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Kyungsang Korean

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Markedness and the Phonetic Implementation of Tone in North Kyungsang Korean

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0. Introduction

North Kyungsang Korean (NKK) has a pitch-accent system similar to that of various Japanese dialects. A distinctively high pitch can occur in four different positions within the word: final, penultimate, initial,¹ or on the first two syllables (which we will call double). Controversy in analyses has arisen as to which of the positions is the unmarked one. N.-J. Kim (1997) proposes an Optimality Theory (OT) analysis in which the default location of high tone is on the penultimate syllable of a word; other locations are lexically marked with pre-linked high tones. In contrast, S.-H. Kim (1999b) proposes a Simplified Bracketed Grid (SBG) metrical analysis in which the final position of a word is the default position; other locations are lexically marked with foot boundaries. The goal of this study is to employ phonetic evidence to resolve this debate.

We start with a basic observation that marked phonological elements tend to have more extreme values along phonetically measurable scales. A simple relevant case is the Korean stop system and the phonetic scales for closure duration (CD) and voice onset time (VOT). Although CD and VOT vary depending on the position in the word (between for example word-initial and intervocalic positions) the relative ranks stay constant. Thus, aspirated stops have longer VOTs, even though the plain stops are moderately aspirated word-initially. Likewise, the CD of tense and aspirated stops is longer than that of plain stops, even though the CD is reduced in word-initial position. Without committing ourselves at this point to an interpretation of such phenomena, we will use this observation to construct a test for the relative markedness of the tones. That is, we should expect to find that *marked* tones are phonetically *more* prominent than unmarked ones. In addition, the two contrasting theories make opposing predictions about the relative pitch values for tones in different positions. Under

¹ The Daegu dialect discussed here seems to be undergoing a change in which the initial tones are being replaced by double tones.

the OT analysis, the stem-final tone is marked in the input. Thus, the F_0 of the final tone in stems is predicted to be higher than the one of the non-final tone in stems (final $H \geq$ non-final H). In the SBG analysis, the stem-final tone is unmarked, whereas the non-final tone in stems is marked. Crucial to this analysis, the difference between the two high tones lies in the type of feet (open feet vs. closed feet). Since open feet are universally less prominent than closed ones (Idsardi 1994), final tone, which is in an open foot, should be lower than the non-final tone which is in a closed foot (final $H <$ non-final H).

In order to test which prediction is correct, we conducted two phonetic experiments measuring the peak F_0 of matched sets of words. The first experiment shows that non-final accents have higher pitch than final accents. The second experiment examines the possibility that the difference observed in the first experiment is due to an effect of final lowering. The peak pitch of doubled high tones in two different environments was measured: word-finally (i.e., in disyllabic words) and non-word-finally (i.e., in trisyllabic words). The results show that there is no significant difference between the two means, which indicates that there is no general process of final lowering operating in NKK.

We therefore conclude that NKK penultimate tones are phonetically higher than final tones, and thus that the penultimate position is the marked one, consistent with the SBG analysis.

1. The tonal patterns of NKK tone

NKK has a pitch accent system in which each phonological word has a single high tone. There are four contrasting locations of a high tone (i.e., final tone, non-final tone, initial and double tone) in lexical items, as illustrated in (1).

- | | | | | |
|-----|--------------------|-------------------|-----------------------------|--------------|
| (1) | a. Final tone: | | [...H] pattern | |
| | satalí | 'ladder' | namwú | 'tree' |
| | palám | 'wind' | kaúl | 'autumn' |
| | b. Non-final tone: | | [...HL] pattern | |
| | hánul | 'sky' | apéci | 'father' |
| | pwulkasáli | 'star fish' | yángpok | 'suit' |
| | c. Initial tone: | | [H...] pattern ² | |
| | myénuli | 'daughter-in-law' | ácime | 'aunt' |
| | d. Double tone: | | [HH...] pattern | |
| | kúlím | 'picture' | mwúcíkay | 'rainbow' |
| | sáép | 'business' | síktáng | 'restaurant' |

One piece of evidence for the relative markedness of the tones is the tonal changes observed in encliticized words. Stems of types (1b-d) maintain the

² As noted above, in the Daegu dialect the initial pattern (1c) is changing to the double tone type (1d). For this reason, initial tone patterns were excluded from the study.

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position of the high tone of the stem in isolation, as shown in (2) and (3). Stems with final tone (1a), however, show a shift with consonant-initial enclitics, (4a).

- (2) Non-final accented stem + enclitics
 - a. apéci ‘father’ + cocha ‘even’ (consonant-initial enclitic) → apéci-cocha
 - b. apéci ‘father’ + eykey ‘to’ (vowel-initial enclitic) → apéci-eykey
- (3) Double accented stem + enclitics
 - a. kúlím ‘picture’ + chelem ‘like’ (consonant-initial enclitic) → kúlím-chelem
 - b. kúlím ‘picture’ + ulo ‘with’ (vowel-initial enclitic) → kúlím-ulo
- (4) Final accented stem + enclitics
 - a. satalí ‘ladder’ + cocha ‘even’ (consonant-initial enclitic) → satali-cócha
 - b. satalí ‘ladder’ + eyse ‘at’ (vowel-initial enclitic) → satalí -eyse

This pattern is analyzed by S.-H. Kim as indicating that consonant-initial enclitics have an accent, that vowel-initial enclitics are pre-accenting, and that the surface tone appears on the first accented position of the word, as long as the stems with final tone are analyzed as unaccented, as discussed in the next section.

2. Two recent phonological analyses on the NKK tone system

The recent accounts of the NKK tone fall into two groups. Some previous analyses claim that the final accent is lexically marked and the penultimate accent is unmarked (G.-R. Kim 1988, N.-J. Kim 1993, 1997, and Kenstowicz and Sohn, 1997). Others (Y.-H. Chung 1991 and S.-H. Kim 1999a, b) propose that the final tone is the lexically unmarked one. S.-H. Kim’s metrical analysis is summarized in (5). Lexical accents are represented with foot boundaries, and high tone is inserted on the final syllable of the first foot of the word. A difference then arises between *closed* feet (5b) – those with both foot boundaries – and *open* feet (5a). Idsardi (1994) argues that closed feet are stronger, and so in the present context we predict that the high tone in (5b) will be higher than that in (5a).

(5)

	a. Final accented stem	b. Penult accented stem
Underlying Rep.	x x x	x x) x
Surface Rep.	H (x x x	H (x x) x

In N.-J. Kim’s (1997) OT analysis, the penult accented stems as analyzed as toneless (unaccented), while final accents are lexically represented with high tone. As S.-H. Kim (1999a) points out, the details of the analysis are not consistent with the principle of Lexicon Optimization in OT, which would select an alternative analysis in which all tones are lexically represented, minimizing the discrepancies

between input and output representations. In such an analysis none of the stems would be unaccented. Therefore, N.-J. Kim's analysis predicts either that final accents should have higher pitch than non-final ones or (with Lexicon Optimization) that they should be equivalent.

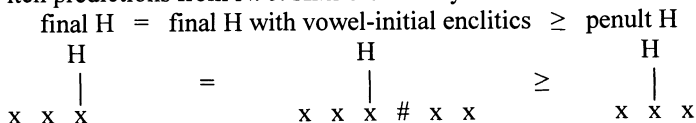
Although the two accounts differ radically in the mechanisms and computations employed, we can reduce the controversy to a question of lexically marked versus unmarked tones. The two accounts differ on the relative status of final and penult tones and the difference of the accounts is attributed to the markedness in the underlying representation. As summarized in (6), the phonologically marked stems with regard to a high tone are different from each other depending on which phonological account we follow.

(6)	Analysis	Final accented stems	Penult accented stems
	N.-J. Kim (OT)	Marked	Unmarked/Marked
	S.-H. Kim (SBG)	Unmarked	Marked

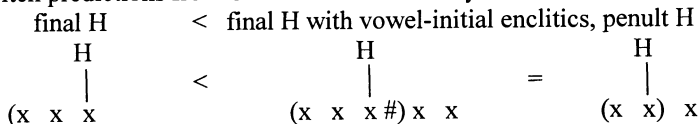
3. Phonetic realization of NKK tone

So far, we have briefly reviewed two competing accounts of tone in NKK stems. Let us now attempt to establish which phonological account better correlates with phonetic evidence on the NKK tones. Based on the above observed phonological controversy, it is important to make some possible predictions for the following experiment, as illustrated in (7).

(7) a. Pitch predictions from N.-J. Kim's OT analysis



b. Pitch predictions from S.-H. Kim's SBG analysis



Under reasonable assumptions about phonology phonetics interface (in particular a principle of *no markedness flip*) the two hypotheses make phonetically different predictions. From N.-J. Kim's OT analysis, we can infer two feasible predictions, as shown in (7a). First, all of the high tones, in terms of F₀, should be the same in the final accented stems, the final accented stem plus vowel-initial enclitic forms, and the penult accented stems. Second, the stem-penultimate high tone should be lower than the stem-final high tone in the isolated stems as well as in the encliticized words, since the final H marked from the beginning should be more prominent than the penult H specified only in the output (parallel to the moderate VOT observed in initial plain stops).

Following the SBG Theory-based analysis, we can, on the other hand, predict that the high tone linked to open feet (final accented stems) should be less prominent (lower F_0) than the high tone linked to closed feet (both penult accented stems and final accented stem plus vowel-initial enclitic forms), as summarized in (7b). Notice also that the SBG account produces representations which preserve markedness information. The right metrical bracket is preserved in the output, indicating the lexically marked positions. Thus, one way of interpreting higher pitch on marked tones is that the high tone itself raises the pitch target, and the right metrical boundary adds its own increment on top of that.

3.1. Experiment 1: comparison between final and penult tones

The purpose of this experiment is to test the predictions outlined in (7). If the subsequent experiment reveals that the F_0 of the stem-final high tones in the isolated stems and the encliticized words are as high as or even higher than the F_0 of the penult high tones, as illustrated in (7a), we would support N.-J. Kim's OT analysis. Conversely, if the result confirms the lower pitch value in the high tone of the final accented stems than in the high tone of the encliticized words and penult accented stems, as in (7b), we can support S.-H. Kim's SBG analysis.

3.1.1. Methods

Ten male native speakers of NKK participated in this experiment. Details about the participants are given in Chang (2002). The thirty words listed in (8) were selected as stimuli (e.g., ten words with a final high tone + ten words in their combination with vowel-initial enclitics + ten words with a penult high tone).

(8) Stimuli used in experiment 1

Final accent		Final accent + enclitic		Penult accent	
<u>na</u> mp <i>i</i>	'pan'	na <u>mp</u> <i>i</i> -eyse	'on a pan'	<u>pi</u> nu	'soap'
sa <u>ta</u> l <i>i</i>	'ladder'	sa <u>ta</u> l <i>i</i> -eyse	'on a ladder'	<u>ta</u> l <i>i</i> mi	'iron'
ma <u>ta</u> ng	'yard'	ma <u>ta</u> ng-eyse	'in the yard'	<u>ta</u> ngmyen	'noodle'
ko <u>a</u>	'orphan'	ko <u>a</u> -eykey	'to an orphan'	co <u>ng</u> ali	'calf'
na <u>m</u> wu	'tree'	na <u>m</u> wu-eyse	'on a tree'	pu <u>n</u> mwu <i>ki</i>	'spray'
mwu <u>wu</u>	'radish'	mwu <u>wu</u> -eyse	'in a radish'	twu <u>ng</u> wu <i>li</i>	'nest'
to <u>ng</u> mwun	'fellow'	to <u>ng</u> mwun-eykey	'to a fellow'	mwu <u>nc</u> ip	'anthology'
ma <u>u</u> m	'heart'	ma <u>u</u> m-ulo	'in the heart'	ma <u>u</u> ms <i>si</i>	'temper'
na <u>m</u> wul	'greens'	na <u>m</u> wul-eyse	'in greens'	mwu <u>l</u> tong	'bucket'
se <u>ya</u> ng	'the West'	se <u>ya</u> ng-eyse	'in the West'	ya <u>ng</u> pok	'suit'

The syllables with high tone, underlined in (8), are the target syllables for the measurement of F_0 . Unfortunately, F_0 can be affected by various other factors, such as the type of onset and the vowel quality. In order to at least partially control for these factors, the stimuli are composed of ten with the same target syllable. We did not include consonant-initial enclitics because the number of consonant-initial enclitics is limited, making it difficult or even impossible to construct triplets using the same target syllable as in the other items.

3.1.2. Procedure

The test words in (8) were written on index cards in Korean orthography. Each speaker read them, in random order, at a natural, comfortable speed. Two repetitions of the entire stack of cards were produced, resulting in a total 60 utterances (30 stimuli x 2 repetitions). The utterances were recorded onto a digital mini disc, using a high-quality microphone (Sony ECM-MS907) and mini-disc recorder (Sharp MD-MT821-A). The recorded words were then converted to WAV files on a computer at a 22 kHz sampling rate and 16 bit quantization. Next, F_0 contours were produced and measured by using Speech Analyzer 1.5, and the peak F_0 values of each word were collected.

3.1.3. Results

For each type of the stimuli 200 measurements were taken (10 subjects x 10 items x 2 repetitions). The mean F_0 and the standard deviation for each type are shown in (9). The final accent (9a) had the lowest mean pitch value.

(9)	Type	Number	Mean F_0	Standard deviation
	a. Final accent	200	123.4 Hz	14.5 Hz
	b. Final accent + enclitic	200	137.3 Hz	15.9 Hz
	c. Penult accent	200	138.9 Hz	16.3 Hz

A repeated measures analysis of variance (ANOVA) shows that the difference in the mean F_0 values among the items is significant: $F(2,297) = 29.8$; $p < 0.0001$. A pairwise post-hoc Scheffé test, (10), shows that (9a) is significantly lower than (9b) and (9c), but that there is no significant difference between (9b) and (9c).

(10) Summary statistics for the Scheffé post-hoc test on F_0 for the three items

Contrasts	Mean Difference	P-Value
(9a) final vs. (9b) final + enclitic	13.9 Hz	< 0.0001
(9a) final vs. (9c) penult	15.5 Hz	< 0.0001
(9b) final + enclitic vs. (9c) penult	1.6 Hz	0.774

Since we do not know from the statistics whether this categorization reflects a uniform pattern across all subjects, we should examine the individual subjects' performances. For every subject, the pitch of the final accent in stems is consistently less than both of the other accent types, as shown in (11). On the contrary, no consistent patterns are found when the final accent in encliticized words is compared with the penult accent in stems. Only six out of ten subjects show a higher F_0 in penult position.

Due to the consistent lower F_0 of the stem-final accent, it should be differentiated from the other accents, which in turn leads us to categorize it as a different group separate from the other accents. This statistical analysis, therefore,

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confirms the previous speculation that the final accent in stems is less marked than the other types, as predicted by S.-H. Kim's SBG analysis.

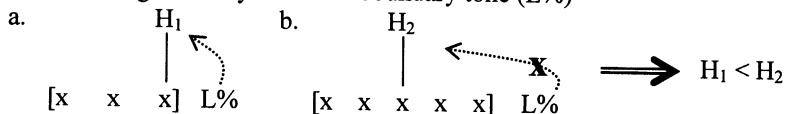
(11) The comparison of F_0 (Hz) among the three items within each subject

Subject	Stem-final H		Stem-final H with enclitics		Stem-penult H
S1	112	<	127	<	130
S2	133	<	160	=	160
S3	144	<	155	<	157
S4	125	<	142	<	148
S5	121	<	133	>	132
S6	119	<	128	<	131
S7	96	<	110	=	110
S8	143	<	154	<	156
S9	114	<	126	>	125
S10	128	<	138	<	140

3.2. Experiment 2: the effect of utterance boundary tone

Although experiment 1 supports S.-H. Kim's SBG analysis, it is possible that final high tones are lowered generally in NKK. That is, perhaps there is no difference in the original pitch targets for the tones, but the lower final tone is due to the influence of a final L% boundary tone, as illustrated in (12).

(12) The lowering effect by utterance boundary tone (L%)



Since the high tone H_1 is located on the final syllable of the final accented stem in (12a), a L% boundary tone might affect this high tone, lowering it somewhat. Contrary to H_1 , H_2 in (12b) is not adjacent to the L% boundary tone, which then might prevent H_2 from being lowered.

3.2.1. Methods

Noticing that the potential lowering effect in (12) is mediated by the number of syllables, we tested this possibility by comparing the pitch value of the double tones in two environments: word-finally (i.e., in disyllabic words) and non-word-finally (i.e., in trisyllabic words). While the doubly linked high tone in a disyllabic word is adjacent to the following boundary tone (L%), the one in a trisyllabic is not adjacent to the boundary tone (L%) due to the final syllable unlinked to H. Therefore twelve pairs of disyllabic and trisyllabic words were constructed, (13). If there is a general L% boundary effect, the tone in disyllabic words should be lower than that in the matched trisyllabic words.

Disyllabic words		Trisyllabic words	
<u>kulim</u>	'picture'	<u>kulimca</u>	'shadow'
<u>yein</u>	'woman'	<u>yein</u> swuk	'inn'
<u>saep</u>	'business'	<u>saep</u> ka	'business man'
<u>wisen</u>	'hypocrisy'	<u>wisen</u> ca	'hypocrite'
<u>thaca</u>	'typing'	<u>thaca</u> ki	'typewriter'
<u>cangnan</u>	'play'	<u>cangnan</u> kam	'toy'
<u>kohyang</u>	'hometown'	<u>kohyang</u> cip	'house in hometown'
<u>cenhwa</u>	'telephone'	<u>cenhwa</u> ki	'telephone'
<u>yensel</u>	'public speech'	<u>yensel</u> mwun	'script for speech'
<u>kiswul</u>	'technic'	<u>kiswul</u> ca	'engineer'
<u>chokcin</u>	'acceleration'	<u>chokcin</u> cey	'palpation drug'
<u>pangsa</u>	'radiation'	<u>pangsa</u> nung	'radioactivity'

3.2.2. Procedure

The procedure of this experiment follows that of experiment 1. The same speakers who participated in the experiment 1 were asked to read the test words in (13). Two repetitions of each word were collected for a total of the 48 utterances (24 stimuli x 2 repetitions) for each speaker.

3.2.3. Results

For each subject, the mean values for the two types of the stimuli were obtained and used for the analysis, as in (14).

Type	Number	Mean F_0	Standard deviation
Disyllabic words	240	129.2 Hz	15.5 Hz
Trisyllabic words	240	131.0 Hz	16.0 Hz

The mean F_0 for disyllabic words (129.2 Hz) is slightly lower than for trisyllabic words (131.0 Hz), but this small difference (1.8 Hz) is not statistically significant, $t(238) = -0.886$, $p = 0.3766$. The observed power for this effect size is only 0.1188, so with this number of subjects we only have a 12% chance of statistically detecting a difference of 1.8 Hz at an alpha level of 0.05. However, the smallest detectable difference for a power of 0.95 given the observed measurements is 8.5 Hz. Therefore, we can be 95% confident that the true difference between the means is less than 8.5 Hz. This is much less than the 14 Hz difference observed in experiment 1, and therefore we conclude that final lowering is not the cause of the difference observed in experiment 1.

Looking at the individual subjects we also fail to find a consistent direction of difference between the types. Disyllabic words have a lower mean F_0 for seven subjects, but three subjects show the opposite pattern, (15).

(15) The comparison of F_0 (Hz) between the two items within a subject

Subject	Disyllabic words		Trisyllabic words
S1	116	<	117
S2	136	<	138
S3	142	<	146
S4	143	>	142
S5	124	>	123
S6	119	>	118
S7	103	<	106
S8	153	<	157
S9	121	<	126
S10	134	<	138

Therefore, we cannot reject the null hypothesis that the means are the same, and the substantial difference in effect sizes (14 Hz in experiment 1, 1.8 Hz in experiment 2) argues strongly against final lowering as an explanation for the results in experiment 1. We should note, however, that Chilin Shih (personal communication) has suggested to us that doubled tones may be universally immune from lowering effects; should that be the case then the markedness and lowering explanations would be confounded in NKK and could not be resolved by empirical tests.

4. Discussion and Conclusion

We have considered two accounts of NKK tone that differ in the markedness assigned to final and penult tones in the analyses. N.-J. Kim's OT account proposes that the penult accent is unmarked, whereas S.-H. Kim's SBG account proposes that final accent is unmarked. Assuming that phonological marked elements are usually phonetically implemented with more extreme values, the two accounts then make contrasting predictions about the relative pitch values for tones in different positions. In line with S.-H. Kim's SBG analysis, the results obtained in the first experiment revealed that F_0 peaks in the final accented stems are significantly lower than those in both the related encliticized words and the non-final accented stems. In the second experiment, the finding that there is little pitch difference of the tones in the disyllabic and trisyllabic words eliminates the possibility that the lower final tone is due to the influence of a final L% boundary tone. Therefore, we conclude that only S.-H. Kim's analysis accounts for the significant difference in tone observed in the first experiment and the final accented stems are better analyzed as unaccented stems than as accented stems.

Having established the superiority of S.-H. Kim's analysis, we wish to elaborate some points. First of all, the greater prominence of marked tones in S.-H. Kim's analysis is not due to a direct phonetic reflection of contrasting inputs *per se*, but due rather to a pertinacious difference in metrical structure. The marked tones, lexically marked with right parentheses, are found at the surface in closed

feet, whereas the unmarked tones are found in open feet. With the relative strength of closed feet, the only prediction based on SBG Theory is that the tone marked with lexically stored parenthesis is higher than the unmarked tone. Unlike SBG Theory, OT can change the marked tones in the input if necessary, which means we cannot make a coherent prediction within OT.

Also relevant in the discussion of markedness is the range of variation exhibited in different constructions. As we already observed in (4), the high tone of the final accented stems remains in its position when the stem is combined with a vowel-initial enclitic, whereas a high tone shifts to an enclitic when a consonant-initial enclitic is attached to the stem. These two different behaviors of the stem-final tone cannot be found in the stem-penult tone in (2). Since S.-H. Kim's analysis considers stem-final tone unmarked and stem-penult tone marked, it is the unmarked element which shows more behaviors. This is, we believe, a highly desirable situation in that it is natural that less information in the underlying representation leads to more variation in the surface.

Furthermore, if we combine the results in the first and second experiments, we find, using the Scheffé post-hoc repeated measures multiple comparison test, that the double tone is significantly different from both the final and penult tones, giving a third, intermediate level. The summary statistics where the four items are compared pair-wise are shown in (16).

(16) Summary statistics for the Scheffé test on F_0 across the four items

Compared Items	Mean Difference	P-Value
stem-final tone vs. double tone	6.7 Hz	0.005
stem-final tone vs. stem-final tone + enclitic	13.9 Hz	< 0.0001
stem-final tone vs. stem-penult tone	15.5 Hz	< 0.0001
double tone vs. stem-final tone + enclitic	7.2 Hz	0.002
double tone vs. stem-penult tone	8.8 Hz	< 0.0001
stem-final tone + enclitic vs. stem-penult tone	1.6 Hz	0.917

In this display, the stem-final tone is significantly different from the other items, as shown in the shaded blocks of the first, the second, and the third rows. In the next two rows, the double tones are also significantly different from the other items such as the tones in encliticized words and penult accented stems. As expected, the mean difference is not significant only when stem-final tone in the encliticized words and the stem-penult tone are compared ($p = 0.917$). Given this result, the four types of the stimuli can be divided into three categories, as illustrated in (17).

(17) Categorization of the stimuli in terms of the F_0 value of H

final accented stem	<	double accented stem	<	encliticized word
				penult accented stem
		≈ 7 Hz		≈ 7 Hz

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It is important to note that the pitch value of the double accented words forms an intermediate category: it is greater than that of the final accented stems by around 7 Hz and less than that of the encliticized words or the penult accented stems by the same amount (around 7 Hz). This observation is consistent with the previous finding that the F_0 in words of the double tone type is relatively lower than that in words of the non-final tone type (Chung 1980:102-107).

Our conjecture about the lower pitch in double tone is that all of the high tones are not necessarily different from one another but that perhaps there is a psychological effect that has to do with the interaction between pitch and time. It can be said that prolonging a somewhat smaller excursion has the same psychological effect as having a very large excursion within a very short amount of time. In other words, since the doubled high tone has a longer pitch excursion, it does not require as much of an increase in the pitch value. In this view, time is traded off against the height of F_0 value. We leave this speculation for further investigation.

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