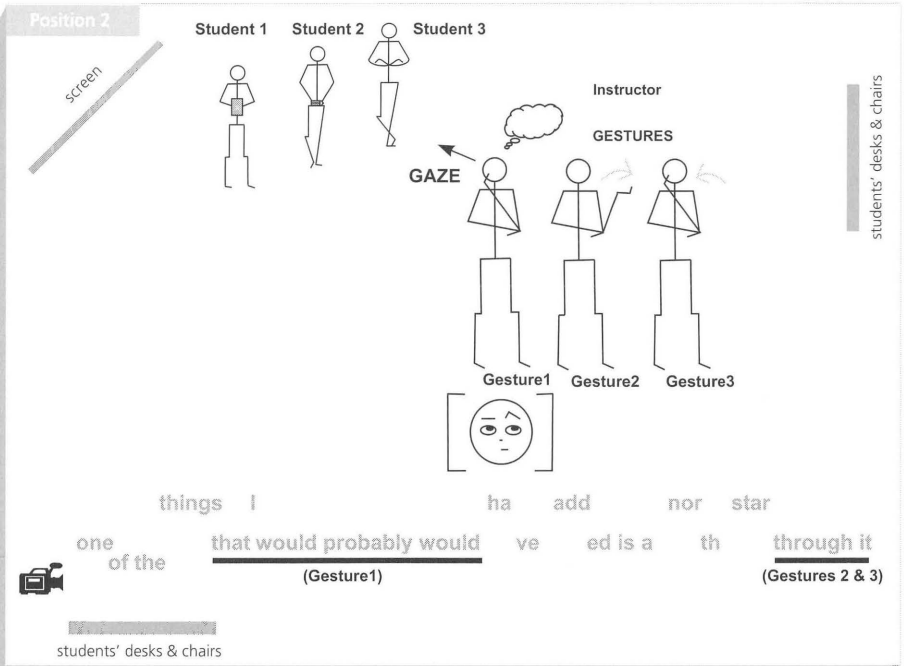


Figure 6d Sample multimodal analysis

In this way, the proposed analysis framework moves from the macro-analysis, through the identification of use of patterns of time and space, to increasing levels of refinement in the analysis, through the identification and examination of the higher, intermediate and lower level actions and the heuristic units of communication, including codes and modes. This process allows both a telescopic and microscopic view of the multimodal classroom and how interactions unfold.

CONCLUSION

The present study sought to expand on an existing multimodal analysis framework, in order to include the classroom affordances for perception and interaction, and to visually map the central role of action to learning. The original framework is characterized by the identification of higher and lower level actions, together with the definition of the heuristic units of analysis or communicative modes. The strategy of analysis moved from the individual analysis of the various communicative modes, to the combined analysis of the interdependent ones, and finally to the analysis of all communicative modes together.

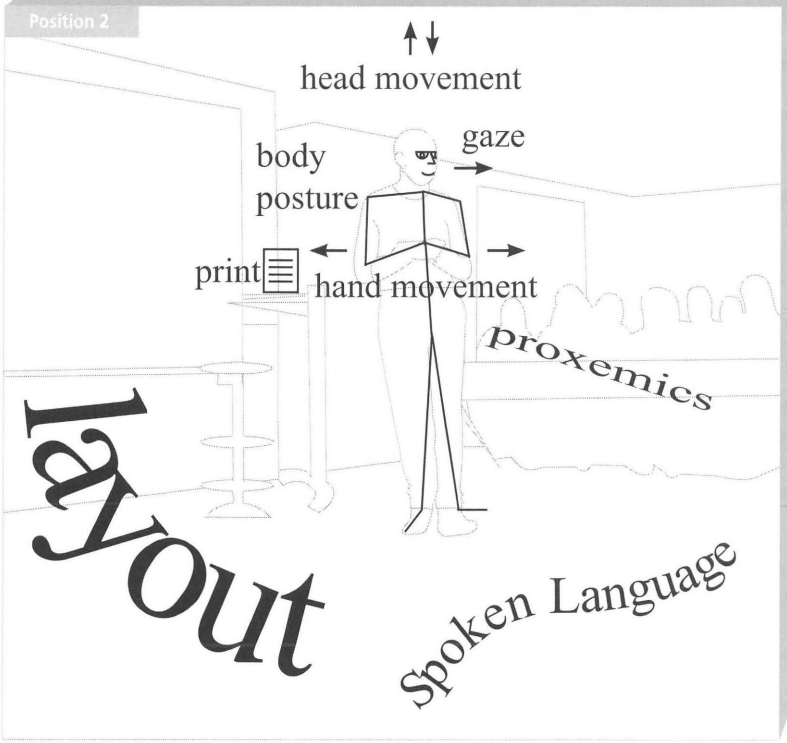


Figure 7 Sample multimodal analysis

The proposed framework moves from the macro-analysis, through the identification of use of time and space, to increasing levels of refinement in the analysis, through the identification, selection and examination of the higher, intermediate and lower level actions and the heuristic units of communication, including codes and modes. The strategy of analysis in the proposed framework uses the macro level phase to identify the major interaction units that need to be explored in the micro level analysis, instead of analyzing all the interaction units. In this way, it makes the analysis more time efficient and adaptable to the researcher's goals within a project.

A video ethnographic study conducted in a graduate Design classroom was used as an illustration for the application of the expanded analytical framework. The process included the visual representation of the various phases of the proposed framework, including: the graphic representation of multimodal analysis across time and space and a table representing all the different levels of analytical units.

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Typography
Behind the Arabetic Calligraphy Veil

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ABSTRACT

In the change from scriptural writing systems to textual mechanical systems and most recently to digital, computer generated text, some languages and their typographic representations have suffered. One such language, along with its visible language representation, that has not made a smooth transition is Arabic. The author argues that misinterpreting language tradition prevents what he calls Arabetic typography from embracing an appropriate technological adaptation. Putting forth an evolutionary argument, he critiques the notion that calligraphic styles must prevail and that legibility and readability of Arabic characters are objective. He further states that the resulting typefaces, when the so-called 'Arabic script rules' are abandoned, are similar in visual impact to the 'free calligraphy' typefaces already widely used in the marketplace. Finally he challenges the notion that technological maturity has been reached in digital character input and generation. Following these critiques, he demonstrates the awkward input system for Arabetic text and proposes a Natural Arabetic Input Method. A political and economic subtext runs throughout the essay

INTRODUCTION

Arabetic typography is clearly a subject still surrounded with intense debates. As an international field, the forces governing its progress are still primarily in the western world despite efforts by many to make it look otherwise. This is not surprising since the defining technology behind Arabetic computing continues to be developed outside the Arabic and Muslim worlds, unlike many other scripts where local expertise and innovation are increasingly dominant with international corporations playing a key role. In our global interdependent economy, driven by global technology, Arabetic typography and computing have much less opportunity to freely evolve through local intrinsic forces as others did, especially when it is being restricted by today's complex high tech solutions. But fortunately it does not, and would not need to, do it locally. Instead, Arabetic typography needs only to adhere to the rules of global competition, economical and technological, to succeed, flourish or even survive. Arabic should once again be faithful to its historical past of creative flexibility and adaptability. It should embrace technology by becoming an independent loyal partner to it, not a dependent burden on it. It should embrace simplification and abandon exaggerated rules that compromise both its users and its ability to survive global competition. Arabetic typography must free itself from its handwriting-imposed conventions in a script world not governed anymore by handwriting rules alone.

WHY ARABETIC? WHY NOT ARABIC?

For a careful reader, the first question for this essay should be: why Arabetic and not Arabic? When we first used the word Arabetic in an article about Arabetic typography, we argued that for those involved in the fields of Arabic and derived scripts, Urdu, Farsi, Pashto and Kurdish, for example, there is no single, clear and user friendly Latin word to address them all at once (Abulhab, 2004). A term like 'Latin' can acceptably be used to refer to all Latin based scripts. One can obviously use the limiting word 'Arabic' alienating many in the non-Arabic speaking world or even invoking their objections, let alone compromising intellectual and scientific facts. But also, in our current world's political and economical picture, the need for a unifying term is essential. Arabetic is a unifying term. It has enough flavor of Arabic for the Arabs to appreciate and take appropriate credit for. But at the same time, it is not pure "Arabic," which can justifiably cause sensitivity and may even sound dismissive of those historically crucial and defining contributions of non-Arab users, calligraphers and civilizations to the Arabic language and script. Arabetic is a single, inclusive and unambiguous word to address all these scripts at once without compromising their distinct and unique characteristics.

Using one word to address all Arabic based writing systems is not an artificially proclaimed necessity nor is a cosmetic contribution. Behind our one

term is an explicit call for unity and therefore strength. Typography projects are complex, costly and time consuming. The economics of typography has its own independent factors. The days when a nation would emphasize a calligraphy style as a sign of its power and grace are gone. Today for example, Western typographers design for multiple Latin scripts, contributing positively to the availability, user choice and economics of Latin typography as a whole. Internationalization and Unicode have even paved the way for creating fonts with harmonized multi-script styles. Insisting on presenting Naskh Taliq as uncompromising separate national identity script styles can only hurt the typographical and technological development of Arabic, Urdu and Persian scripts. Arabetic type designers must create commonly accepted and used typefaces in order to survive globally. They must work jointly to make available rich Arabetic font libraries not exaggerated exclusive national type styles.

Using one word to address all Arabic based writing systems is not an artificially proclaimed necessity nor is it a cosmetic contribution.

It is not very clear in my mind why such a word did come about historically. Was it because western colonialists were not interested in a word that can have a lasting, meaningful, unifying effect on the Muslim world? Or was it a byproduct of an orientalist mentality as explored by Dr. Edward Said who argued in his book *Orientalism* (1978) that most western philosophers and thinkers of past centuries simply treated the world outside of Europe as a single entity not worthy of its rich diversity.

LIFTING THE ARABETIC CALLIGRAPHY VEIL

It is not an exaggeration to place Arabetic calligraphy in a class of its own when evaluating its power and beauty. In a few decades after Islam, the Arabs have evolved from people who primarily and fascinatingly memorized words and poetry to one of the most sophisticated script using people in the world. The Quraan, being both their main religious and law (shareeah) book was one of the key forces behind that leap. Centuries later, both the art of reading Quraan aloud (tajweed) and the art of drawing its words and letters (calligraphy) became among the most magnificent, captivating and powerful forces of Islam. Most calligraphy schools revolved around Quraanic text. But unlike the untouchable and unarguable words of god in the Quraan, the Arabic script itself was open

to change, adaptation and artistic creativity. One must point out that Muslims today write the Arabic words of Quraan even in Latin or other scripts without the slightest objection from Muslim religious scholars. The myth repeated by many that Arabic is a sacred, untouchable script or language is just that: a myth. On the contrary, historically, Arabic proved to be a very adaptive script both for Arabs and non-Arabs alike.

The magnificence and beauty of Arabetic calligraphy was without a doubt the leading force behind keeping its underlying scripts away from the popular move of world scripts toward a meaningful simplification in the age of typography. In a way these scripts became victims of their own success. But one must not blame the success of Arabetic calligraphy solely and forever. Calligraphy specified unique rules for specific styles but never for the scripts themselves. The doors were wide open for the emergence of calligraphic styles, radically different from each other or from the most common ones. In its defense, calligraphy had never eliminated the basic abstract shapes and characteristics of the Arabic letters. The look and feel of an Arabic letter has survived the dictates of the art of calligraphy. More or less, with or without those exaggerated added 'serifs' for connectivity and/or directionality purposes, the letter "Alef" was and still is a vertical line; the letter "Baa" was and still is a horizontal line with one dot under; the letter "Taa" was and still is a horizontal line with two dots above, and so on. (*See figures 1, 2 and 3.*) The concept of the so-called 'Arabic script rules' is a concept introduced by modern Arabic typography in its continuing struggle to impose standards for duplicating the prevailing calligraphic styles on the machine. It is more a corporate and business concept than it is a genuine Arabic script concept.

Behind our one term is an explicit call for unity and therefore strength.

There is no historical evidence that letters of Arabic or Arabic-derived scripts must follow certain fixed glyph-changing rules. Various Arabic calligraphy schools introduced two, four or many more shapes per letter as required by their specific style harmony. This clearly shows that the Arabic script has no fixed rules. It is certainly not confined by the rigidly defined multiple shapes per letter model that is implied by USP10.dll. Certainly, a one-glyph per letter can be yet another model based on its open variable shapes approach. Nor is there historical evidence of rules dictating that Arabic letters must appear connected. The Arabic script had most likely evolved from the one isolated shape per letter model of the old Southern Arabian Misnad script to its more practical and economical connected forms as was required by the world of scribes where speed and productivity is crucial. This evolution was a natural

And smart one. But it was not unique to Arabic. Old Cyrillic, Hebrew and other scripts used similar multiple shapes per letters as dictated by adjacent letters or mark combinations. The key concept of the argument here is that Arabic has no fixed rules other than the natural rules of evolution and adaptation. Arabic was and still is as free to adapt new appropriate forms as ever.

The beauty and innovation of the Arabetic calligraphy was a direct beneficiary of its exaggerated freedom to veil basic Arabic letter abstract shapes. Without a doubt, the blown-up letter connectivity approach contributed significantly to its calligraphic and artistic openness and diversity. The key to its success was the excessive freedom available to the hand of the calligrapher.

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ص ض ط ظ ع غ ف ق ك ل م ن ه و ى ي

بسم الله الرحمن الرحيم. الحمد لله رب العالمين. الرحمن الرحيم. مالك يوم الدين. إياك نعبد وإياك نستعين. إهدنا الصراط المستقيم. صراط الذين أنعمت عليهم. غير المغضوب عليهم ولا الضالين. قل هو الله أحد. الله الصمد. لم يلد ولم يولد ولم يكن له كفوا أحد. إقرأ بسم ربك الذي خلق. خلق الإنسان من علق. إقرأ وربك الأكرم. الذي علم بالقلم. علم الإنسان ما لم يعلم. صدق الله العظيم.

ويعد هذان التمثالان إضافة إلى عدد آخر من التماثيل التي عثر عليها في المناطق المجاورة ما يسمى التماثيل "السحلية" وذلك نظرا لمظهرها المشابه للزواحف. والذي يعود أساسا إلى شكل عيونها المشابه لحبوب القهوة وشكل رؤوسها المستطيلة، الذي من المحتمل أن يكون راجعا إلى القماط في فترة الرضاعة. كما تم استعمال القار لإظهار الشعر، وقد تشير الكريات الطينية أو العلامات المصبوغة على الكتف إلى الوشم أو إلى القرابين.

Figure 1 Sample Arabic text using 'Arabetic San Serif' font designed by the author.

To create beautiful calligraphic styles, a calligrapher would veil the visual identity of an Arabic letter leaving ample evidence of its defining characteristics.

The multiple shapes per letter still shared very similar common visual characteristics; defining letter characteristics were preserved. In a way, this is a parallel example to the classical case of a veiled woman's beauty wherein a veil, no matter how exaggerated, can never suppress or eliminate her beauty, but to the contrary for many eyes, it enhances it. Centuries of elaborate calligraphic veiling practices had not eliminated the basic shapes of the Arabetic letters or their unique and defining visual characteristics, beauty or functionality.

ء آ أ ؤ إ ئ ا ب ت ث ج ح خ د ذ ر ز س ش

ص ض ط ظ ع غ ف ق ك ل م ن ه و ى ي

بسم الله الرحمن الرحيم. الحمد لله رب العالمين. الرحمن الرحيم. مالك يوم الدين. إياك نعبد وإياك نستعين. إهدنا الصراط المستقيم. صراط الذين أنعمت عليهم. غير المغضوب عليهم ولا الضالين. قل هو الله أحد. الله الصمد. لم يلد ولم يولد ولم يكن له كفوا أحد. إقرأ بسم ربك الذي خلق. خلق الإنسان من علق. إقرأ وربك الأكرم. الذي علم بالقلم. علم الإنسان ما لم يعلم. صدق الله العظيم.

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Figure 2 Sample Arabic text using 'Arabetic Serif' font designed by the author.

Figure 3 The letter "Alif" in major traditional Arabetic calligraphy styles

THE POLITICS OF ARABETIC TYPOGRAPHY

Discussing Arabetic typography issues are almost always accompanied by emotion and very legitimately related political debates. One should not shy away from or dismiss the importance of such debates. After all, calligraphy, typography, scripts and language are cultural phenomena directly related and governed by real life international or national political, economical or religious factors. Denying and suppressing this fact is by itself a biased, politically motivated, stand. Many topics are repeatedly brought up when debating Arabetic typography but singled out here are four of the most crucial ones.

The first topic is related to the politics and controversy surrounding change. Many have called the use of one isolated shape per letter a move to 'Latinize' a national script. For the sake of argument let us assume that Latinization is simplification. But Latin has no patent or monopoly on the process of simplification, it is not its inventor or owner, and it can hardly claim it alone. There is no doubt that evolution is an eternal fact like life and death. Evolution has its own internal forces and cannot be stopped. We can only leave our mark on it, divert it or distort its natural course. Accepting the fact of natural evolution is our duty when dealing with 'living' beings including a national script. At the heart of evolution is adaptation, with simplification being one of its complex processes. In a way, today's televisions,

radios, telephones, computers and programs, are very simplified versions of the old ones. Scripts can adapt to both a social environment like language and a materialistic environment like technology. Someone of a specific nationality invents technology, but the basic laws behind it are natural laws that have no cultural flavor. The Arab world invented Algebra or Chemistry, but utilizing them today is not Arabization. Manufacturing automobiles in China or wearing jeans is not Westernization. Simplifying Arabic to smoothly utilize movable printing machines or today's computers is not Latinization or Orientalization. Calling efforts to simplify the Arabic script 'Latinization' is at best absurd. But it is probably a lot more than that. It is a politically motivated stubbornness. Especially when voiced by those who are advocating designs to ensure that Arabic text would look 'good' and 'harmonious' next to a Latin text! These designs, despite their absolute legitimacy, can really be called 'Latinized' since they abandon the main visual characteristics of Arabic, variable x-heights and horizontality, in favor of Latin visual characteristics. When we look around us today we see that Arabetic typefaces have changed significantly from fifty years ago. The evolution and adaptation process has already taken its course. Hundreds of Arabic fonts, legible and very acceptable to users, have radically different look and feel from the previously prevailing calligraphic-like type styles. But unfortunately that radical look and feel has not brought any substantial benefits to the Arabic script regarding its competitiveness or future global survival. In a way, we have sacrificed the beauty of Arabic calligraphy for extremely low return. The main cause of this constrained evolution is the imposition of those arbitrarily defined 'Arabic script rules.'

Evolution has its own internal forces and cannot be stopped. We can only leave our mark on it, divert it or distort its natural course.

The second favorite debate relates to theories about legibility and readability of scripts. While there is some partial truth in the scientific arguments presented in such theories, they should not be taken for more than what they are: pure theories. They do not amount to definite, absolute, complete, scientific facts. But most importantly, even if they were true facts, these theories can only apply in relation to an existing and established script style. The clarity of a glyph image is relative to what the human eyes and brain perceive that image to be in the first place. This process is governed by both habit formation and practice. Just as it is absurd to compare two different scripts in terms of their legibility or readability characteristics it is absurd to compare two styles of the same script. A calligraphy imitating Arabic script style is more readable

only because most of us grew up with it. Arabic Naskh style is more readable today than Kufi, because ninety percent of the Arabic books and newspapers are printed in Naskh instead of Kufi. Persian readers are more comfortable reading text in Naskhtaaliq than in Naskh because of habit formation not the claims of readability and legibility theories.

Third is the argument of those who claim users will never accept radical change. But they did in front of our eyes and eagerly! Just browse a few magazines or websites in the Arab or Muslim worlds. Examine the beautiful so called 'free calligraphy' typefaces in the market today. They are as unconventional as our proposed, truly free, 'Arabic script rules' challenging typefaces, but unfortunately adding no significant value for the future of Arabetic scripts. In addition to being a claim not based on any actual and neutral surveys, research or facts, this dismissive negative position reflects a distorted understanding of what the word 'accepts' means in the age of typography. Let us say that one percent of users will accept new unconventional typefaces, isn't that a very legitimate user acceptance? Isn't that how users gradually accept any new product? But most important, why does anyone, expert or not, corporation or influential individual have the right to speak and act on behalf of users, an action that can effectively be translated to censorship? Typography today is about options and choice. It is about display as much as about text. Type designers and software producers have an obligation to serve their customers by presenting options and preserving user freedom of choice to ensure customer satisfaction for all. New and old styles can live together for a long time as change is rarely an abrupt overnight jump.

Typography today is about options and choice. It is about display as much as about text.

Fourth and finally, we must discuss the very popular, self-praising and over confidant claim that current developments in typography are very advanced and mature, therefore there is no need for change anymore. Even those who advocate simplified Arabic typography in the past found refuge in this very damaging assertion. In addition to being not actually true, this claim may reflect a lack of understanding of the mechanism of technological evolution and the economic factors at its heart, a lack of appropriate technical expertise and experience or even a lack of respect for Arabetic scripts. Technology is a constantly changing phenomenon. No software or hardware product will forever be tied to any current stage of a technological evolution cycle. Technology solutions today may not necessarily be appropriate tomorrow. Economics determines the next stage of all technological developments. Scripts must

The Arabetic scripts should not constantly be waiting in the dark under the captivity of future dll versions and upcoming software applications.

be prepared not only for current technology but for future unknown ones. The Arabetic scripts should not constantly be waiting in the dark under the captivity of future dll versions and upcoming software applications. Furthermore, producing Arabetic typefaces after investing thousands of hours of unique technical expertise runs contrary to Arabetic typography competitiveness and its future no matter how magnificent the resulting work is. Creating or technologically implementing common Arabetic typefaces should not require any unnecessary additional expertise or knowledge of complex and sometimes 'primitive' tools.

Moreover, the technological solutions available today for Arabetic computing are not educationally intuitive or user friendly. Reliance on the so-called smart font glyph-substituting approach introduced a hyper model in which glyphs are constantly and annoyingly changing shapes. In addition to violating the actual natural Arabetic input process, this alien model is discouraging and unattractive to new learners. And to add insult to injury, this 'dancing glyphs' model was further supplemented by the imposition of a complex bi-directional overhead requirement leading to a hyper complex environment where glyphs, spaces, punctuation and cursors can potentially change even their positions in front of users' eyes.

Let us examine this further. In a bizarre decision of the influential Arabic computing circles, we were told that Arabic, a clearly and predominantly right to left script, was really a bi-directional (bidi) script since users write numbers in a left to right order for fifty percent of the cases. This was a legitimate and valid observation, but to solve this impossible obstacle, the great Arabic computing minds introduced a model where users would input numbers correctly for this fifty percent of the cases, but now input them incorrectly for the other fifty percent of the cases! All for nothing, they added an annoying model that users do not really need for most of their normal daily activities. In actuality this bidi environmental 'trap' is only important for the less frequent situation of mixing left to right scripts with Arabic within a single paragraph. As for dealing with numbers, during the Arabic typewriter era, when numbers were keyed in always from right to left, this was not completely useless. But we must admit that the bidi model can be useful in heavily mathematical or accounting documents containing extra long numbers. Bidi should therefore become an option not the

norm; Arabic has enough problems on its own without this. Table 1 illustrates to those unfamiliar with Arabic what a user has to go though when typing Arabic in a typical bidi environment word processor today, with text aligned left. It demonstrates a hypothetical example substituting an English equivalent typing string "abC (D)"

User action	Desired Result	Screen Result	Auto Actions taken
press 'a'	a	A	"A" displayed
press 'b'	ab	aB	"B" displayed and "A" changes to "a"
Press "c"	abC	abC	"C" displayed and "b" changes to "b"
press "Space Bar"	abC	abC	Space is added and "B" changes to "b"
press '('	abC (	)abC	Wrong parenthesis added to left
press 'd'	abC (D	abC (D	"D" displayed, Parenthesis moves right and changes shape
press ')'	abC (D)	(abC (D	Wrong parenthesis added to left
press "Space Bar"	abC (D)	abC (D)	Parenthesis moves right and changes shape

Table 1 Hypothetical process to type the string "abC (D)"

Has this shakey kludged approach above really solved permanently and satisfactorily the Arabetic technological challenges? Displaying text is only one aspect of script computerization. Clearly, today's technology has not yet conquered the complexities of calligraphic Arabetic scripts nor does it need to. These scripts should be allowed to adapt naturally in order to conquer technology instead. We need to design smarter, more innovative typefaces not smarter complex technologies. It is not forgivable that Arabic, which is known historically for its design openness and flexibility, should fail the challenges of modern typographic design.

INTRODUCING *NAIM*: NATURAL ARABETIC INPUT METHOD

To bring the Arabetic scripts and typography back to a user focus, we have been working on an alternative input method (U.S. Utility Patent pending) to the prevailing one today. The proposed method, NAIM, works in harmony with, and as close as possible to, how users actually write and visualize Arabetic characters in a word while it is being typed. It works best with a two glyphs per letter model, but can be implemented in today's widely used four-glyphs per letter model as well. As a background, the two-glyph per letter model consists of one unique 'normal' glyph per letter and an alternative 'final' glyph to be

displayed only at the end of words or as an isolated shape. This model is what we have implemented in the design of our Mutamathil Taqlidi families of fonts (Abulhab, 2004). In that model we combined current Open Type 'initial' and 'medial' shapes into one 'normal' glyph, and the 'final' and 'isolated' shapes into one 'final' glyph. Here is how NAIM works. As users key in a word, the first letter is always displayed in its 'normal' (or 'initial' shape in a four-glyph per letter model)

The proposed method works in harmony with, and as close as possible to, how users actually write and visualize Arabetic characters in a word while it is being typed.

form, as it naturally should be. The second letter typed would again be displayed in its 'normal' form in a two-glyph per letter model, or in its 'medial' form in a four-glyph per letter model. As users keep on typing, letters would continue to be displayed in their 'normal' (or 'medial' in a four-glyph per letter model) forms until a 'final trigger' character is keyed, in which case the last glyph typed would be replaced with its 'final' shape glyph. A 'final trigger' is basically any non Arabetic letter or diacritic character like space, number, punctuation mark or any other designated character. In both models, exceptions apply to letter shape selections when said letters are typed after letters that cannot connect simultaneously with other letters from two sides in traditional Arabic or when isolated shapes are desired.

The main goal of the NAIM model is to eliminate as much as possible the negative effects of the current glyph substitution model which we have referred to as the 'dancing' or 'hyper' model. Implementing NAIM, particularly when combined with the two-glyph per letter typeface design model, would have significant technological, typographical and most importantly educational impact. Technologically, it would eliminate the excessive complexities of Open Type features and their corresponding software libraries. Typographically, it would make developing Arabetic fonts easier and more economical and as a result expand the production and availability of more fonts, especially non calligraphic fonts. Educationally, it would make learning Arabetic script much easier. New learners would not quit the educational process early due to the many 'confusing' shapes needed to be memorized up front. They can instead appreciate learning such optional shapes if they are interested in Arabetic calligraphy later on. Ordinary users would also benefit from editing the resulting static Arabic documents.

Unfortunately, we were not successful in implementing NAIM solely through utilization of the current Open Type features or the current Arabic script engines. This fact we have confirmed after detailed correspondences with typography experts familiar with the production of common Adobe and Microsoft Arabic computing solutions, including prominent Arabic linguist and typography expert, Thomas Milo of DecoType. In our opinion this is due mainly to the current rigid technological adaptation of the so-called 'Arabic script rules' which in effect create a complicated technology not able to address simple solutions! To overcome such technological difficulties, we have developed a Java applet prototype model for users to test drive NAIM. Please visit http://arabetics.com to experience it in action.

CONCLUSION

Centuries later, the development of modern Arabetic typography is still being shaped by a hidden struggle between choice and passion. A struggle wherein freedom of choice, which can only be guaranteed by the availability of options, a crucial condition for script evolution, is being challenged by a runaway, yet incomplete or even distorted, passion for past Arabic calligraphy beauty and glory. The passion of engineers, programmers, publishers and others who responded to the challenges of Arabic typography, calligraphy and script, and were intrigued by the technical complexity of the so-called script rules, but were not as intrigued by the fine details of calligraphy itself. This is an intellectually satisfying passion for solving unique technical challenges of common Arabetic script styles in the age of automation. But behind the shadow of this sometimes-obsessive passion, users' desire for choice and options, which is the natural and fundamental aspect of script renewal and survival, is being unnecessarily compromised. In our computer era, preserving genuine historical Arabetic calligraphy or its modern simplified typeface imitation is as important as preserving the script itself. Still, the safest way to accomplish that is by guaranteeing free choice through the availability of wide-open options, not by imposing handwritten calligraphy rules as script rules.

ACKNOWLEDGEMENT

The Java applet prototype application developed to demonstrate our proposed, patent pending, alternative Arabic input method, NAIM, was supported by a grant from The CUNY Research Foundation.

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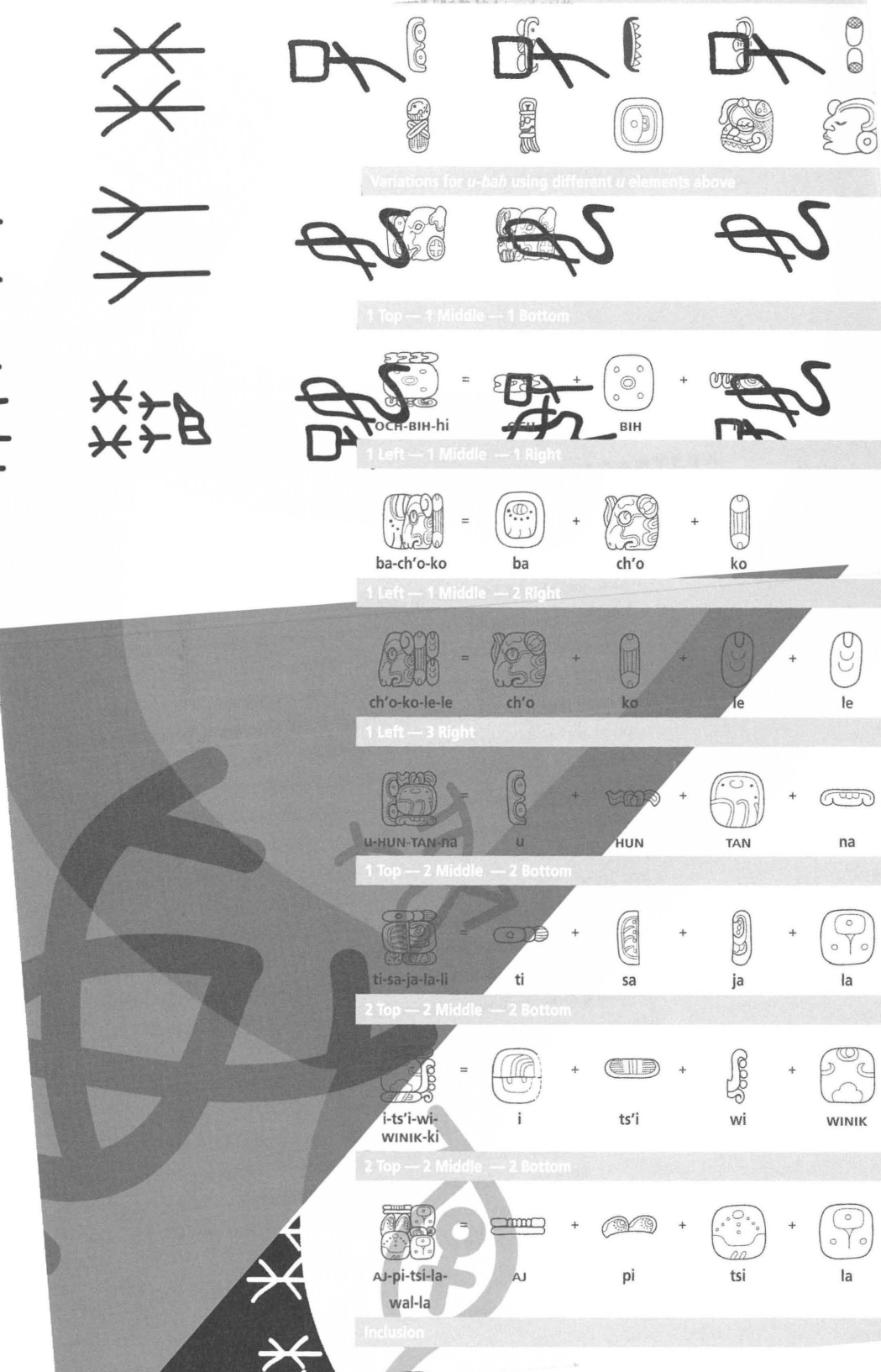
Said, Edward W. 1978. *Orientalism*. New York: Pantheon Books.

AUTHOR NOTE

Saad D. Abulhab was born in Sacramento, California, and grew up in Iraq. He has been involved since 1992 in the fields of Arabic computing and Arabic font design. Since 1979 he is a US resident and is currently the Director of Technology at the Newman Library of Baruch College, The City University of New York. He designed many nontraditional Arabic font families, noted among them is his Mutamathil typeface family, 1999, which was awarded a US Design Patent in the year 2000 and a US Utility Patent in 2003.


Variations for u-bah using different u elements above
1 Top — 1 Middle — 1 Bottom
OCH-BIH-hi
BIH
1 Left — 1 Middle — 1 Right
ba-ch'o-ko
ba
ch'o
ko
1 Left — 1 Middle — 2 Right
ch'o-ko-le-le
ch'o
ko
le
le
1 Left — 3 Right
u-HUN-TAN-na
u
HUN
TAN
na
1 Top — 2 Middle — 2 Bottom
ti-sa-ja-la-li
ti
sa
ja
la
2 Top — 2 Middle — 2 Bottom
i-ts'i-wi-WINIK-ki
i
ts'i
wi
WINIK
2 Top — 2 Middle — 2 Bottom
AJ-pi-tsi-la-wal-la
AJ
pi
tsi
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Inclusion

A Comparison
of Maya and Oracle Bone Scripts

William Chiang

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ABSTRACT

Maya script and Oracle Bone script are described and compared in terms of relationship between glyph, sound and meaning, glyph composition and grapheme positioning. They are found to be similar in having graphemes that are pictographic and adaptable to different glyph compositions, having glyphs that are square shaped, belonging to the category of logo-syllabic scripts and having the textual device of double dots/dashes for repetition. They are different in that Oracle Bone script is more abstract and has a much higher number of glyphs, that grapheme shape and the relationship between glyph, sound and meaning is more standardized than in Maya script. Another difference is that there are many more cases in Maya where one glyph includes several words, and that Maya is closer to the syllabic end on the logo-syllabic continuum. It is suggested that these differences may be the result of differences in the conceptions of "self" (as suggested by Houston and Stuart), the languages, the degree of political centralization and the extent of public use of the scripts. It is also suggested that early writing systems may reflect how tightly morphemes are bound in the language, as the agglutinative nature of Maya language may have led to the Maya script's containing more multi-word glyphs. It is surmised that the literacy rate in the two societies may have been similar.

BIOGRAPHICAL NOTE

William Chiang is an assistant professor in the Department of Foreign Languages at National Taichung Institute of Technology, in Taichung, Taiwan, ROC. He did graduate work in the United States and his research is concerned with the relation between writing systems, language and culture.

The Oracle Bone script is a logo-syllabic writing system used in north China (*figure 1*) from middle to late Shang dynasty (approximately 1500 B.C. to 1000 B.C.). Most of the extant writing is carved on tortoise shells and ox scapulae for the purpose of divination. A question is asked in both positive and negative manners, such as "Will there be unlucky events in the next ten day period? Will there not be unlucky events in the next ten day period?" The answer is determined from cracks in the shell/scapulae caused by drilling and heating with further text written to indicate how things turned out. The text is usually written from top to bottom, with the positive question on one side and the negative question on the other (*figure 2*).[1]

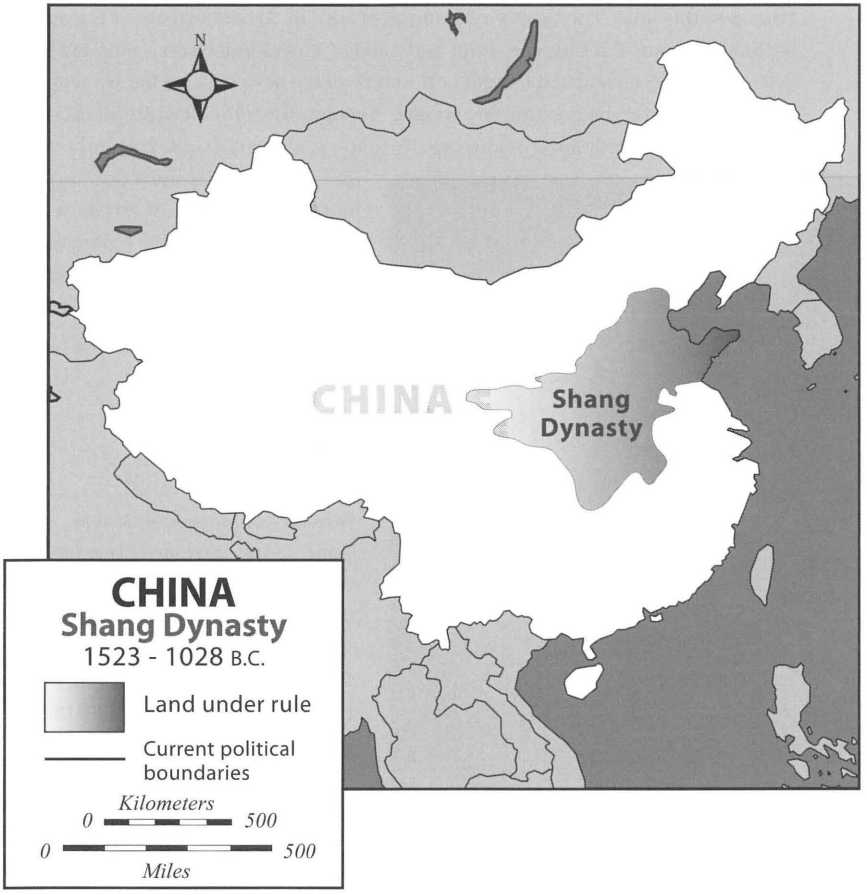


Figure 1 Map of the Shang area.[2]

The Maya script is a logo-syllabic writing system used in the Mayan area, encompassing present day southern Mexico, Honduras, Guatemala and Belize (*figure 3*) from the first century B.C. to the time of the Spanish Conquest in the 16th century. Most of the extant writing appears on ceramic vessels, stone stelae, building surfaces and bark paper codices. Its function seems to be naming the owners/donors of objects involved in ritual practices such as feasting, captive taking, building dedication[4] and in the case of codices, recording calendrical and religious information for divination purposes. Maya texts from the Classical period of 250 A.D. to 900 A.D. usually run in columns of two, with the reading order of upper left, to upper right, to lower left, to lower right (*figure 4*).[5]

There are two reasons for comparing the Maya and the Oracle Bone scripts. First, there has been some mention of the similarity between Chinese and Maya writing systems[8] yet, as far as I know, no detailed comparison of the two up to this date. The Spanish Jesuit priest Jose de Acosta discussed European alphabets versus the Chinese script and native Central American script, but the discussion only concerned the general nature of the script, i.e., what we would term phonetic versus logographic scripts.[9] Second, since the decipherment of Maya script has been progressing rapidly in the past thirty years, and since it is considered the most developed of the Mesoamerican scripts, a possible candidate for independent script invention, such a comparison might throw some light on the development of early writing systems.

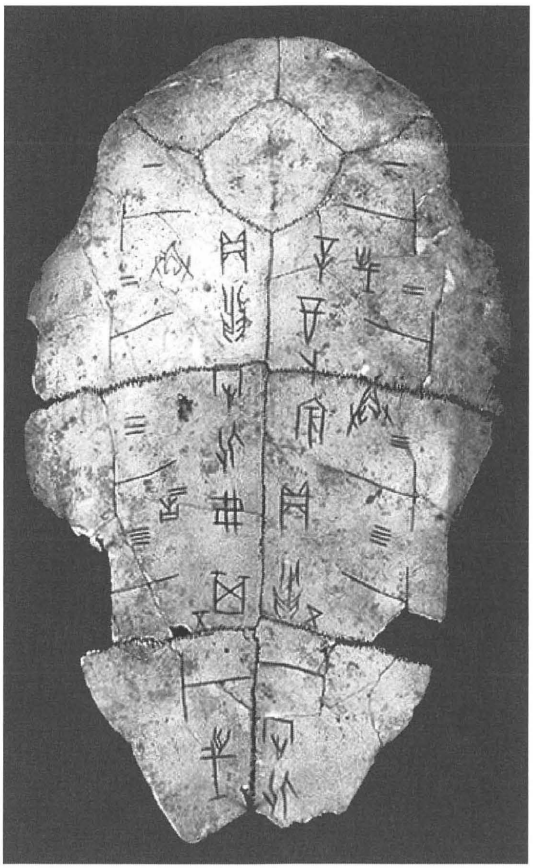


Figure 2 Tortoise shell with Oracle Bone script.[3]

A BRIEF NOTE ON TERMINOLOGY[10]

Scholars of Maya and Oracle Bone scripts have developed their own specialized vocabularies for describing the smaller units out of which whole texts were composed. In order to make comparison of these two scripts clearer, I will be using the following vocabulary to describe the units of both Maya and Oracle Bone texts. A "glyph" will refer to a roughly square-shaped unit of space into

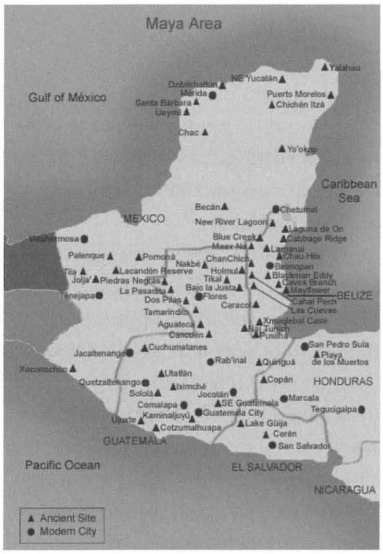


Figure 3 Map of the Mayan area.[6]

which the arrangement of one or more smaller units ("graphemes") is organized. These square glyphs are usually arranged in horizontal and vertical columns. The grid-of-square-glyphs nature of Maya inscriptions can be clearly seen in the inscription illustrated in figure 4. The linear lines of glyph units in Oracle Bone script can be seen in figure 2.

"Glyphs," in turn, are composed of one or more smaller units that I refer to as graphemes, of which there are two types: phonetic graphemes are those that make reference to a sound and assist in indicating how a glyph was pronounced; semantic graphemes are those that make reference to a semantic category and assist in indicating the meaning of the glyph. One glyph may correspond to one word or several words. If one word is represented by only one grapheme and that grapheme represents only one meaning, that grapheme is termed a logograph. If that grapheme can represent homonymous words, it is termed a phonetic grapheme.

As we will see below, Maya glyphs are composed of either a logograph or a single phonetic grapheme, or a logograph combined with one or more phonetic graphemes, or simply a combination of phonetic graphemes. Thus one way to write the Mayan word *balam* 'jaguar' would be to combine the **ba** syllable with the **BALAM** logograph to form the glyph (*see*

Figure 4 Unprovenienced panel of Maya script (possibly from La Corona, Guatemala) (drawing by David Stuart).[7]

Table 1 Maya Script

Table 2 Oracle Bone Script

Table 3 Relationship of glyph, sound, and meaning

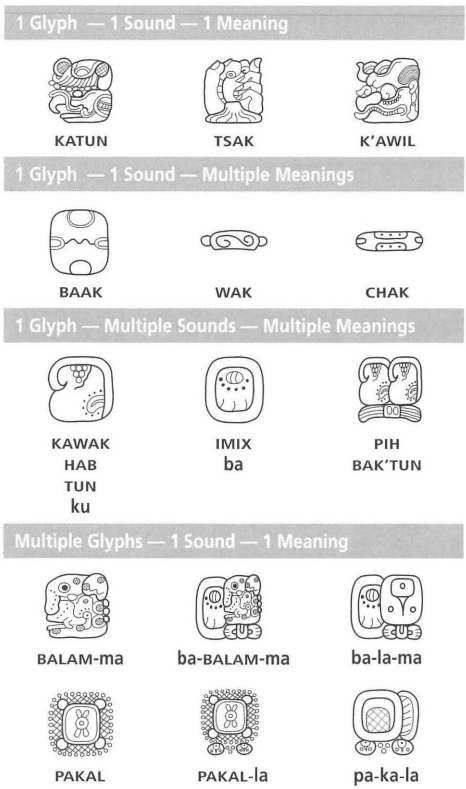


table 1).[11] Semantic graphemes were quite rare in Maya writing. It is estimated that Maya script has around 800 glyphs and around 200 graphemes.[12]

Oracle Bone glyphs were usually composed of either a logograph, or a phonetic and a semantic grapheme, or a combination of semantic graphemes. For example (*see table 2*), the glyph pronounced *gip* and meaning 'reach,' is composed of two semantic graphemes, one meaning 'person' and the other meaning 'hand.' Whereas the glyph pronounced *muar* and meaning 'younger sister,' is composed of the phonetic grapheme pronounced *miur* , and the semantic grapheme meaning 'woman.' It is estimated that Oracle Bone script has over 4,000 glyphs and 348 graphemes.[13]

The remainder of this paper will consider in more detail the relationship between glyph, sound and meaning, and how graphemes were combined into glyphs for Maya and Oracle Bone script respectively.

THE MAYA SCRIPT

As we pointed out, the Maya script has around 800 glyphs and 200 graphemes. Of the 90 possible syllables based on Cholan and Yucatecan Maya, glyphs and graphemes representing 71, or about 79%, have been deciphered. About 85% of all extant texts can be read.[14]

RELATIONSHIP OF GLYPH, SOUND, AND MEANING

Some logographs are structured with one glyph, one sound and one meaning; for

example, KATUN, a unit in the Maya calendar; TSAK 'conjure up'; KAWIL, name of a god (*see table 3 for this and following examples*).

One glyph, one sound with multiple meanings is a situation that arises mostly from sound borrowing, in other words, the Rebus principle. For example, BAAK (*baak* can mean both 'bone' and 'prisoner'), WAK (*wak* can mean both 'six' and 'raised'), CHAK (*chak* can mean both 'red' and 'great').

An example of one glyph – multiple sounds – multiple meanings is one glyph representing KAWAK (*Kawak* the name of a day sign in the Maya calendar), or HAB (*hab* 'year'), or TUN (*tun* '360-day cycle'), or **ku**, a phonetic grapheme can all be represented by the same glyph.[15] A second example is one glyph for the day sign IMIX or the phonetic grapheme **ba**. A third example is one glyph representing PIH (*pih* 'bundle') or BAK'TUN (*bak'tun* a unit in the Maya calendar).[16]

In the case of multiple glyphs – one sound – one meaning, Mayan words can be represented by a logograph, or a logograph plus one or more phonetic graphemes, or simply one or more phonetic graphemes. For example, the word *balam* 'jaguar' can be represented by the logograph BALAM representing the head of a jaguar for example or others: **ba**-BALAM, BALAM-**ma**, **ba**-BALAM-**ma**, **ba**-**la**-**ma**. Likewise the word *pakal* 'shield' can be represented by a logograph PAKAL representing a shield, by a logograph PAKAL plus the phonetic grapheme **la**, or simply the phonetic graphemes **pa**, **ka**, and **la**.

Table 4 Variant glyphs resulting from variant forms of a logograph or grapheme

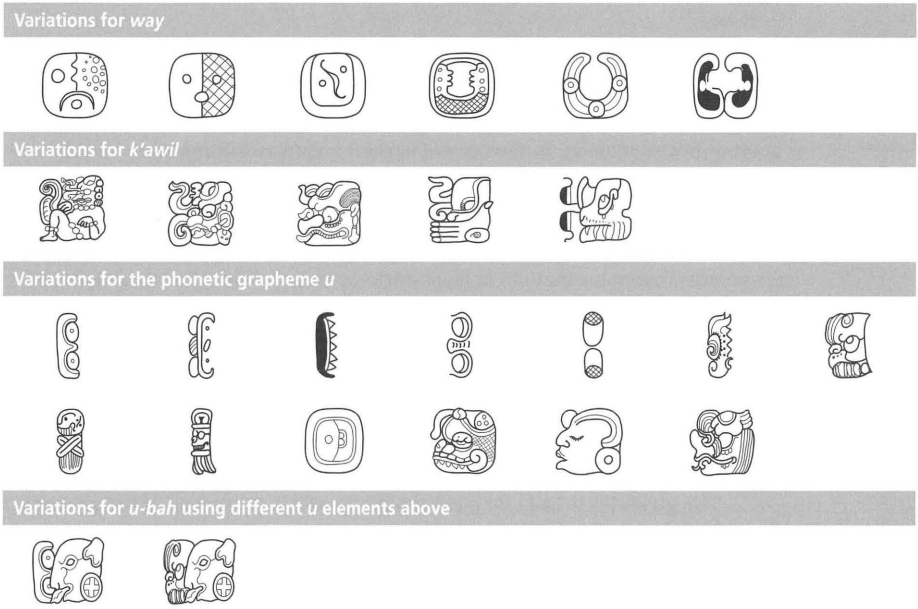


Table 5 Multiple words in one glyph

Another common way variant glyphs come to represent the same word is through variant forms of a logograph, or variant forms of a phonetic grapheme (*see table 4*). In the case of variant glyphs resulting from variant forms of a logograph, examples include at least six variant forms for *way* 'spirit companion,' and five variant forms for *k'awil*, the name of a god.

In the case of variant glyphs resulting from variant forms of a phonetic grapheme, examples include at least thirteen variant forms for the grapheme representing the sound *u*. The phrase *u-bah* 'he/she/it goes' can be represented by a glyph that uses one of two of the variants of *u*.

Multiple words in one glyph are common in Maya script where a phrase or even an entire sentence can be represented in one glyph. For example, **ti-WAK-BEN** (*ti wak Ben* 'on the day six Ben') is composed of **ti** (*ti* 'on'), **WAK** (*wak* 'six'), and **BEN** (*Ben* a day name) (*see table 5 for this and following examples*).

The glyph for **tu-ba-hi** (*tu baah* 'on his head') is composed of the phonetic graphemes **tu** (*tu* 'on his/her/its') and **ba** and **hi**, which together form *baah*, 'head.'

Table 6 One sound with multiple meanings and glyphs

1 Sound — Multiple Meanings — Multiple Glyphs		
KAN		
AK'BAL		
IX		
AHAW		

The glyph **och-bih** (*och bih* 'he/she/it enters the path,' a metaphor for death) is composed of **och** (*och* 'enter') and **bih** (*bih* 'path').

'Holy king of Palenque' (*k'uhul Baakal ahaw*), written as **k'uhul-baak-la-ahaw** is composed of **k'uhul** (*k'uhul* 'holy'), **baak** and **la** (*Baakal* 'Palenque') and **ahaw** (*ahaw* 'king').

The glyph **hok'aj-ti-ahaw-le** (*hok'aj ti ahawlel* 'he is tied into the kingship') is composed of **hok'aj** (*hok'aj* 'he/she/it is tied'), **ti** (*ti* 'into'), **ahaw** (*ahaw* 'king') and **le** (*le/* –ship or –ness).

The glyph **u-ch'am-wa-lo-mu** (*u cha'maw lom* 'he/she/it takes the staff') is composed of **u** (*u* 'he'), **ch'am** (*ch'am* 'take'), **wa** (*-aw* transitive suffix), **lo**, and **mu**, which together form *lom* 'staff.'

Although one sound can represent several different meanings and be represented by several different glyphs, all glyphs are interchangeable for the various meanings (*see table 6*). For example, three glyphs representing **kan** can all mean 'snake' or 'sky' or 'four.' The only homophones that are differentiated by glyphs achieve this by the rare semantic graphemes. For example, the semantic grapheme  indicates a day sign in the Mayan calendar; it serves to differentiate meaning in the following instances. The sound **ak'bal** can mean 'darkness' or the name of a day. The sound **ix** can mean 'jaguar' or the name of a day. The sound **ahaw** can mean 'king' or the name of a day.

Yet even here, the glyphs without the day signs can still sometimes represent the day names. Nevertheless, Maya script is considered a logo-syllabic script because of the many glyphs which only represent one sound and one meaning.

GLYPH COMPOSITION: OVERVIEW

In terms of glyph composition, we have already seen how a Maya glyph can consist of a logograph, or a logograph plus one or more phonetic graphemes, or simply some phonetic graphemes. Semantic graphemes that only convey meaning and not sound are rare. We have already seen the day sign indicator. Another is the headband scarf on top which indicates kingly status. In addition, there is a textual device consisting of two dots placed at the upper left corner of a phonetic grapheme, indicating

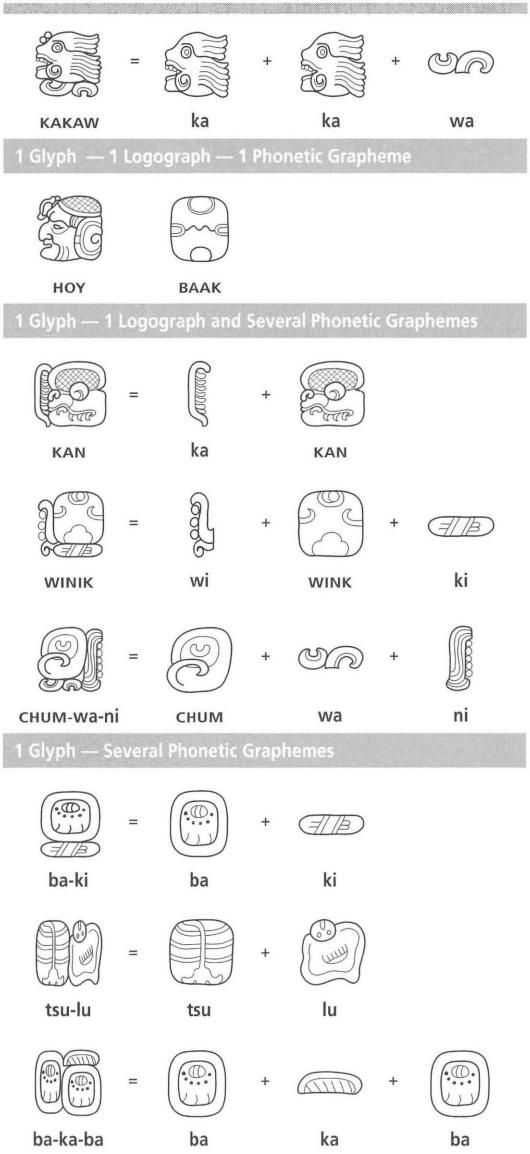
repetition of that grapheme. For example, *kakaw* 'chocolate' is composed of the phonetic grapheme **ka**, repeated by the two dots and the phonetic grapheme **wa** (*see table 7 for this and the following discussion*).[17]

We have already seen examples of the following three categories with the words *balam* and *pakal*. Here we give more illustrations separated according to their structure. One glyph with one logograph or one phonetic grapheme is exemplified by **HOY** 'he/she/it prepared' and **BAAK**.

One glyph with one logograph and several phonetic graphemes is exemplified by three illustrations: 'snake' is constructed with **ka** and the logogram **KAN**. *Winik* 'person' is constructed with **wi** and the logogram **WINIK** and **ki**. **CHUM-wa-ni** (*chumwan* 'he/she/it sits') is constructed with the logogram **CHUM** 'be seated' with **wa** and **ni** (*-wan* positional suffix).

One glyph and several phonetic graphemes is exemplified by three illustrations also: **ba-ki** (*baak* 'prisoner') is constructed with **ba** and **ki**. Likewise **tsu-lu** (*tsul* 'dog') is constructed with **tsu** and **lu**, while **ba-ka-ba** (*bakab* an aristocratic title) is formed with **ba**, **ka** and **ba** again.

Table 7 Glyph composition



GLYPH COMPOSITION: GRAPHEME POSITIONING

In terms of grapheme position, one Mayan glyph may contain as little as one, or as many as twelve graphemes, all combined according to the principles of conflation, where graphemes overlap one another, or inclusion, where a grapheme occurs inside another. If a logograph exists, the phonetic graphemes may occur as affixes to its left, right, top and bottom. The grapheme reading order is generally from left to right, top to bottom.[18] Table 8 contains examples of conflation and inclusion based on structure.

For one left – one right, there are three examples: tsu-lu (*tsul* 'dog') composed with tsu and lu. KAN (*kan* 'snake') composed with ka and KAN. u-ba (*u bah* 'his/her/its image') composed with u and ba.

For one left – two right, there are also three examples: ba-ka-ba (*bakab* an aristocratic title), formed with ba and ka and ba. wi-WINIK-ki (*winik* 'person') is composed with wi, WINIK and ki. tu-ba-hi (*tu baah* 'on his head') is composed with tu and ba and hi.

Two left – one right, has three examples: CHUM-wa-ni (*chumwan* 'he/she/it sits') composed with CHUM and wa and ni. tu-pa-ja (*tu pah* 'it is an earspool') composed with tu and pa and ja. chu-ka-ja (*chukaj* 'he/she/it is captured') composed with chu, ka, and ja.

One top – one bottom has three examples: ba-ki (*baak* 'prisoner') is composed with ba and ki; OCH-BIH (*och bih* 'he/she/it enters the path,' a metaphor for death), is composed with OCH and BIH; and PAKAL-la (*pakal* 'shield') is composed with PAKAL and la.

One top – two bottom is exemplified with the following example: ti-WAK-BEN (*ti wak Ben* 'on the day six Ben') is composed with ti and WAK and BEN.

One top – two bottom has three examples: pa-ka-la (*pakal* 'shield') is composed with pa and ka and la. K'AL-SAK-HUN (*k'al sak hun* 'he ties the white headband') is composed with K'AL, SAK, and HUN.

Quadripartite structure is known with sa-ja-la-la (*sajalal*, underlordship) is composed with sa, ja, la, and la.

One top – one middle – one bottom is shown with OCH-BIH-hi (*och bih* 'he/she/it enters the path,' a metaphor for death) is composed with OCH, BIH, and hi.

One left – one middle – one right is exemplified with the following: ba-ch'o-ko (*bach'ok* 'first sprout') composed with ba, ch'o, and ko.

One left – one middle – two right is shown with ch'o-ko-le-le (*ch'oklel* 'sprouthood') constructed with ch'o, ko, le, and le.

One left – three right is shown with the following example: u-HUN-TAN-na (*u huntan* 'her beloved one') composed with u, HUN, TAN, and na.

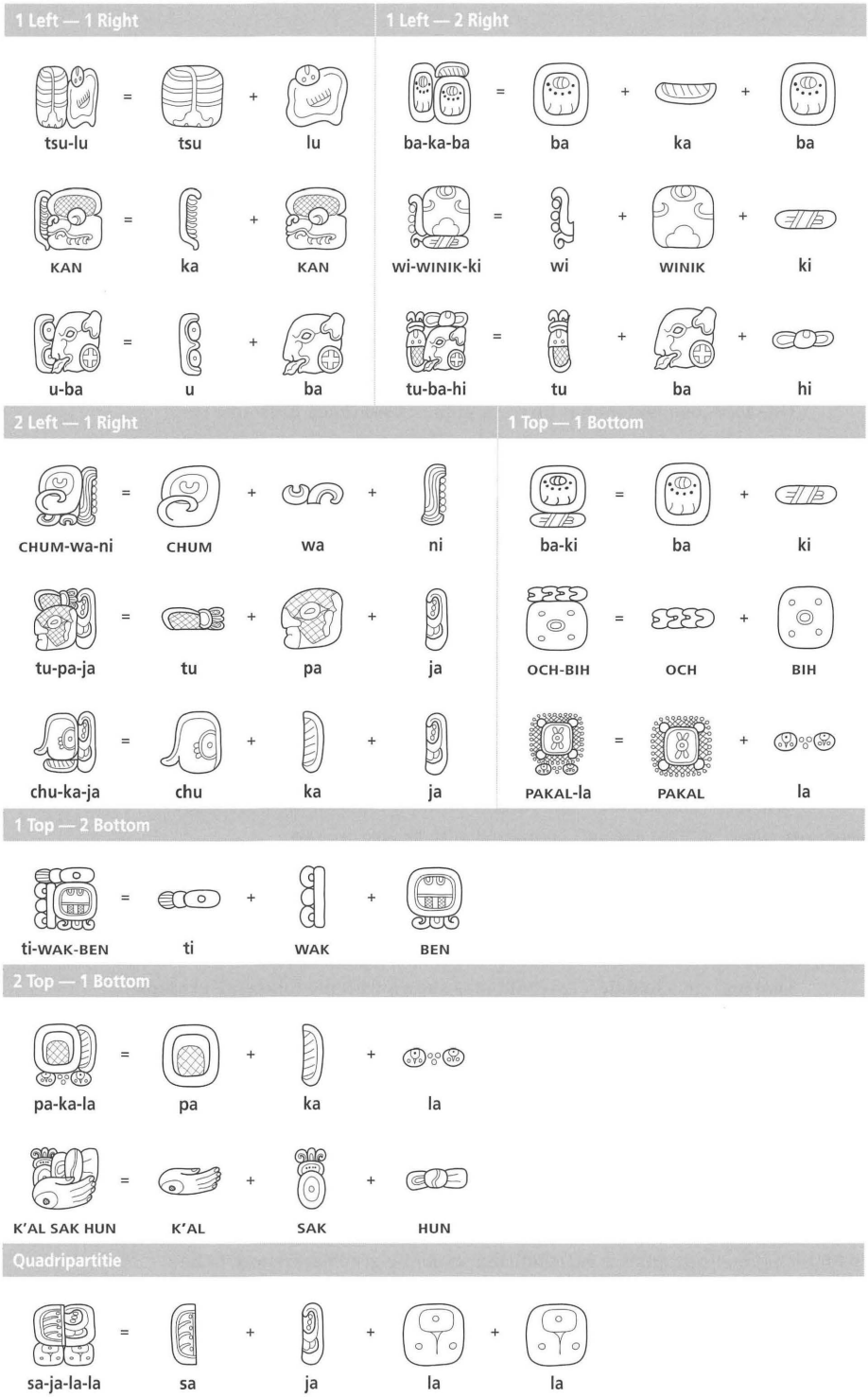
One top – two middle – two bottom is shown with the following example: ti-sa-ja-la-li (*ti sajalal* 'in the underlordship') is composed with ti, sa, ja, la, and li.

Two top – two bottom left – one bottom right is shown with the following: i-ts'i-wi-WINIK-ki (*its'i winik* 'younger brother') is composed with i, ts'i, wi, WINIK and ki.

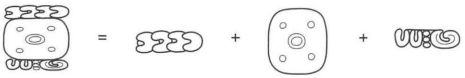
Two top – two middle – two bottom is shown with the following: AJ-pi-tsi-la-wa-la (*aj pitslawal* 'he of the ballgame') is composed with AJ, pi, tsi, la, wa, and la.

Inclusion has three examples: CHUM-mu (*chum* 'to be seated') is composed with the phonetic grapheme mu inside the semantic grapheme CHUM 'to be seated.' sa-ja-la (*sajal* an aristocratic title) is composed with the phonetic graphemes ja and la inside sa. mo-lo (*Mol* a month name) is composed with the phonetic grapheme lo inside the phonetic grapheme mo.

Table 8 Glyph composition: Grapheme positioning



1 Top — 1 Middle — 1 Bottom

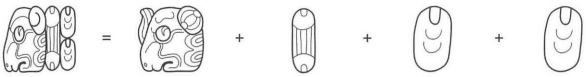


OCH-BIH-hi | OCH | BIH | hi

1 Left — 1 Middle — 1 Right

ba-ch'o-ko | ba | ch'o | ko

1 Left — 1 Middle — 2 Right



ch'o-ko-le-le | ch'o | ko | le | le

1 Left — 3 Right

u-HUN-TAN-na | u | HUN | TAN | na

1 Top — 2 Middle — 2 Bottom

ti-sa-ja-la-li | ti | sa | ja | la | li

2 Top — 2 Middle — 2 Bottom

i-ts'i-wi-WINIK-ki | i | ts'i | wi | WINIK | ki

2 Top — 2 Middle — 2 Bottom

AJ-pi-tsi-la-wal-la | AJ | pi | tsi | la | wal | la

Inclusion

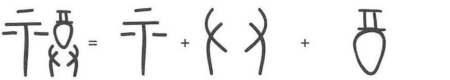
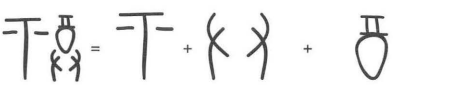
CHUM-mu | mu | CHUM | mo-lo | lo | mo

sa-ja-la | ja | la | sa

Table 9 Oracle Bone glyph, sound, and meaning

1 Glyph — 1 Sound — 1 Meaning			1 Glyph — 1 Sound — Multiple Meanings		
					
wood	rain	ear	name of a ritual	aristocratic title	to attack first month

1 Glyph — Multiple Sounds — Multiple Meanings		
		
armor seven	mountain fire	moon night

Multiple Glyphs — 1 Sound — 1 Meaning								
								
blessing				blessing	=	hands	+	phonetic grapheme
								
blessing	=	hands	+	phonetic grapheme	blessing	=	religious	+	phonetic grapheme
								
blessing	=	religious	+	phonetic grapheme	blessing	=	religious	+	phonetic grapheme
								
blessing	=	religious	+	phonetic grapheme	blessing	=	religious	+	phonetic grapheme
								
blessing	=	religious	+	phonetic grapheme	blessing	=	religious	+	phonetic grapheme
									
blessing	=	religious	+	phonetic grapheme	blessing	=	religious	+	hands	+	phonetic grapheme
									
				blessing	=	religious	+	hands	+	phonetic grapheme
									
				blessing	=	religious	+	hands	+	phonetic grapheme
									
				blessing	=	religious	+	hands	+	phonetic grapheme
				blessing	=	religious	+	roof	+	phonetic grapheme

THE ORACLE BONE SCRIPT

There are currently about 150,000 pieces of Oracle Bones, containing over 4,000 glyphs. Of these glyphs, about 1,500 have been deciphered.[20]

RELATIONSHIP OF GLYPH, SOUND AND MEANING

In terms of the relationship between glyph, sound and meaning, there are several categories (*see table 9 in regard to the following discussion*).

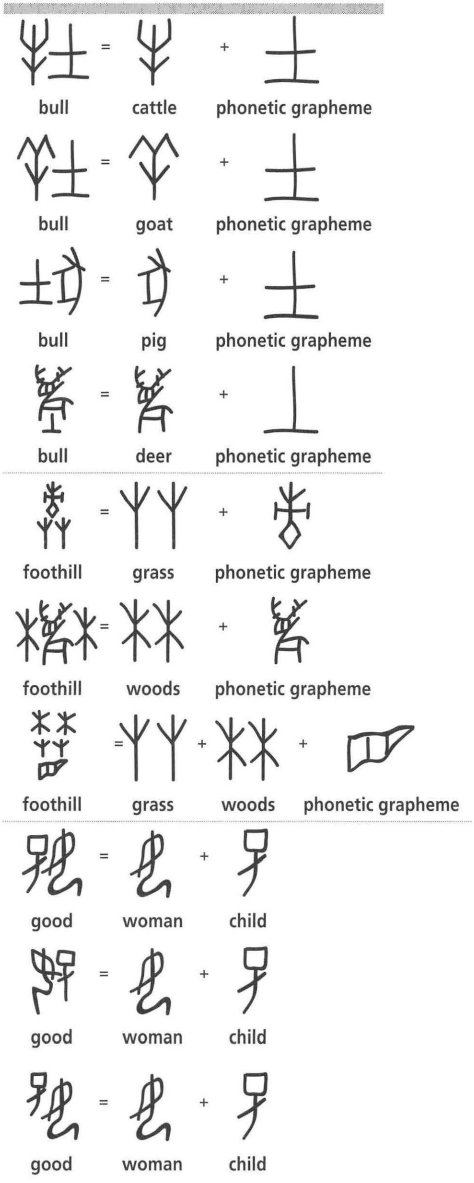
In the one glyph – one sound – one meaning category, for example, the glyph pronounced meuk and means 'wood'; the glyph pronounced ɣ*iu*aɣ means 'rain'; the glyph pronounced *ni*əɣ and means 'ear.'[21]

The one glyph – one sound – multiple meanings situation arises mostly from sound borrowing, in other words, the Rebus principle. For example, the glyph ɣxiuəɣ means 'also' 又 as well as the name of a ritual 祐;[22] the glyph *pak* means 'white' 白 as well as an aristocratic title 伯;[23] the glyph *tie*ŋ means 'to attack' 征 as well as 'first month'.[24]

One estimate puts the percentage of this type of glyph at 46.8%[25] but many of the borrowed glyphs have lost their original meaning, which is one reason often cited to explain why Oracle Bones glyphs are difficult to decipher. Permanent borrowings and the differentiation of homophones through different glyphs also partly explain why Oracle Bone script is considered logo-syllabic, in spite of extensive sound borrowings.

Regarding the category one glyph – multiple sounds – multiple meanings, the glyph 十 could represent 甲 *kra p* 'armor' or 七 *ts*h *iet* 'seven'; the glyph 山 could represent 山 *srian* 'mountain' or 火 *xu*əɣ 'fire'; the glyph 月 could represent 月 ŋ*iuat* 'moon' or 夕 *riak* 'night.'[26]

Table 10 Multiple Glyphs – 1 Sound – 1 Meaning cont.



The situation of multiple glyphs – one sound – one meaning arises mostly from variant forms of the same glyph (*see table 9 for the following examples*). For example, the word 福 piuək meaning 'blessing' has 127 variant glyphs. The 14 shown here are created by the addition or deletion of graphemes or grapheme elements.[27] The word 牡 *muu* meaning 'bull' has 15 variant glyphs. The four shown here are created by changing the semantic grapheme (*see table 10 for this and following examples*).[28] The word 麓 *leuk* meaning 'foothill' has 12 variant glyphs.[29] The three shown here are created by changing the phonetic grapheme. The word 好 *xəu* meaning 'good' has 11 variant glyphs. The three shown here are created by changing the position of the two semantic graphemes meaning 'woman' and 'child.'[30]

Table 11 Multiple words in one glyph

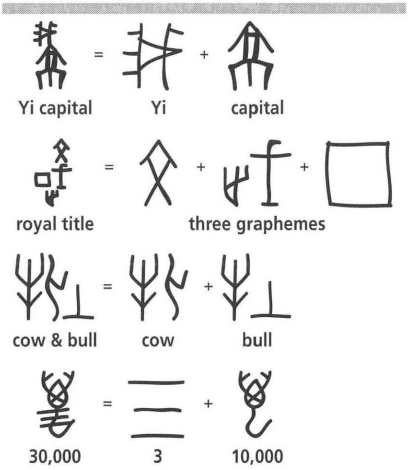
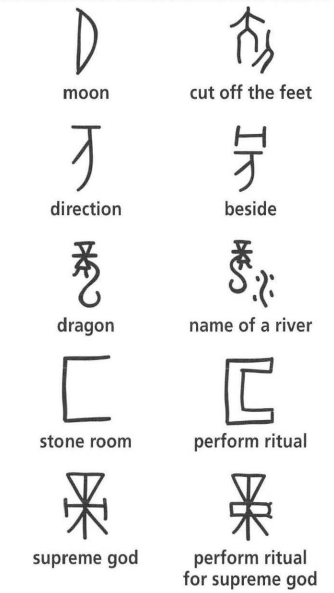


Table 12 One Sound – Multiple Meanings – Multiple Glyphs



In the multiple words in one glyph situation (*see table 11*), four examples are provided, the glyph ŋia *kiaŋ* 'Yi capital' is a combination of two graphemes —ŋia 'Yi' and *kiaŋ* 'capital.' The glyph *mluən miuaɣ teŋ* (a proper royal title) is a combination of three graphemes *mluən*, *miuaɣ* and *teŋ*. The glyph *bien muəu* 'cow and bull' is a combination of the graphemes *bien* 'cow' and *muəu* 'bull.' The glyph *səm mluan* 'thirty thousand' is a combination of the graphemes *səm* 'three' and *mluan* 'ten thousand.'[31]

The condition of one sound – multiple meanings – multiple glyphs contains homonyms differentiated by different glyphs (*see table 12*). For example, the sound ŋiuat can mean 'moon' or 'to cut off the feet.' The sound *buaŋ* can mean 'direction' or 'beside.'[32] The sound *lieuŋ* can mean 'dragon' or the name of a river.[33]

A subcategory of this case is related words differentiated by related glyphs. For example, *pəu* 'stone room for ancestral tablet' is represented by a glyph similar in form to the verb *pəu* 'perform a ritual to locate the ancestral spirit.'[34] Another possible candidate is *teɣ* 'supreme god', represented by a glyph similar to another glyph pronounced *teɣ* and meaning 'to perform the ritual for the supreme god.'[35]

GLYPH COMPOSITION: OVERVIEW

In terms of glyph composition, there are a total of 348 graphemes in the Oracle Bone script, as mentioned above. A grapheme is either phonetic or semantic, depending on its function within the glyph. Oracle Bone also has a device for indicating duplication of a glyph/syllable – two horizontal dashes placed at the lower left of the glyph, as in the third glyph down in the following example:[36]

This phrase is usually read as 王受有祐, 'the king has the protection of the gods.'[37] The glyph ɣ*iu*əɣ "right" is borrowed to represent its near homonyms 有 and 祐.

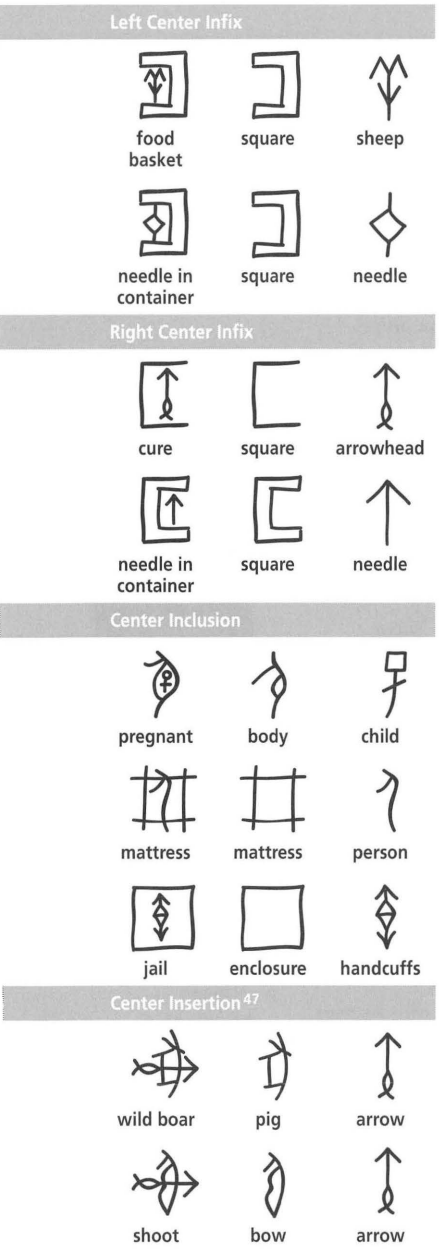
Based on an analysis of 1,341 glyphs from Jiaguwen Heji[38] there are two types of glyphs by glyph composition (*see table 13*): 226, or 16.8%, belong to the category one glyph – one grapheme, for example, ɣiuəɣ 'right hand,' *gua* 'grain stalk' and *nien* 'human being.'

One glyph – multiple graphemes, based on grapheme function, can be further divided into two types: one glyph – multiple graphemes (753 or 56.1% are in this category) or one glyph – multiple semantic and phonetic graphemes (119 or 8.9% are in this category).[40]

Table 13 Types of glyph composition

1 Glyph — 1 Grapheme		
		
right hand	grain stalk	human being
1 Glyph — Multiple Semantic Graphemes		
 =	 +	
reach	person	hand
 =	 +	
pregnant	child	body
 =	 +	
cut off the feet	big person	sword
1 Glyph — Multiple Semantic and Phonetic Graphemes[39]		
 =	 +	
younger sister	phonetic grapheme	woman
 =	 +	
to go	step	phonetic grapheme
 =	 +	
room	roof	phonetic grapheme

Table 14 Grapheme positioning



In most cases, the phonetic grapheme is on the left and the semantic grapheme on the right.[41] Based on an analysis of 257 semantic phonetic glyphs, 81 semantic graphemes and 175 phonetic graphemes were identified. Among the semantic graphemes, 'kneeling woman' appeared most often, with about 100 glyphs containing it, perhaps indicating the continued importance of matrilineal lineages in Shang times.[42]

Of the 175 sound graphemes, 37% had the same sound and tone as the entire glyph, 36.6% had only a different initial consonant cluster, 8% had only the same rhyme, 7.59% had only a different tone, 2.7% had only the same tone, 2.23% had only the same initial consonant cluster, and 1.3% had only a different rhyme. These figures indicate that in choosing a phonetic grapheme, the most important factor is rhyme. Tone comes second and initial consonant cluster is the least important.[43] The other 18.2% could not be clearly categorized.[44]

GLYPH COMPOSITION: GRAPHEME POSITIONING

In terms of grapheme position, multiple grapheme glyphs can be divided into fourteen types (*see table 14*):

one left – one right accounts for 46.2% of glyphs composed of two graphemes[45] whereas one top – one bottom accounts for 28.5% of glyphs composed of two graphemes.[46]

COMPARISON AND DISCUSSION

SIMILARITIES

The most outstanding similarity between Maya and Oracle Bone script is that the graphemes of both are pictographic in nature. Secondly, the shape of individual graphemes in both is flexible and can be adapted to fit in a particular glyph composition. Thirdly, the glyphs are generally in a square shape.

In terms of relationship between sound, glyph and meaning, both belong to the category of logo-syllabic scripts, meaning that in many cases a glyph stands for a word, with some graphemes indicating syllables.

Both scripts have a textual device for repetition — double dashes that appear to the lower left of the glyph in Oracle Bone and double dots at the upper left for Maya. This device appears in Chinese Bronze script of the Chou Dynasty as well, in which case the two dashes appear usually to the lower right and sometimes to the lower left corner of the glyph (*figure 5*).[48]

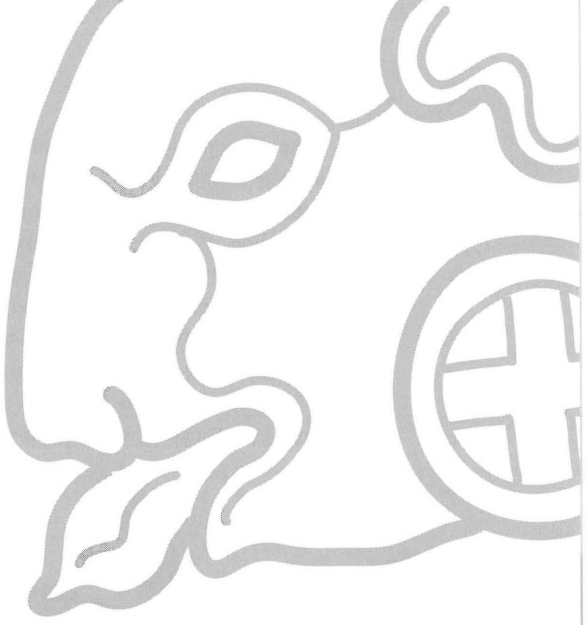
Figure 5 Double dashes for repetition in Bronze Script. The text reads 'son (son) grandson (grandson)' meaning 'for all posterity.'[49]

DIFFERENCES

In terms of pictographic shape, Oracle Bone script is more abstract and shapes are often reduced to lines. Maya graphemes are full-bodied, perhaps contributing to the overlapping and partial blocking of graphemes in multi-grapheme glyphs. Stephen Houston attributed it to "the need to preserve superficial reading ability among a larger group of people" among the Maya.[50] I would disagree with this, arguing that the high degree of variability in Maya script shapes would increase the reading difficulty for the audience. Houston and David Stuart also suggested that the Central American idea of self is more diffused compared to that of the West, and some of this life voice helps animate the Mayan glyphs.[51] Another possible explanation for the full bodied character of Maya script is the fact that Maya script often occurred on public monuments supposedly for public consumption which may have encouraged artistic expression by the scribes.

In terms of glyph number, Oracle Bone script far exceeds Maya script. This may be because Archaic Chinese as a monosyllabic language had many more homophones than Classic Maya, and therefore needed many more glyphs to differentiate them.

In terms of the relationship between glyph, sound and meaning, there is more fluidity in Maya where different glyphs representing the same sound



can stand in freely for one another. Whereas this occurs in Oracle Bone script also, there more glyphs are bound to specific meanings and cannot represent homophonous words, hence the bond between glyph and meaning is stronger. This ties in to the previous point where Oracle Bone script needs to differentiate between homophones. Also, there are many more cases in Maya where one glyph includes several words. In Oracle Bone script this occurs only with proper names, closely knit noun pairs and objects with numbers, whereas in Maya the unit presented could be a phrase or a sentence. This may reflect the agglutinative nature of Classic Maya language, where the bond between morphemes is stronger.

In terms of glyph composition, variations in Maya seem to be due to both variation in the graphemes, for instance, the variant forms of the phonetic grapheme representing *u* and variation in glyph composition, i.e., addition/deletion/substitution of graphemes. On the other hand, graphemes seem to be relatively stable in Oracle Bone and most variations result from glyph composition, for instance, the variant forms of 'blessing,' 'bull' and 'foothill.' This greater degree of grapheme standardization in Oracle Bone may be due to differences in the political situation, as Shang was a more or less centralized polity, whereas the Maya cities were either independent or loosely allied. The difference in grapheme standardization may also be due to the previously mentioned greater artistic freedom in Maya public epigraphy. Although we cannot be certain, the reading of Oracle Bone texts was more likely a private affair among the king and a few officials.

The fact that Maya has few semantic graphemes may be due to the fact that its language is polysyllabic, therefore containing fewer homophones that need to be differentiated by semantic graphemes.

Another difference is that the phonetic graphemes in Oracle Bone script often serve only to remind the reader of the rhyme or tone or initial consonant cluster. In Maya, phonetic graphemes represent entire syllables except when they represent syllable ending consonants. This, together with the greater fluidity between glyph and meaning in the Maya script, places it closer to the syllabic end on the logo-syllabic continuum in comparison with Oracle Bone script.

In terms of grapheme positioning, Maya is much more complicated than Oracle Bone script because most glyphs contain many syllables whereas most Oracle Bone glyphs contain only one.

In short, the differences between Maya and Oracle Bone script probably result from the differences in the languages represented, the different degrees of political centralization, the different extent of public use of the script and the different conceptions of "self" in the two cultures.

What do the two scripts tell us about literacy in Classic Maya and Shang China? I suggest they pose about the same degree of difficulty (or ease) in terms of learning, writing and reading. Maya has fewer glyphs, but the graphemes are

less standardized, the grapheme shapes have more pictographic detail and the grapheme positions are more complicated. Oracle Bone has more glyphs, but the graphemes are more standardized, the graphemes have less pictographic detail and the grapheme positions are less complicated. Similar political economic systems – early kin based states with agricultural economies – would indicate a similar rate of literacy.

Lastly, does the comparison tell us anything new about the development of early scripts? Perhaps that the writing system may reflect how tightly morphemes are bound in the language, as the agglutinative nature of Maya language may have led to the Maya script containing more multi-word glyphs.

ENDNOTES

1 For more general information in English on Oracle Bone script, see Keightley, David N. 1978. *Sources of Shang History: The Oracle-Bone Inscriptions of Bronze Age China.* Berkeley: University of California Press.

2 http://www.artsmia.org/art-of-asia/history/shang-dynasty-map.cfm, accessed 6/12/2006.

3 http://brian.hoffert.faculty.noctrl.edu/REL100/OracleBone, accessed 6/5/2006.

4 Stuart, David. 1995. A Study of Maya Inscriptions. Ph.D. dissertation, Vanderbilt University. Also Stuart, David. 1994. "The Fire Enters His House: Architecture and Ritual in Classic Maya Texts." In Houston, Stephen D., editor. 1997. *Function and Meaning in Classic Maya Architecture.* Washington D.C.: Dumbarton Oaks. Stephen D. Houston. 1997. The Shifting Now: Aspects, Deixis, and Narrative in Classic Maya Texts. *American Anthropologist* 99.2, 291-305.

5 For more general information on Maya script, see Coe, Michael D. and Mark Van Stone. 2001. *Reading the Maya Glyphs.* London: Thames and Hudson.

6 http://www.mesoweb.com/resources/handbook/WH2005.pdf, 35, accessed 6/5/2006.

7 http://www.mesoweb.com/resources/handbook/WH2005.pdf, 6, accessed 6/5/2006.

8 Tolstoy, Paul. 1999. Trans-Pacific Contacts: What, Where and When? *The Review of Archeology* 20.1, 19.

9 De Acosta, Jose. 1986. *Historia Natural y Moral de las Indias.* Madrid: Historia, Book 6, chapters 4, 5, 6, 7. I wish to thank an anonymous reviewer for bringing this and some other articles on Maya script and literacy to my attention, as well as for making numerous helpful suggestions.

10 This section is closely based on an example provided by the anonymous reviewer.

11 Most of the Maya glyphs used in this paper come from http://jefferson.village.virginia.edu/med/glyph_catalog.html. This article uses a standard system for transcribing the signs of Maya glyphs into the Roman alphabet. This system is described in Coe and Van Stone, Reading, 19: "A transcription is a more-or-less accurate record in Roman letters of the values of individual signs in a Maya glyph or text, each sound being separated from its neighbors by hyphens. Transcriptions will always be in boldface type, with LOGOGRAMS in upper case, and syllabograms in lower case…A transliteration, always in italics, represents actual Maya language (Classic Mayan) recorded in the glyphic original and/or its transcription…A translation, always in quotes and regular type, is the English-language version of a Classic Maya transcription."

12 Coe and Van Stone, *Reading the Maya Glyphs*, 19. Kettunen. Harri and Christophe Helmke. Date? Introduction to Maya Hieroglyphs. Location: Publisher? http://www.mesoweb.com/resources/handbook/index.html, accessed 6/13/2006, 6. Harris, John F. and Stephen K. Stearns. 1997. *Understanding Maya Inscriptions*. Philadelphia: University of Pennsylvania. Museum of Archeology and Anthropology, 3.

13 胡厚宣. 1984. "八十五年來甲骨文材料之再統計." 史學月刊 1984:2 (Hu, Hou-xuen. 1984. "Bashiwunianlai Jiguwen Cailiao Zhi Zai Tongji (A Recounting of Oracle Bone Data for the Past 85 Years)." *Shixue Yuekan* (Historical Studies Monthly) 1984:2). 李圃. 1995. 甲骨文文字學. 上海: 學林, 24, 173 (Li, Pu. 1995. *Jiaguwen Wenzixue* (Oracle Bone Scriptology). Shanghai: Xuelin, 24, 173). 鄒曉麗, 李彤, 馮麗萍. 1999. 甲骨文字學述要. 長沙: 岳麓, 12 (Zou, Xiao-li, Li Tong, and Feng Li-ping, 1999. *Jiagu Wenzixue Shuyao* (Summary of Oracle Bone Scriptology). Changsha: Yuelu, 12).

14 Coe. Michael D. 1992. *Breaking the Maya Code*. New York: Thames and Hudson, 262.

15 Coe, *Breaking the Maya Code*, 235.

16 Coe and Van Stone, *Reading the Maya Glyphs*, 46.

17 Harris and Stearns, *Understanding Maya Inscriptions,* 34-35.

18 Coe and Van Stone, *Reading the Maya Glyphs*, 18. Harris and Stearns. *Understanding Maya Inscriptions*, 3.

19 Harris and Stearns, *Understanding Maya Inscriptions*, 50.

20 Hu, "Bashiwunianlai Jiguwen Cailiao Zhi Zai Tongji." Li, *Jiaguwen Wenzixue*, 24, 173. Zou, Li and Feng, *Jiagu Wenzixue Shuyao*, 12.

21 周法高. 1974. 漢字古今音彙. 香港: 中文大學 (Chou, Fa-kao. 1974. *Hanzi Gujin Yinhui* (A Pronouncing Dictionary of Chinese Characters in Archaic and Ancient Chinese, Mandarin and Cantonese). Hong Kong: Chinese University. I take my data from Chou's interpretation. Some of the notation is changed to conform to IPA.

22 王宇信, 楊升南, 聶玉海. 1996. 甲骨文精萃選讀. 北京: 語文, 15, 31 (Wang, Yu-xin, Yang Sheng-nan, and Nie Yu-hai. 1996. *Jiaguwen Jingcui Xuandu* (Best Selections of Oracle Bone Readings). Beijing: Yuwen, 15, 31).

23 Wang, Yang and Nie, *Jiaguwen Jingcui Xuandu*, 59, 75.

24 Wang, Yang and Nie, *Jiaguwen Jingcui Xuandu*, 469.

25 Zou, Li and Feng, *Jiagu Wenzixue Shuyao*, 65.

26 Zou, Li and Feng, *Jiagu Wenzixue Shuyao*, 39-40.

27 Examples for "blessing" are from Zou, Li, and Feng. *Jiagu Wenzixue Shuyao*, 34-36, and 李孝定. 甲骨文字集釋. 中央研究院歷史語言研究所專刊之五十, 57 (Li, Xiao-ding. *Jiagu Wenzi Jishi*. (Combined Explanations for Oracle Bone Scripts). Institute of History and Philology, Academia Sinica, Special Publications, No. 50).

28 Examples for "bull" are from Li. *Jiagu Wenzi Jishi*, 291.

29 Examples for "foothill" are from Li. *Jiagu Wenzi Jishi*, 2043.

30 Examples for "good" are from Li, *Jiagu Wenzi Jishi*, 3647.

31 Zou, Li and Feng, *Jiagu Wenzixue Shuyao*, 11, 260.

32 Wang, Yang and Nie, *Jiaguwen Jingcui Xuandu*, 345, 351.

33 Wang, Yang and Nie, *Jiaguwen Jingcui Xuandu*, 79, 151.

34 白川靜. 1977. 甲骨文的世界. 台北: 巨流, 66 (Shirakawa, Shizuka. Koukotubun no Sekkai (The World of Oracle Bone Script). Taipei: Juliu, 66). Wang, Yang and Nie, *Jiaguwen Jingcui Xuandu*, 53, 91, 136, 366, 402, 496, 552, 562, 641.

35 Shirakawa. *Koukotubun no Sekkai*, 53.

36 郭沫若編. 1983. 甲骨文合集. 第十二冊. 北京: 中華, 4505 (Guo, Muo-ruo, editor. 1983. *Jiaguwen Heji* (Collection of Oracle Bone Script), vol. 12. Beijing: Zhonghua, 4505). Other examples of this phrase and the repetition mark can be found on vol. 12, pp. 4509, 4546, and vol. 9, pp. 3330, 3438 and Shirakawa. *Koukotubun no Sekkai*, 48.

37 The first person to interpret it this way is Guo Muo-ruo. See郭沫若. 2000.卜辭通纂. 北京: 北京圖書館, 世系十五 (Guo, Muo-ruo. 2000. *Buci Tongzuan* (Complete Edition of Oracle Bone Scripts), Beijing: Beijing Library, Shixi 15).

38 胡厚宣主編. 1999. 甲骨文合集. 北京: 中國社會科學 (Hu, Hou-xuan, editor. 1999. *Jiaguwen Heji* (Collection of Oracle Bone Script). Beijing: China Social Sciences).

39 Li, *Jiaguwen Wenzixue*, 40-45.

40 This percentage is according to Zou, Li, and Feng. *Jiagu Wenzixue Shuyao*, 6, but later on using a different method of calculation she argues for 20% on p p. 12.

41 Li, *Jiaguwen Wenzixue*, 208.

42 Zou, Li and Feng. *Jiagu Wenzixue Shuyao*, 13, 55.

43 Zou, Li and Feng, *Jiagu Wenzixue Shuyao*, 59-61.

44 Zou, Li and Feng, *Jiagu Wenzixue Shuyao*, 6.

45 朱歧祥. 2002. 甲骨文字學. 台北: 里仁, 103 (Zhu, Qi-xiang. 2002. *Jiagu Wenzixue* (Oracle Bone Scriptology). Taipei: Liren, 103).

46 Zhu, *Jiagu Wenzixue*, 103.

47 Examples from Li. *Jiaguwen Wenzixue*, 104-109.

48 白川靜. 1989. 金文的世界. 台北: 聯經, 79, 84, 201 (Shirakawa, Shizuka. 1989. *Kinbun no Sekkai* (The World of Bronze Script). Taipei: Linking, 79, 84, 201). 何琳儀. 1989. 戰果文字通論. 北京: 中華, 224-225.

49 http://tech2.npm.gov.tw/DM2003/wcbi/c/cintro01.htm, accessed July 5, 2006.

50 Houston, Stephen. 1994. Literacy among the Pre-Columbian Maya: A Comparative Perspective. *Writing Without Words*, Elizabeth Hill Boone and Walter D. Mignolo, editors. Durham, NC: Duke University Press.

51 Houston and David Stuart. 1998. The Ancient Maya Self. Res 33, 88. The fact that the more animated glyphs generally occur in less public settings, as pointed out in the article, may indicate that some private life-force enhancing rituals were held in these settings, provided that Houston and Stuart's theory of the diffused self is correct.

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Index
for Volume 40

BY AUTHOR

Abulhab, Saad D., Typography Behind the Arabetic Calligraphy Veil, 294-307
Chiang, William, Comparison of Maya and Oracle Bone Script, 310-333
Duncan, Alison, Linda Reynolds and Sue Walker, Children's Responses to Line Spacing in Early Reading Books or 'Holes to tell which line you're on', 246-267
Friedman, Ken and Owen Smith, editors, special issue, part 2, Fluxus after Fluxus, 4-127
Friedman, Ken and Owen Smith, A Fluxus Bibliography, 114-127
Friedman, Ken and Owen Smith, The Dialectics of Legacy, 4-11
Friedman, Ken, The Literature of Fluxus, 90-113
Klefstad, Ann, What has Fluxus Created? 12-27
Miscellaneous, Artists' Statements, 44-65
Moren, Lisa, Introduction: Signatures, Music, Computers, Paranoia, Smells, Danger & the Sky, 28-43
Moura, Heloisa, Analyzing Multimodal Interaction within a Classroom Setting, 270-291
Okayama, Emiko and Barrie Shelton, Between Script and Pictures in Japan, 155-176
Pearce, Celia, Games as Art: The Aesthetics of Play, 66-89
Reynolds, Linda, Sue Walker and Alison Duncan, Children's Responses to Line Spacing in Early Reading Books: 'Holes to tell which line you're on', 246-267
Sabady, Stacie, Eric Swanson and Chris Yin, Teaching Design: Analysis from Three Different Analytical Perspectives, 207-237
Swanson, Eric, Stacie Sabady and Chris Yin, Teaching Design: Analysis from Three Different Analytical Perspectives, 207-237
Shelton, Barrie and Emiko Okayama, Between Script and Pictures in Japan, 155-176
Smith, Owen and Ken Friedman, editors, special issue, part 2, Fluxus after Fluxus, 4-127
Smith, Owen and Ken Friedman, A Fluxus Bibliography, 114-127
Smith, Owen and Ken Friedman, The Dialectics of Legacy, 4-11
Walker, Sue, Linda Reynolds and Alison Duncan, Children's Responses to Line Spacing in Early Reading Books: 'Holes to tell which line you're on', 246-267
Yin, Chris, Eric Swanson and Stacie Sabady, Teaching Design: Analysis from Three Different Analytical Perspectives, 207-237
Zender, Mike, Advancing Icon Design for Global Nonverbal Communication: or What does the word 'bow' mean? 177-206
Zuern, John, System, Suspension, Seduction: Anne Bush's Critical Design Practice, 132-154

BY TITLE

Advancing Icon Design for Global nonverbal Communication, Mike Zender, 177-206

Analyzing Multimodal Interaction within a Classroom Setting, Heloisa Moura, 270-291

Artists' Statements, Miscellaneous, 44-65

Between Script and Pictures in Japan, Barrie Shelton and Emiko Okayama, 155-176

Children's Responses to Line Spacing in Early Reading Books: or 'Holes to tell which line you're on', Linda Reynolds, Sue Walker and Alison Duncan, 246-267

Comparison of Maya and Oracle Bone Script, William Chiang, 310-333

The Dialectics of Legacy, Ken Friednman and Owen Smith, 4-11

A Fluxus Bibliography, Ken Friednman and Owen Smith, 114-127

Fluxus after Fluxus, special issue, part 2, Ken Firedman and Owen Smith, editors, 4-127

Games as Art: The Aesthetics of Play, Celia Pearce, 66-89

Introduction: Signatures, Music, Computers, Paranoia, Smells, Danger & the Sky, Lisa Moren, 28-43

The Literature of Fluxus, Ken Friedman, 90-113

System, Suspension, Seduction: Anne Bush's Critical Design Practice, 132-154

Teaching Design: Analysis from Three Different Analytical Perspectives, Eric Swanson, Stacie Sabady and Chris Yin, 207-237

Analyzing Multimodal Interaction within a Classroom Setting, Heloisa Moura, 270-291

What has Fluxus Created? Ann Klefstad, 12-27

Visible Language 40.1 presents pages 1-128

Visible Language 40.2 presents pages 129-240

Visible Language 40.3 presents pages 241-336

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