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Résumé de l'article

The texts BM 36628+ and BM 45720 contain number schemes, which in their first four columns list consecutive lines of Calendar Texts. These texts add six more columns (columns 5–10) to the classic Calendar Text. Therefore, we shall call them expanded Calendar Texts. The additional column 10 lists house numbers j , while column 9 contains four signs (labeled i) over four consecutive lines, one of which equals a j -value. As we shall see, the i -values are chosen so that they always form the zodiacal squares with j as one of the corners. I investigate the system behind the schemes by analyzing their number columns. We thus find a structure similar to that of the circular tablet BM 47762, which I presented in Part I [Aestimatio ns 2.2 (2021) 43–58]. This tablet lists the dates of first half, full, second half, and black Moon, where the zodiacal position of these special lunar phases joins to a square in the zodiacal circle. I investigate the connection between the two systems.

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Babylonian House Numbers and Squares of Zodiacal Signs

The Origin of the Quadruplicities, Part II

by

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Abstract

The texts BM 36628+ and BM 45720 contain number schemes, which in their first four columns list consecutive lines of Calendar Texts. These texts add six more columns (columns 5–10) to the classic Calendar Text. Therefore, we shall call them expanded Calendar Texts. The additional column 10 lists house numbers j , while column 9 contains four signs (labeled i) over four consecutive lines, one of which equals a j -value. As we shall see, the i -values are chosen so that they always form the zodiacal squares with j as one of the corners. I investigate the system behind the schemes by analyzing their number columns. We thus find a structure similar to that of the circular tablet BM 47762, which I presented in Part I [*Aestimations* 2.2 (2021) 43–58]. This tablet lists the dates of first half, full, second half, and black Moon, where the zodiacal position of these special lunar phases joins to a square in the zodiacal circle. I investigate the connection between the two systems.

About the Author

LIS BRACK-BERNSSEN'S research is in the history of mathematics and astronomy, especially the development of Babylonian astronomy and the use of computer simulations of ancient Babylonian observational data in systematic analyses. Her aim is to reconstruct the ancient rules governing prediction and to discover the concepts and methods behind early Babylonian astronomy.

Keywords Babylonian astronomy/astrology, lunar phases, *Dodecatemoria* (mean-value scheme), squares of zodiacal signs

1. Presentation and analysis of the texts (BM 36628+ and BM 45720)

The number schemes of interest derive from two cuneiform tablets: BM 45720, obv. II, 10'–21' [Steele 2015, 210] and text C = BM 36628+, lines C1'–C30' [Steele 2015, 197, 203].¹ Here, we shall follow the nomenclature and explanations given by Steele in his comments to the texts on page 209. Each line of the schemes starts with a set of four numbers (a, b, c, d) known from the Calendar Texts. Both pairs (a, b) and (c, d) can be read as (month day), (sign degree), or both.² There follows a pair of numbers (e, f) that are derived from (c, d) by subtracting 12 days or degrees (according to the reading). And finally, it is indicated that from (e, f) to (g, h) ($= c, d$) (i.e., during 13 days or 13°), a number i (the micro-sign number) is in the “house number” j . Let us call such schemes *expanded* Calendar Texts. In both texts (BM 45720 and BM 36628+), the scheme is written in one tablet column with up to 10 numbers $a, b, \dots, j$ in each line. In order to analyze the numbers more easily, in Tables 1 and 2 below, the numbers are reproduced in a scheme with 10 columns, 1 column for each number. An important question is: How are the house numbers j and the numbers i found? In the following, I shall try to illustrate my strategy for finding the structure behind the system by analyzing the numbers in the expanded Calendar Text schemes. Some further important questions arise: How are the numbers in the different columns connected? and How are the number pairs from the Calendar Text utilized for finding i (the micro-sign?) and j (the house number)?

The Calendar Text numbers on the two tablets originate from the first two Calendar Texts: those for months I and II or for signs I and II. Let me start by presenting the expanded Calendar Text scheme in BM 45720 obv. Column 2, published in Steele 2015, 210.

¹ See Table 1 [p. 100] and Table 2 [p. 102].

² However, astronomically, the Calendar Text scheme can be understood in the following way: (a, b) listed in consecutive lines gives the position of the Moon in consecutive degrees in the zodiac, while the number pair (c, d) indicates the date when the Moon was in the given position, according to the *Dodecatemoria* mean value scheme. See Brack-Bernsen 2021a.

BM 45720	<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	<i>e</i> from	<i>f</i> to	<i>g</i>	<i>h</i>	<i>i</i> of	House <i>j</i>
10'	1	1	10	7	9 TA	25 EN	10	7	10 šá	É BAR
11'	1	2	7	14	7 TA	2 EN	7	14	7 šá	É BAR
12'	1	3	4	21	4 TA	9[EN]	4	21	4 šá	É BAR
13'	1	4	1	28	1 TA	16 EN	1	28	1 šá	É BAR
14'	1	5	11	5	10 TA	23 EN	11	5	11 šá	É 2
15'	1	6	8	12	7 TA	30 EN	8	12	8 šá	É 2
16'	1	7	5	19	4 TA	7 EN	5	19	5 šá	É 2
17'	1	8	2	26	2 TA	14 EN	2	26	2 šá	É 2
18'	1	9	12	3	11 TA	21 EN	12	3	12 šá	É 3
19'	1	10	9	10	8 TA	28 EN	9	10	9 šá	É 3
20'	1	11	6	17	6 TA	5 EN	6	17	6 šá	É 3
21'	1	12	3	24	3 TA	12 EN	3	24	3 šá	É 3

Table 1. The expanded Calendar Text I from tablet
BM 45720, found in column 2, lines 10'–21'

If we read (*c d*) and (*e f*) as positions in line 10', then the text starts with (*c d*) = sign 10 degree 7 to find (*e f*) = sign 9 degree 25 by subtracting 12° from position (*c d*). The text tells us that (during the 13°) from sign 9 degree 25 until sign 10 degree 7 = (*g h*), the number 10 = *i* of house *j* = 1 = «BAR» applies. If the pairs are understood as dates, then *i* = 10 of house number *j* = 1 applies to the 13 days from date (*e f*) to date (*g h*).

The Babylonians often used tables for the calculation of astronomical events. In such tables, the numbers in the later columns are often dependent on, or derived from, some of the earlier columns, i.e. the columns to the left. Knowing this habit, let us look after connections or dependencies in the columns of Table 1. Evidently, the number pair (*e f*) is derived from (*c d*) by going 12 degrees/days back, while (*g h*) in all lines equals (*cd*). Note also that in all lines the numbers *i* and *c* are equal and that the house number *j* is equal to the *c*-value in each fourth line. To me *j* seems to be determined by *c* of each fourth line. In those lines 13', 17', and 21', we have *c* = *i* = *j*. For example, *j* = 2 is the house number in line 17', determined by *c* = 2. The same house number 2 also applies to the three lines 16', 15', and 14', above. In line 17', *i* = *j* = 2, while the numbers *i* (= *c*) in the three lines above are all different: 5, 8, 11. The text shows that house number 1 has the following numbers *i* (1, 4, 7, 10). The numbers *i* of house number 2 are (2, 5,

8, 11), and those of house number 3 are (3, 6, 9, 12). When we interpret the numbers i as zodiacal signs, we have here three groups of signs in a square relationship, i.e., each group (of four signs i) shapes a square in the zodiacal circle.

Hypothesis The number c in every fourth line determines the house number j , which in the fourth (determining) line also equals i .

This hypothesis is based on the numbers c , i , and j in Table 1, which are marked in dark red, that is, in every fourth line where the values happen to be equal: $c = j = i$. In the three lines above the fourth line, the same house number is used, while for all lines, the numbers i are equal to c .

The second text (BM 36628+, called text C by Steele) has the same structure as that seen in Table 1 but with one difference, or abbreviation: only in the cases where the numbers c and e (indicating sign or month) are different is the value of c repeated in column g . When $c = e$, g is omitted (as Steele noticed, too). However, some values i are also missing, namely, exactly those where in each fourth line the number i would be equal to the house number j . Based on our hypothesis, I have added the missing i -values (those equal to j) to the scheme and marked them with dark red in Table 2 [p. 102]. The scribe seems to omit repeating numbers.

As one can see, in many cases, i is different from c . We have to find out how the numbers i are found in this text. From the scheme, we can see that i is independent of c and e . It is not the difference between c and e that determines the number i . In some lines, we find that $i = c$. In other lines, $i = c + 1$; whereas in lines C3', C7', and C11', we find $c = e + 1$ and $c = i$. But in lines C8' and C12', we have $c = e + 1$ but $c + 1 = i$. We must conclude that i here is not determined directly by c . Only in each fourth determining line does $i = c = j$. However, for each house number j , the other three values of i are chosen so that they are the three missing numbers of the zodiacal square with j as one of the corners. The number i (in scheme 2), then, is exactly different from c in those cases where c is not a number from the square of j . Accordingly, I propose that the numbers i are chosen so that they build a zodiacal square with j as a corner.

John Steele [2015, 210] has suggested that we read the numbers i as micro-signs of (the house) j . If this is correct, we have here a zodiacal sign (j) that is called the house of four values of i , indicating the four micro-signs of the square defined by j .

Maddalena Rumor [2021, 59–63] has also analyzed the structure of Calendar Texts and noticed that the numbers c in four (and sometimes five)

BM 36628+	<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	<i>e</i> TA	<i>f</i> EN	<i>g</i>	<i>h</i>	<i>i</i> sá	É <i>j</i>
C1'	[2	16	5	22	5 from	10 to		22	6]	12
C2'	[2	17	2	29	2 from	27 to]		29	3	12
C3'	[2	18	12	6	11] from	24 to	12	6	[12]	12
C4'	[2	19	9	13]	9 from	1 to		13	10	1
C5'	[2	20	6	20]	6 from	8 to		20	7	1
C6'	[2	21	3	2]7	3 from	13 to		27	4	1
C7'	[2	22	1]	4	12 from	22 to	1	4	[1]	1
C8'	[2	23	10	1]1	9 from	29 to	10	11	11	2
C9'	[2	24]	7	18	7 from	6 to		18	8	2
C10'	[2	25	4]	25	4 from	13 to		25	5	2
C11'	[2	26	2]	2	1 from	20 to	2	2	[2]	2
C12'	[2	27	1]1	9	10 from	27 to	11	9	12	3
C13'	[2	28]	8	16	8 from	4 to		16	9	3
C14'	[2	29]	5	23	5 from	11 to		23	6	3
C15'	[2	30]	2	30	2 from	18 to		[30	3	3]
C16'	1	1	[10]	7	9 from	25 to		[10	7	...]
C17'	1	2	[7]	14	7 from	2 to		1[4		...]
C18'	1	3	[4	2]1	4 from	9 to		[21		...]
C19'	1	4	[1	2]8	1 from	13! to		[28		...]
C20'	1	14	10	8	[9 from]	25 to	10	7	12	15?
C21'	1	27	10	9	[9 from]	27 to	10	9	10!	
C22'	1	5	1[1]	5	10 from	2[3 to	11	5		...]
C23'	1	18	11	6	10 from	2[4 to	11	6		...]
C24'	2	1	11	7	10 from	2[5 to	11	7		...]
C25'	2	14	11	8	10 from	2[6 to	11	8		...]
C26'	2	27	[11]	9	10 from	27 [to	11	9		...]
C27'	1	[9	12]	3	11 from					
C28'	1	[22	12]	4	11 from					
C29'	[2	5	12]	5	11 from					
C30'	[2	18	12]	6	11 from					

Table 2. The expanded Calendar Text II from tablet BM 36628+, lines 1'–30' as reconstructed in [Steele 2015](#), 203

The numbers in line C20' are very difficult to read and hopelessly wrong. Therefore, I shall not use that line in my investigations. In line C21', I read $i = 10$ and not 20. Note that the number $g (= c)$ is omitted in all those lines where $e = c$ and that the values of i are missing in exactly those lines where $i = j$ according to our hypothesis. Note that in many lines i is not equal to c . Note also that the distance from (a, b) given in one line to (a, b) in the next is equal to 13° for lines C22', C23', C24', C25', and C26'.

consecutive lines constitute a sign square and she connected them to quadruplicities of zodiacal signs, known from Greek medicine and astrology. She noticed that the three Greek types of zodiacal square are identical to the three squares of the “house numbers j ” written on the expanded Calendar Text BM 45720, published in [Steele 2015](#). She proposes that $\acute{E}$, the “House” term, might refer to quadruplicities, which seems to be a reasonable and very convincing idea. But her reconstructed squares do not reproduce the system found on BM 36628+, the second known expanded Calendar Text.

However, her observation that the c values in each of the four consecutive lines build a zodiacal square might have been the starting point for the construction of the expanded schemes [see §5, p. 115 below]. Independently, I had also investigated the expanded Calendar Texts and noticed that on BM 36628+, the numbers c and i are not always the same. So, I tried to find out exactly when and why the numbers c and i were different in some lines of the text. It took me a very long time to realize that in all cases where c and i were different, the number i was always part of the square of house number j , but c was not. (That was how I found the squares.) This investigation of the two expanded Calendar Texts leads to a system which is always organized in blocks of four (but never in five!) lines. To me, it seems that the house number system with squares of four signs i : (10, 7, 4, 1), (11, 8, 5, 2), or (12, 9, 6, 3), is organized by other (and stronger) criteria than the structure of the normal Calendar Texts. The signs i only sometimes happen to be equal to c from the Calendar Text; however, they are always chosen such that they build the square of the house number j . Remember that the house number j is determined by the c listed in each fourth line of the Calendar text. These criteria determine the system uniquely, and we shall see that this was the way in which the expanded Calendar Texts were constructed.

Let us return to the expanded Calendar Texts presented in Tables 1 and 2 and check this hypothesis. Both number schemes start out with sets of quadruple numbers that we know from the Calendar Texts for month/sign I and II. In order to get a comprehensive look at the lines occurring in the two schemes, [Table 3 \[p. 104\]](#) reproduces the numbers (a , b , c , d) from the first two Calendar Texts I and II, together with an indication of the lines of the two expanded Calendar Text schemes in which the quadruples occur. The number c in each fourth line, which, according to our hypothesis indicate the house number j , is printed in dark red.

In Table 3, BM 45720 shows the first 12 consecutive lines of Calendar Text I, lines 10'–21' of Table 1, while BM 36628+ lists the first five lines plus line 9 in line C16'–C19', C22' and C27' of Table 2. Such consecutive lines in a

BM 45720	Calendar Text I+				BM 36628+	Calendar Text II				BM 36628+
	<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>		<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	
10'	1	1	10	7	C16'	2	1	11	7	C24'
11'	1	2	7	14	C17'	2	2	8	14	
12'	1	3	4	21	C18'	2	3	5	21	
13'	1	4	1	28	C19'	2	4	2	28	
14'	1	5	11	5	C22'	2	5	12	5	C29'
15'	1	6	8	12		2	6	9	12	
16'	1	7	5	19		2	7	6	19	
17'	1	8	2	26		2	8	3	26	
18'	1	9	12	3	C27'	2	9	1	3	
19'	1	10	9	10		2	10	10	10	
20'	1	11	6	17		2	11	7	17	
21'	1	12	3	24		2	12	4	24	
	1	13	1	1		2	13	2	1	
	1	14	10	8		2	14	11	8	C25'
	1	15	7	15		2	15	8	15	
	1	16	4	22		2	16	5	22	C1'
	1	17	1	29		2	17	2	29	C2'
	1	18	11	6	C23'	2	18	12	6	C3' C30'
	1	19	8	13		2	19	9	13	C4'
	1	20	5	20		2	20	6	20	C5'
	1	21	2	27		2	21	3	27	C6'
	1	22	12	4	C28'	2	22	1	4	C7'
	1	23	9	11		2	23	10	11	C8'
	1	24	6	18		2	24	7	18	C9'
	1	25	3	25		2	25	4	25	C10'
	1	26	1	2		2	26	2	2	C11'
	1	27	10	9	C21'	2	27	11	9	C12' C26'
	1	28	7	16		2	28	8	16	C13'
	1	29	4	23		2	29	5	23	C14'
	1	30	1	30		2	30	2 3	30 0	C15'
(=2	= 0	= 2	= 0)			(= 3	= 0	= 3	= 0)	
2	1	11	7			3	1	12	7	

Table 3. The numbers (*a, b, c, d*)
from Calendar Texts I and II

This table lists which lines are represented in our two expanded Calendar Texts together with the line numbers in which they occur.

Calendar Text is exactly what one would expect if someone is constructing an enlarged scheme in which the house numbers are somehow derived from the Calendar text scheme. That the same six lines of month/sign I are listed in both expanded Calendar Texts and that they agree in all readable numbers is very important. It shows that both tables are concerned with one and the same system. At the same time, we know the three house numbers for the first 12 lines of month/sign I from BM 45720 while the house numbers for the last 15 lines of Calendar Text II are listed on BM 36628+. Assuming that there is a rational system underlying the house numbers, these house numbers have to connect. And indeed, they do! Our hypothesis claims that house number j is determined by each fourth number c of column three. These numbers c are marked dark red, and in Table 3 [p. 104] we see that they continue nicely from Text I to Text II.

A last comment to Table 3 concerning BM36628+: note that the following dark green lines, C22'–C26', end on consecutive number pairs ($c d$): (11 5), (11 6), (11 7), (11 8), and (11 9). Similarly, the dark blue lines C27'–C30' are selected so that the last number pairs again indicate consecutive positions or dates: (12 3), (12 4), (12 5), and (12 6). To me, this looks as though someone is analyzing, arguing, or utilizing the structure of the scheme.

Summing up Our analysis has shown that the four values of i build the square of the house number j , where j equals the c listed in each fourth line of the Calendar text. These criteria determine the system uniquely, and we shall see that this was the way in which the expanded Calendar Texts were constructed: in Tables 4 [p. 106] and 5 [p. 108] are the expanded Calendar systems for months I and II including the numbers i and j reconstructed according to our criteria. In Table 3 we had only reproduced the quadruple numbers ($a b c d$) from the Calendar Texts but not the numbers i and the house numbers j . The columns e, f, g and h have no influence on the numbers i and j , therefore they are not reconstructed in Tables 4 and 5.

In Table 4, I present the reconstructed house numbers j in the column labeled “House Numbers” (“HN” otherwise) while the four signs i of each square are given in the **micro-sign** column. All the numbers given in the expanded Calendar Texts are reproduced in the first 12 columns. In the following reconstructed lines, the missing house numbers are constructed according to our hypothesis: **HN** equals the number c in each fourth line, (starting in line 4 of sign/month I), the micro-sign numbers in these lines equal $c = \text{HN}$, whereas the three other micro-signs always belong to the square of **HN**: the micro-sign equals c when c is part of the square while it equals $c + 1$ whenever c is not part of the square of **HN**. The **HN** and micro-sign constructed in this way are listed in the last two dark red columns of Table 4.

BM 36628	BM 45720	<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	<i>e</i> TA	<i>f</i> EN	<i>g</i>	<i>h</i>	<i>i</i>	<i>j</i>	micro- sign	House Number
C16' (C20'?)	10'	1	1	10	7	9	25	10	7	10	1	10	1
C17'	11'	1	2	7	14	7	2	7	14	7	1	7	1
C18'	12'	1	3	4	21	4	9	4	21	4	1	4	1
C19'	13'	1	4	1	28	1	16	1	28	1	1	1	←1
C22'	14'	1	5	11	5	10	23	11	5	11	2	11	2
	15'	1	6	8	12	7	30	8	12	8	2	8	2
	16'	1	7	5	19	4	7	5	19	5	2	5	2
	17'	1	8	2	26	2	14	2	26	2	2	2	←2
C27'	18'	1	9	12	3	11	21	12	3	12	3	12	3
	19'	1	10	9	10	8	29	9	10	9	3	9	3
	20'	1	11	6	17	6	5	6	17	6	3	6	3
	21'	1	12	3	24	3	12	3	24	3	3	3	←3
		1	13	1	1							1	4
C20' !?		1	14	10	8							10	4
		1	15	7	15							7	4
		1	16	4	22							4	←4
		1	17	1	29							2	5
C23'		1	18	11	6							11	5
		1	19	8	13							8	5
		1	20	5	20							5	←5
		1	21	2	27							3	6
C28'		1	22	12	4							12	6
		1	23	9	11							9	6
		1	24	6	18							6	←6
		1	25	3	25							4	7
		1	26	1	2							1	7
		1	27	10	9							10	7
		1	28	7	16							7	←7
		1	29	4	23							5	8
		1	30	1	30							2	8

Table 4. The partly reconstructed scheme
for finding house and micro-sign numbers in the
first expanded Calendar Text [Table 1, p. 100]

The red arrows in the column “House Number” point at the *c*
value in the same line, which determines the house number *j*.

In the first 16 lines of Table 4 [p. 106] the numbers c and i are always equal, but that is not the case for the subsequent reconstructed lines. The same is true for the following expanded Calendar Text II, reconstructed in Table 5, where the first house number $j = c$ is found in line 2, i.e., four lines after line 28 in Text I. Starting in line 2, the house numbers $i = j = c$ are found in each fourth line. The reconstructed house numbers j are listed in column **HN** while the four signs i of each square are given in the column for micro-signs. In this case again, the numbers i in the other lines are not always equal to c in the same line of the expanded Calendar Text. We see that the j numbers in column **HN** continue nicely from Text I to Text II. In addition, the numbers i and j agree in all cases with those listed on BM45720 and BM 36628+. This confirms our hypothesis.

The rule of choosing sign c in each fourth line as house number j results in two different types of house number schemes: The expanded Calendar Texts for the “odd” months or signs: I, III, V, VII, IX, and XI find the house number in the lines 4, 8, 12, 16, 20, 24, and 28 of column c . The schematic month has, however 30 days. The fourth lines after line/day 28 in month I is line/day 2 in month II. Therefore, the expanded Calendar Texts for the “even” months II, IV, VI, VIII, X, and XII find the house numbers in lines 2, 6, 10, 14, 18, 22, 26, and 30 of column c . The way the expanded Calendar Texts find the house numbers **HN** and micro signs = i , is now clear: Table 4 shows the structure of all “odd” months/signs, while Table 5 is a model for the “even” months/signs.

The reconstructed house numbers connect the two tablets (BM 45720 and BM 36628) correctly, and the house numbers are again determined by number c of each fourth line. In addition, we see from the text that $(c\ d) = (2\ 30)$ in the last line is read as $(3\ 0)$ since we find house number $j = 3$ in the text.³ We have seen that i is not determined directly by c . Mostly, the micro-sign number $i = c$; sometimes, however, in $i = c + 1$, c is corrected by the addition of 1. This happens exclusively when c is not part of the quadruple of j ; then it is corrected to $i = c + 1$. We see that the number i is determined only partly by c . The house number j determines when c is corrected. For each house number j , the four numbers i are the square numbers of the square

³ In astronomical and astrological texts, one often finds the identifications:

day 30 of month M = day 0 of month $M+1$, and

degree 30 of sign M = degree 0 of sign $M+1$.

In the last line of Table 5 [p. 108], we have 30° of sign 2 identified with 0° of sign 3.

BM 36628	<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	<i>e</i> TA	<i>f</i> EN	<i>g</i>	<i>h</i>	<i>i</i>	<i>j</i>	micro- sign	House Number <i>j</i>
C24'	2	1	11	7							11	8
	2	2	8	14							8	←8
	2	3	5	21							6	9
	2	4	2	28							3	9
C29'	2	5	12	5							12	9
	2	6	9	12							9	←9
	2	7	6	19							7	10
	2	8	3	26							4	10
	2	9	1	3							1	10
	2	10	10	10							10	←10
	2	11	7	17							8	11
	2	12	4	24							5	11
	2	13	2	1							2	11
	2	14	11	8							11	←11
C25'	2	15	8	15							9	12
	2	16	5	22	5	10		22	6	12	6	12
C1'	2	17	2	29	2	17		29	3	12	3	12
C2'	2	18	12	6	11	24	12	6	12!	12	12	←12
C3' C30'	2	19	9	13	9	1		13	10	1	10	1
C4'	2	20	6	20	6	8		20	7	1	7	1
C5'	2	21	3	27	3	15!!		27	4	1	4	1
C6'	2	22	1	4	12	22	1	4	1!	1	1	←1
C7'	2	23	10	11	9	29	10	11	11	2	11	2
C8'		24	7	18	7	6		18	8	2	8	2
C9'	2	25	4	25	4	13		25	5	2	5	2
C10'	2	26	2	2	1	20	2	2	2!	2	2	←2
C11'	2	27	11	9	10	27	11	9	12	3	12	3
C12' C26'	2	28	8	16	8	4		16	9	3	9	3
C13'	2	29	5	23	5	11		23	6	3	6	3
C14'	2	30	2	30	2	18		30	3	3	3	←3
C15'												

Table 5. The partly reconstructed scheme for finding house numbers in the second expanded Calendar Text

Here again, the value of *c* in each fourth line determines the house number, and this house number determines the micro-sign number so that they build the square with *j* or the house number as one of the corners. Note that the reconstructed house number and micro-sign in all cases are the same as what we can read in columns *j* and *i* in text BM 36628+.

determined by j . This enables us to reconstruct the expanded Calendar Text scheme for all 12 months/zodiacal signs.

We conclude the following:

- j and the quadruple structure decide the numbers i .
- For each of the house numbers $j = 1, 4, 7, 10$, the number i has the cyclic values 10, 7, 4, 1.
- For each of the house numbers $j = 2, 5, 8, 11$, the number i has the cyclic values 11, 8, 5, 2.
- For each of the house numbers $j = 3, 6, 9, 12$, the number i has the cyclic values 12, 9, 6, 3.

If this reconstruction is correct, then I must question whether the numbers i should be understood as micro-signs in the same way as in the *Dodecatemoria*. Maybe they result from a more abstract construction, a construction based on the square numbers. But this would again bring it further away from the mean value schemes for the movement of the Sun and the Moon.

2. The connection between the house number tablets BM 36628+, BM 45720, and BM 47762

There is, however, a close connection between this house number system and the system found on a circular tablet BM 47762, presented in [Brack-Bernsen 2021b](#). BM 47762 connects a month or sign of the Sun to the signs of the Moon when it is at its four important phases within that month. It results in a special quadratic structure of signs, which is very similar to what we have found here. The expanded Calendar Texts are structured by the same sign squares (1, 4, 7, 10), (2, 5, 8, 11), or (3, 6, 9, 12), as implicitly given in BM 47762. See Table 6 [\[p. 110\]](#) for a comparison of the two systems.

To me, the “house number” system ($j\ i$) found in the expanded Calendar Text scheme looks like it could have been derived from, or related to, the structure of tablet BM 47762. Here the zodiacal squares are built by the signs of the Moon in its four important phases. Based on the Calendar Text scheme, the expanded scheme might have been constructed to become similar to the structure of those zodiacal lunar squares.

We know how the house number j and micro-sign i were derived from the Calendar Texts, and this enables us to reconstruct the house numbers j with their i numbers for all 12 Calendar Texts. For the six Calendar Texts where the first column a is uneven, the structure of the house numbers scheme is similar to that in [Table 4 \[p. 106\]](#): the number in column c agrees with the micro-sign i in most of the lines. Only in lines 17, 21, 25, and 29 is c

BM 47762		BM36303+					
Sector XI, Sign 11	Sign of the Moon	Expanded Calendar Texts				<i>j</i>	<i>micro-sign i</i>
		<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>		
Month 11, day 7	2	2	23	10	11	2	11
Month 11, day 14	5	2	24	7	18	2	8
Month 11, day 21	8	2	25	4	25	2	5
Month 11, day 28	11	2	26	2	2	2	2

Table 6. The Moon sign and house number systems

The Moon sign system (columns 1 and 2), constructed on the basis of the dates from BM 47762, is compared with the house number system (columns 3–8) to determine the connection between the two systems. The signs of the Moon (2 5 8 11) are the same as the micro-signs *i*, just in reverse order.

corrected: $i = c + 1$. In all Calendar Texts where *a* in the first column is even, the micro-sign number *i* is 1 higher than the number *c* in the lines 3, 4, 7, 8, 11, 12, 15, 16, 17, 19, 20, 21, 23, 24, 25, 27, 28, and 29 (as in Table 5 [p. 108], where $a = 2$).

Maybe the expanded Calendar Text simply took over the square structure as an organizing system. This system was stronger than the rules that determine the numbers *c* in the third column of the Calendar Text scheme. The analyses of the two available expanded Calendar Texts revealed that it was the month (or the position of the Sun) given in each fourth line that determined the house number *j*. In the “odd” Calendar Texts with $a = 1, 3, 5 \dots$, the number *j* was given through the *c*-values in lines 4, 8, 12, 16, 20, 24, and 28, while for the “even” Calendar Texts where $a = 2, 4, 6 \dots$, it was the *c*-values in lines 2, 6, 10, 14, 18, 22, 26, and 30 that determined the house number *j*.

That the house numbers are found in different lines in “even” and “odd” texts is a consequence of how house numbers are determined, that is, through the value of *c* in each fourth line of the schemes. In line 28 of the first Calendar Text, the value of $c = 7$ indicates house number 7. This is the solar position when the Moon is in sign 1, degree 28. Four lines later, in line 2 of the second Calendar Text, the schematic Moon is at the position sign 2, degree 2. The corresponding sign 8 of the Sun is given in line 2 of column *c*; it delivers the house number 8 for that line and the three lines above it.

3. The astronomical significance of the *Dodecatemoria* and the Calendar schemes

I postulate here a connection between the two systems with groups of four zodiacal signs, attested in the expanded Calendar Texts BM 45720 and BM 36628+, on one hand, and in BM 47762, on the other. The system found in BM 47762 is based on the *Dodecatemoria* scheme, while our texts BM 45720 and BM 36628+ are based on the Calendar Text scheme. We know that the two types of schemes are inverse number schemes and that the Babylonians knew it, too [see Brack-Bernsen 2021a]. The *Dodecatemoria* delivers the lunar position for all dates in the schematic year. It is based on a very simple model utilizing mean values: the Sun moves 1° each day, while the Moon moves 13° per day. Its inverse, the Calendar Text scheme, delivers, for each position in the zodiacal circle, the date when the Moon was in that position. Does this knowledge give us more insight into an eventual astronomical/astrological basis of the house number systems? In the *Dodecatemoria* the first pair of numbers, which increases by 1 from one line to the next, indicates a date in the schematic calendar; the second pair (which is increasing by 13 from one line to the next) indicates the position of the Moon on that day. In the Calendar Text scheme, the pair that is increasing by 1 from one line to the next indicates the position of the Moon at consecutive degrees in the zodiacal circle. In the case of the expanded Calendar Text, it is the pair (a, b) . The other number pair (c, d) , which is increasing by 277 from one line to the next, delivers the date at which the Moon was in the given position. Note that c indicates a month, which at the same time also indicates the zodiacal sign of the Sun, and that c in each fourth line determines the house number j for that line and for the three lines above it.

This observation, however, leads to this question: If we interpret the (expanded) Calendar Text (a, b) as lunar position and (c, d) as date or solar position, then why does the text go 12 days or 12° back from the solar position (c, d) to (e, f) ? The 13° starting at (c, d) and ending at (e, f) are reminiscent of the daily movement of the Moon in the *Dodecatemoria*! What we find here is strange.

Now, tablet BM 36628+ has another link to 13° . As we noticed in Table 2 [p. 102], the distance from (a, b) given in one line to (a, b) in the next line is equal to 13° for the lines C22', C23', C24', C25', and C26'. The 13° movement of the schematic Moon seems to play an important role. However, the determination of the numbers i and j is independent of the numbers

Section XI		☾ Sign	☉ Sign	Expanded Calendar Text				micro- sign	House Number	☉ Sign	☾ Sign
Month	Day			<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	<i>i</i>	<i>j</i>		
11	7	2	11	11	1	8	7	8	11	8	11
11	14	5	11	11	2	5	14	5	11	5	11
11	21	8	11	11	3	2	21	2	11	2	11
11	28	11	11	11	4	11	28	11	11	11	11
				11	5	9	5	9	12	9	11

Table 7. Comparison of the two systems including the schematic position of the Sun and the Moon

In columns 3 and 4 are the positions of the Sun and the Moon listed for the dates (columns 1 and 2) from section XI of BM 47762. Columns 5 and 6 list the first five lines of the Calendar Text for sign 11. Columns 7 and 8 list the numbers *i* and *j* from the reconstructed expanded Calendar Text XI, while columns 9 and 10 indicate the zodiacal signs of the Sun and the Moon for the dates in column 6. Note that the house number in line 5 is 12. Therefore, it is not the lunar sign that determines *j*.

(*e f*). Maybe the positions (*c d*) and (*e f*) were part of the construction of the planetary Terms?⁴ I leave that problem to others.

Let us return to the two systems with zodiacal squares and compare them again to see if we can identify new information by also considering the schematic positions of the Sun and the Moon on the given dates.

The zodiacal sign 11 is written on the top of section XI in BM 47762. It is the same as sign 11 of the Sun in all four lines of column 1. But note that it is also the sign of the black Moon taking place on day 28 of month 11.

In BM 47762, treated in columns 1–4, the zodiacal squares are created by the zodiacal signs where the Moon resides when it is in its special phases. In the case of the expanded Calendar Texts (columns 5–10), it seems to be the Sun that partly decides the micro-sign numbers *i*: in the first four lines of the expanded Calendar Text for uneven lunar signs, the signs of the Sun build a square in the zodiac together with the house number *j*. I propose that the similarity, seen in Table 7, was the basis of the construction of the house number system for the Calendar Texts. The square structure was found and

⁴ See Jones and Steele 2011; and Steele 2015, 210–212.

dominated: the micro-sign i was the sign of the Sun in many cases. It just had to be changed to the next sign in those cases where it was not part of the square of house number j . In this way, the system could be continued to include all lines of each Calendar Text.

A potential astronomical/astrological basis for the schemes with squares of zodiacal signs might be the schematic positions of the Sun and the Moon. The system found in BM 47762 is based on the Moon: the positions of the Moon at its special four phases form a square in the zodiacal circle. In the case of the inverse scheme, the Calendar Texts scheme, the position of the Sun delivers the house numbers j , and this number combined with the chosen values i always builds a square but i is not always the sign of the Sun. The symmetry between the Sun and the Moon agrees with the fact that we have inverse schemes here, but it also means that we can hardly identify the numbers i as micro-signs.

4. Conclusion

In Part I of my investigation of the quadruplicities of the zodiacal signs [Brack-Bernsen 2021b], I showed how the dates given on the circular tablet BM 47762 lead to squares of zodiacal signs. The *Dodecatemoria* mean value scheme for lunar movement, used to determine the position of the Moon on schematic days 7, 14, 21, and 28, leads directly to the quadruplicities of zodiacal signs. I propose, therefore, that the schematic positions of the Moon in its important phases—first half, full, second half, and “black”—is the origin of quadruplicities of zodiacal signs. This system of squares of signs was then applied to the inverse, Calendar Text, schemes. In each fourth line of the calendar schemes, c , the sign of the Sun, determined the house number j , which was valid for that line and the three lines above it. The house numbers j were then combined with the solar positions c in the three lines above it. They should build a square with j as one of the corners. Sometimes all numbers c could be taken over directly; sometimes some of them had to be corrected by the addition of 1. It seems that the square structure was dominant and led to the system of house numbers and their squares of i numbers, constructed in the expanded Calendar Text systems in BM 45720 and BM 36628+. In BM 47762, it was the positions of the schematic Moon that constituted zodiacal squares. In BM 45720 and BM 36628+, it was the positions of the schematic Sun that determined the house number j . This number j , then, determined whether the sign of the Sun could be used as an i -value or whether the i -value should be that of the next sign.

<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	<i>i</i>	<i>j</i>	<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	<i>i</i>	<i>j</i>	<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	<i>i</i>	<i>j</i>
1	1	10	7	10	1	2	1	11	7	11	8	3	1	12	7	12	3
1	2	7	14	7	1	2	2	8	14	8	8	3	2	9	14	9	3
1	3	4	21	4	1	2	3	5	21	6	9	3	3	6	21	6	3
1	4	1	28	1	1	2	4	2	28	3	9	3	4	3	28	3	3
1	5	11	5	11	2	2	5	12	5	12	9	3	5	1	5	1	4
1	6	8	12	8	2	2	6	9	12	9	9	3	6	10	12	10	4
1	7	5	19	5	2	2	7	6	19	7	10	3	7	7	19	7	4
1	8	2	26	2	2	2	8	3	26	4	10	3	8	4	26	4	4
1	9	12	3	12	3	2	9	1	3	1	10	3	9	2	3	2	5
1	10	9	10	9	3	2	10	10	10	10	10	3	10	11	10	11	5
1	11	6	17	6	3	2	11	7	17	8	11	3	11	8	17	8	5
1	12	3	24	3	3	2	12	4	24	5	11	3	12	5	24	5	5
1	13	1	1	1	4	2	13	2	1	2	11	3	13	3	1	3	6
1	14	10	8	10	4	2	14	11	8	11	11	3	14	12	8	12	6
1	15	7	15	7	4	2	15	8	15	9	12	3	15	9	15	9	6
1	16	4	22	4	4	2	16	5	22	6	12	3	16	6	22	6	6
1	17	1	29	2	5	2	17	2	29	3	12	3	17	3	29	4	7
1	18	11	6	11	5	2	18	12	6	12	12	3	18	1	6	1	7
1	19	8	13	8	5	2	19	9	13	10	1	3	19	10	13	10	7
1	20	5	20	5	5	2	20	6	20	7	1	3	20	7	20	7	7
1	21	2	27	3	6	2	21	3	27	4	1	3	21	4	27	5	8
1	22	12	4	12	6	2	22	1	4	1	1	3	22	2	4	2	8
1	23	9	11	9	6	2	23	10	11	11	2	3	23	11	11	11	8
1	24	6	18	6	6	2	24	7	18	8	2	3	24	8	18	8	8
1	25	3	25	4	7	2	25	4	25	5	2	3	25	5	25	6	9
1	26	1	2	1	7	2	26	2	2	2	2	3	26	3	2	3	9
1	27	10	9	10	7	2	27	11	9	12	3	3	27	12	9	12	9
1	28	7	16	7	7	2	28	8	16	9	3	3	28	9	16	9	9
1	29	4	23	5	8	2	29	5	23	6	3	3	29	6	23	7	10
1	30	1	30	2	8	2	30	2	30	3	3	3	30	3	30	4	10
2	1	11	7			3	1	12	7			4	1	1	7		

Table 8. The reconstructed house and *i* numbers
for the first three months/signs I, II, and III

The *c* values determining the house numbers *j* are marked bold dark red, while those *c* values which are different from the *i* values in the same line are marked bold black. If additional tables with expanded Calendar Texts are found, they may serve to test this reconstructed system.

As a convenience to the reader, I now append [Table 8, p. 114](#), a compact survey of the expanded Calendar Text as it has now been reconstructed.

5. Speculation: How the Babylonians constructed the expanded Calendar Texts⁵

Based on the Calendar Text's numbers for month I and II, Rumor [2021, 63 (Table 3)] has constructed 14 squares, all being one of the three types (Cardinal, Fixed, and Mutable), mentioned in Ptolemy's *Tetrabiblos*. Referring to one of the expanded Calendar Texts (BM 45720), which contains the first 12 lines of Sign/Moth I [see her Table 1], she identifies Square 1 with House I. She proposes that É, the "House" term might refer to quadruplicities, which seems to be a reasonable and very convincing idea.

The problem is that Rumor's squares for month II are different from the houses j and numbers i found on BM 36628+. Her squares constructed for month II are given in the right half of her Table 3, and they do not agree with the House numbers j and i values given in the expanded Calendar Text (BM 36628+) for the days/degrees 16 to 30 of Month/Sign II. In [Table 9 \[p. 116\]](#), to the left I have reproduced Rumor's construction and compared it with the numbers i and j given in BM 36628+. The houses j in this text cover always four lines and the i values in these lines shape the square of j . The scheme is consistent and clear. But these squares cannot be identified with the squares in Rumor's Table 3, and the numbers of the squares, constructed by Rumor directly from the numbers (c, d) of the Calendar Text, are different from the house numbers j in these lines as written in BM 36628+.

That Rumor gets squares of mostly four and sometimes five lines is just the consequence of the distance of -83° from one line to the next in columns (c, d) of a Calendar Text. This leads in column c to the sequence of signs 10, 7, 4, 1 for the first four lines of the first Calendar Text, and 11, 8, 5, 2 for the next four lines, and 12, 9, 6, 3 for the following. This is, indeed, an important discovery, which the Babylonians may have made, too, and then also noticed that the first three such groups of four signs are the same as those determined by the important *four(!)* lunar phases. They are, however, coming in reversed order. We know from many cuneiform texts that the Babylonian scholars played with number- and other symmetries. The same signs in reversed order found in the Calendar Text is encouraging. Therefore, it is quite possible that the house number system, with the four signs i in

⁵ I am grateful to the referee who asked for better explanations and thus stimulated these speculations.

Rumor's Reconstruction					Expanded Calendar Text			
Square Number	<i>a</i>	<i>b</i> Day	<i>c</i> Sign	<i>c</i> Number	<i>a</i>	<i>b</i>	Sign of	HN <i>j</i>
11	II	16	Leo	5	2	16	6	12
11	II	17	Taurus	2	2	17	3	12
12	II	18	Pisces	12	2	18	12	12
12	II	19	Sagittarius	9	2	19	10	1
12	II	20	Virgo	6	2	20	7	1
12	II	21	Gemini	3	2	21	4	1
1	II	22	Aries	1	2	22	1	1
1	II	23	Capricorn	10	2	23	11	2
1	II	24	Libra	7	2	24	8	2
1	II	25	Cancer	4	2	25	5	2
2	II	26	Taurus	2	2	26	2	2
2	II	27	Aquarius	11	2	27	12	3
2	II	28	Scorpio	8	2	28	9	3
2	II	29	Leo	5	2	29	6	3
2	II	30	Taurus	2	2	30	3	3

Table 9. Comparison of Rumor's construction and the expanded Calendar Text for month/sign II

each house *j*, was constructed by adjusting the Calendar Text system to the structure of the *Dodecatemoria* determined system as found on the circular tablet BM 47762. We may therefore speculate that the starting point for the “Quadruplicities in Babylon”, based on Calendar Texts, may have been the sequence of signs in consecutive lines of the Calendar texts, as noticed by Rumor. The Babylonians may have seen how similar these first three squares of four lines each are to the system of squares defined by the important four lunar phases. Rumor compared the squares structure found in consecutive lines of the Calendar texts with the house numbers of the expanded Calendar Texts. Here we shall compare the zodiacal signs of consecutive lines in Calendar Text I with the squares of signs produced by the four important lunar phases.

In Table 10, the first 12 lines of Calendar Text I are now compared to the system determined by the *Dodecatemoria* scheme which delivers the zodiacal signs of the lunar phases first half (on day 7), full Moon (on day 14)

second half (on day 21) and black Moon (on day 28) [see [Brack-Bernsen 2021b](#), Table 6]. The signs of the Moon are given in column 3, the Calendar Text numbers are listed in columns 5–8 and, and the corresponding house numbers and micro-sign values are listed in columns 9 and 10. Note that the *c* values in column 7 are the same as the signs of the Moon in column 10 but in reversed order, and that the house numbers in column 10 agree with the signs of the Sun listed in columns 1 and 4.

Sector I											
Month	Day	Moon Sign	Sun Sign	Calendar Text				micro-sign	HN	Sun Sign	Moon Sign
				<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>				
1	7	4	1	1	1	10	7	10	1	10	1
1	14	7	1	1	2	7	14	7	1	7	1
1	21	10	1	1	3	4	21	4	1	4	1
1	28	1	1	1	4	1	28	1	1	1	1
Sector II											
2	7	5	2	1	5	11	5	11	2	11	1
2	14	8	2	1	6	8	12	8	2	8	1
2	21	11	2	1	7	5	9	5	2	5	1
2	28	2	2	1	8	2	26	2	2	2	1
Sector III											
3	7	6	3	1	9	12	3	12	3	12	1
3	14	9	3	1	10	9	10	9	3	9	1
3	21	12	3	1	11	6	17	6	3	6	1
3	28	3	3	1	12	3	24	3	3	3	1

Table 10. Comparison of the two systems as in Table 7 [p. 112]

Here the reconstructed Sections I, II, and III of BM 47762 [[Brack-Bernsen 2021b](#), Table 6] are compared to the first 12 lines of the expanded Calendar Text I. We see, that the lunar signs in column 3 are the same as the signs of the Sun, given by *c* in column 6 and repeated in column 9. The zodiacal signs are, however, in reversed order.

All these similarities and symmetries make me postulate that the square structure of the lunar phases was the starting point of quadruplicities in Babylon. The quadruplicities in the expanded Calendar Text was constructed,

leaning at and adjusting to the square structure of the lunar phases. If this reconstruction is accepted, we have here explained the system behind the i - and house numbers j listed in the expanded Calendar texts. Text BM 36628+ is, however, also concerned with determining the Turns of the planets [see [Steele 2015](#), 194–212]. Which role the expanded Calendar Texts plays in the development of the system called the Babylonian Terms, is still a very interesting and open question. I hope that more texts will come to light so that someone will be able to solve these problems and find answers to the questions raised here.

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