# HIGH, MIDDLE OR LOW?

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Part 3

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**Lodding:**
- What we shall hear now is the contribution by Professor Huber from Harvard, who will talk about "Astronomical evidence for the long chronology and against the middle and short chronologies".

Professor Huber summarized his paper as published in part 1 of the Acts, p. 5-17.

**Wilhelm:**
- I have a question concerning the Venus tablet. The date of the 8th year of Ammi-saduqa follows the incomplete omen 10. A possible explanation for the appearance of a date formula might be that the Old Babylonian tablet used by a later compiler only contained ten omens and that the tablet was dated. This would agree with the fact that Late Old Babylonian literary tablets often are dated. In parenthesis it should be mentioned that the dating of the tablet only dates the manuscript; if it is the copy, the original text remains undated. How would your computations be affected if the omens of Enuma Anu Enlil tablet 63 are not one sequence of observations, but two or three separate ones, which had only been combined by a later compiler?

**Huber:**
- Yes, that's a question, which was raised by Pingree. If we assume that the text was pieced together by a later compiler from two or three unrelated parts, we have the problem of finding places in time for the separate parts. I won't talk about the hopelessly corrupt third part, but the first two parts fit calculations very nicely, if one assumes they are consecutive, one immediately after the other. If they are not consecutive, then the next feasible place for part 2 is 120 years later. Since the feasible places are so sparse, I consider it highly unlikely that unrelated pieces collected by a later compiler would match up like consecutive ones.

If we use only one of the two parts, we obtain the same main chronologies (-1701, -1645, -1637, -1581) from either of them. Both parts separately even show the same behavior, for -1645 the events tend to be early, for -1637 late. I looked into this in Huber et. al. (1982), p.19f.; see in particular Table 4.3.a.With the data from part 1, the early/late imbalance is significant for -1645 on the 1% level (but does not reach significance for -1637), with the data from part 2, it is significant on the 5% level for both -1645 and -1637.

**Wilhelm:**
- If only omens 1 to 10 go back to the time of Ammi-saduqa, there could be a gap of hundreds of years between this sequence of observations and the following one, since all of the preserved manuscripts have been written during the first millennium B.C.

**Huber:**
- It could be in principle, but I think it is quite unlikely.

**Wilhelm:**
- The background of my remarks is the development of other kinds of omen collections - e.g. hepatoscopic omens. Comparing Old Babylonian and first

millennium collections, we get an idea of the process of compilation and the enlargement of an originally limited corpus. There is no tablet from the late "canonical" corpus, which is identical with the Old Babylonian one. Since the primary purpose of the Venus tablets is prognostic, not astronomical, a comparable textual history should be assumed.

Thomas:
- I can remember a day at the Oriental Institute, it was at the time of Sidney Smith's publication, late 30's early 40's, and this whole issue of textual validity was raised by Poebel and others at that time busy mainly with their Assyrian dictionary. But I remember the students would say the text was unreliable and should not be trusted, we are dealing with them in the same way as the Turin papyrus. I would prefer to see it in terms of broader possibilities, we have letters of exchange in the Amarna period from that time of connection, and the rest remains speculation, unless we can absolutely prove the validity of the text.
The evidence is not sound.

Huber:
- I should try to make the point very carefully, it is possible to work around the validity of the Venus tablet. My first step was to try to reject some of the four main Venus chronologies. The basis, the sole basis for these Venus chronologies is the Venus tablet, and I would have been quite content if I had had to reject all of them (this would have ended the controversy about the validity of the Venus tablet). Anyway, the last three of them are out: the middle two agree poorly with the Venus data themselves, and all three disagree with the month-length data from contemporary economic texts. The first one (the -1701 chronology) I could not reject, but being the only compatible chronology does not imply that it is right (the Venus tablet data might be invalid, after all).

Now as for testing a chronology by the month-lengths: in principle, it does not matter where the suggestion for the -1701 chronology comes from, it could come from anywhere, it might even have been proposed by a clairvoyant. Clearly, there is some evidence in its favor, but maybe very little, and I am not going to rely on its strength quantitatively in any way. When I am testing it against the month-length data and it turns out to agree significantly better than it ought to if it were wrong, then I have to assume it is right. The crucial quantity in the test is the probability that a randomly chosen chronology agrees as well or better than the actually chosen one, the way how it was chosen does not enter into this kind of argument at all. But it is important to note that if the test had come out inconclusive, I would have had to admit defeat -- I would not be allowed to come back and repeat the test using the same data with another suggestion for a chronology.

Kromholz:
- In connection with this, I think we have always to consider Occam's razor. Let us not throw in things that are not really necessary: The KIS principle, "keep it simple".

**Thomas:**
- Occams's razor, which is widely used in this neo-scholastic society should not accept the revival of scholasticism in analyses taken over from cybernetics.

**Kromholz:**
- And as you can see I don't use any razor. One question about sensitivity analyses. You mentioned in the beginning you did a sensitivity analysis on the data themselves. To what extent, if at all, have you considered doing a sensitivity analysis on the base of the astronomical structure? Stretching it and compressing it in different ways to see if things have shifted and if our astronomical view projecting backwards from now is in fact 100% reliable.

**Huber:**
- That is one of the very tricky parts. The trickiest is the rotation of the earth. The empirical evidence for the rotation of the earth is reliable back to about 400 B.C. (mainly based on Late Babylonian eclipse observations), and everything else is extrapolation. Fortunately, if we test the agreement between observed and calculated month-lengths, we simultaneously also test the reliability of the extrapolation.

**Kromholz:**
- .. for example, .. change by some realistic method from the 53 - 47 ratio to let us say, 53.5.

**Huber:**
- Oh, that is not the problem. You would need a Velikovskian catastrophe to change that ratio in a noticeable way.
What matters are irregularities in the rotation of the earth. Our clocks are determined by the rotation of the earth, and if that clock is off by a few hours, visibility conditions for the first sighting of a lunar crescent can be changed. The moon moves about 1° in two hours, and I believe our current formulas are accurate to within two hours back to the year -2000, which is good enough. If the clock were off by about 4 hours things would become questionable.

**Kromholz:**
- That you have a slight shift in the orbit of the earth?

**Huber:**
- These shifts, they do not matter for the period of the first thousand years; what matters are irregulatities in the rotation of the earth which can upset things by say a few hours. Essentially our clocks are determined by the rotation of the earth, and a few hours off can change the visibility conditions, I think it is we are accurately seen about two hours or so back to -2000. If you were accurately seen about four hours things become questionable.

**Kromholz:**
- But have you tried to stretch?

**Huber:**
- I have tried some!

**Thomas:**
- This game has been going on for approximately fifty years. I think Fothingham did his work before World War 1.

**Huber:**
- It started I think in 1912.

**Thomas:**
- Yes, now, more important, for those who indulge in the game, Jacobsson chose the most high alternative and projected his Sumeric chronology and that left a great tragedy as you know. Very cautiously the evidence must be analyzed in a Ranklan sense. Then we can have computers and statistical control of development. For the chronology, itself, you cannot change it,without changing the whole structure.

**Huber:**
- But what I mean is, if you are willing to accept as feasible a historical range that contains -1701, you are forced to accept the high chronology. If that range does not contain -1701, if you say it is not feasible, then OK, we will have to start from scratch. What I claim is that the low and middle Venus chronologies are out, and they are out whether or not you consider the Venus table to be valid.

**Kromholz:**
- But you stated that not quite an infinite number of years was mentioned, but there is in fact a very limited number in a range of a couple of hundred years. Why couldn't we, in fact, cycle through every one of these 200 or so possibilities and find the best fit and then say: "Oh, this looks pretty good. Now let's see why it doesn't work, find out why that one isn't any good either." But the total amount of computation that is involved for 200, with the techniques and tools that are available to us, would be relatively simple, I would think.

**Huber:**
- I did it!

**Kromholz:**
- You said you tested only four.

**Huber:**
- I did the calculations based on the binomial distribution for the four only. But that is an approximation, and I did not trust it. So as a check, I calculated all 33,000 month-lengths between I don't remember which years and slid the observed sequence along the 33,000 month-lengths and counted how many times the fit was better than the -1701 fit, and it was about 1% of the time. This is precisely the meaning of the 1% significance level I

mentioned: if you do 33,000 fits, then up to 330 wrong fits may be better than the correct one. The correct date does not necessarily give the best fit, for example it was not the best in the Neo- and Late Babylonian control material (Huber et.al. (1982), p. 30).

**Åström:**
- I have a note here from Dr Krauss who is not able to come and he says that you have based your computations on the classic work by Neugebauer's Astronomical chronology of 1929. They have now checked some of Neugebauer's data, with modern computer calculation, and Neugebauer's data do not seem to be as exact as is possible; especially his data for lunar horizontal positions, other data may also be incorrect to a lesser degree. Such an inaccuracy would effect the calculation of the length of all lunar-months. If Neugebauer's data are to be corrected, then Huber's results based on the book cited should be reconsidered. That is one point. You said here that you felt happy about your fits and I would say that as an archaeologist I am not happy with a long or high chronology. What speaks in favour of the long chronology as I see it are statistical calculations and $C^{14}$ dates which we shall discuss after the break. But from an archaeological point of view it is not possible, or at any rate not easy, to fill up the time span if you have a long chronology. For Cyprus that is impossible and that was seen by the late Professor Stewart long ago. I can give also an example of what happened at Ugarit where Schaeffer used a Middle chronology and ended up by having a scarcity of remains so that he had to create an hiatus at 1650-1600. He could not fit in anything because he used a wrong chronology. If he had lowered it 50 years it would all fit in.

**Huber:**
- I should say a few words on this. My calculations were based on the same theories as those of P.V. Neugebauer. This is partly because the programs were easier to debug by comparing results with existing tables, and partly because those theories had been checked against Late Babylonian observations. If you take more modern theories, you have to do all the checking again, to make sure the secular terms are correct and that they work outside of modern times. Actually I have done some checking, with the lunar eclipse material I mentioned briefly. If you calculate these eclipses with P.V. Neugebauer's parameters, and if you calculate them with the best available modern theories, you get only a few minutes difference. And I feel confident that the problem is not there.

**Åström:**
- Well, the difference is one day. They have checked a lunar month in 1808 BC, month 6 of the Babylonian year. With the help of Dr Axel Wittman of the University in Göttingen, Krauss checked this particular example. According to Wittman's computation the length of the month in question was 30 days and not 31 days, that is one day's difference, not minutes as you say.

**Huber:**
- Let's go back to one of my first slides. The main problem with the calculation of month-lengths is this empirical curve determining the visibility of the crescent (the slide corresponds to Figure 5.1 of Huber et al. (1982)), and there are several such empirical curves in the literature. If the moon is within about 1° of the curve, it depends on the luck of the observer whether he sees the crescent on that day or not, even under ideal atmospheric conditions. Some of the curves differ by up to about 1°. The moon moves about 0.5° per hour, and in most cases the differences do not matter, but occasionally they do and you get a one day difference when the moon is near the borderline -- and you always have a borderline case when a 31 day month is involved. Checking a single month does not tell you anything. You have to check a lot of them, and I have done extensive checking with dated Late Babylonian material.

**Lodding:**
- If everybody is happy about that?

**Hennessy:**
- If I may ask one question. Are we presuming also in the calculations of the oracular observations made each time, that the observers noted the movements immediately they happened, and immediately they ceased.

**Huber:**
- Abe Sachs provided me with a total of 153 month-lengths from Neo- and Late Babylonian economic texts. As I said, with those the agreement rate between observed and calculated month-lengths is only 67% instead of 90% (as in the observational astronomical texts). The Old Babylonian month-length information comes from the same kind of economic texts as the Neo-Babylonian. I think it is relatively safe to assume that the agreement rates are the same, but of course we cannot be totally sure.