

Variation in the numeral system of Japanese Sign Language and Taiwan Sign Language

A comparative sociolinguistics study

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The numerals 10, 100 and 1,000 are expressed variably in Japanese Sign Language (JSL) and Taiwan Sign Language (TSL), two languages that also have historic links. JSL was used in deaf schools that were established in Taiwan during the Japanese colonial era, leaving a lasting impression on TSL, but complex sociolinguistic situations have led to different outcomes in each case (Fischer, 2014; Sagara, 2014). This comparative sociolinguistic analysis is based on two datasets comprising a total of 1,100 tokens produced by 72 signers from the Kanto and Kansai regions (for JSL) and the cities of Tainan and Taipei (for TSL). Mixed effects modelling reveals that social factors such as the age and region of the signer have a significant influence on how the variable is realised. This investigation shows how careful cross-linguistic comparison can shed light on variation within and between sign languages that have been in contact, and how regional variation in one language may influence regional variation in another.

Keywords: Japanese Sign Language, Taiwan Sign Language, variation, numerals, typology

1. JSL and TSL: Two sign languages in East Asia

Very little is known about the circumstances surrounding the emergence of Japanese Sign Language (JSL). A key moment in its history was the founding of a School for Deaf and Blind Children in Kyoto in 1878, with 31 deaf pupils (Ito, 1998): The use of sign language in Japan may predate the foundation of this school, though nothing is known about it.¹ What is certain is that the Kyoto school, together with

1. In addition to JSL, at least two village sign languages have been identified to date: Amami Sign Language (Osugi, Supalla, & Webb, 1999) and Miyakubo Shuwa (Yano & Matsuoka, 2018).

subsequent schools founded in Tokyo (1880) and Osaka (1900), provided opportunities for deaf children to meet, and for JSL to develop.

Similar comments can be made about the emergence of sign language in Taiwan: prior to its colonisation by Japan, little is known (Tai & Tsay, 2015a), but given the absence of deaf schools it is likely that any sign language use was similar in nature to homesign.²

Deaf schools are widely reported to have played an influential role in variation, including for Irish Sign Language (Leeson & Grehan, 2004), British Sign Language (Quinn, 2010) and Indonesian Sign Language (Palfreyman, 2019, p. 52). The same is true for JSL (Oka & Akahori, 2011, p. 106) and Taiwan Sign Language (TSL) (Sasaki, 2007), and in both cases schools are linked with regional variants. An overview of research on regional variation in JSL is given by Kikusawa and Sagara (2019).

At least two distinct regional varieties in JSL are linked with deaf schools that are based in the Kanto region, around Tokyo; and the Kansai region, around Kyoto and Osaka (Oka & Akahori, 2011, p. 104). One conspicuous example of variation occurs when people from each region introduce themselves, with different lexical variants for 'name'. Of course, variation can also occur within a city or region, and Yonekawa (1997) describes eight terms for which several variants exist in the city of Fukuoka.

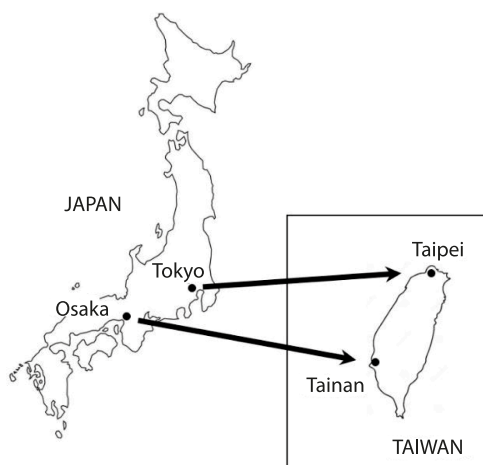


Figure 1. A simplified map (not to scale) showing early links between deaf schools in Japan and Taiwan

2. Homesign is 'a basic communication system created within a family and involves one (or possibly a few) linguistically, but not socially isolated deaf individuals' (Brentari & Coppola, 2012, p. 2).

TSL is said to have two major dialects, the northern variety, centred on Taipei, and the southern variety, centred on Tainan (Smith, 2005, p. 188; Tai & Tsay, 2015a, p. 771). The origin of these varieties is connected to the early Japanese deaf schools (Sasaki, 2007) – teachers from the Osaka school worked in Tainan (est. 1915), while teachers from Tokyo worked in Taipei (est. 1917). These links, shown in Figure 1, were sustained over the remainder of the colonial period (Smith, 2005; Su & Tai, 2009). The modern-day varieties of TSL are mutually intelligible, and the variation between them is mostly lexical: examples include signs for ‘car’, ‘wine’ and ‘vegetable’ (Tai & Tsay, 2015a, p. 772).

Later, TSL was influenced by the lexicon of Chinese Sign Language (CSL) (Sasaki, 2007, p. 131; based on Smith, 1987a, 1987b, 1989). Teachers and students from Nantong School for the Deaf and Blind in China moved to Taiwan and taught in Kaohsiung and Taipei after 1949, and in this way, some CSL signs seem to have been introduced into TSL (Tai & Tsay, 2015b). However, the present study focuses on variants in JSL and TSL which are understood to have been introduced to TSL from JSL during the Japanese colonial period, as a result of the contact described above.

2. Numeral variables in JSL and TSL

This study adopts a comparative sociolinguistics approach, which is particularly suitable for shedding light on the patterning of linguistic variables in different but related data sets (Tagliamonte, 2012). The aim is to investigate connections between numeral variables in JSL and TSL, which have similar variant forms in both languages due to the historic links outlined in the opening section of this article. The three numeral variables in question are referred to here as (TEN), (HUNDRED) and (THOUSAND). In the Kanto and Kansai regions, these are realised as two main variants: one uses numeral incorporation (NI) and the other is based on the number of zeros in the term (Z).

2.1 The NI variant

Numeral incorporation is a morphological process combining two stems, a numeral and a base, to form a new sign (Liddell, 2003, pp. 14–15). For JSL, the multiplier is represented by a handshape, while the movement parameter signifies the base, or multiplicand (ten, hundred or thousand) – Figure 2 for each case.

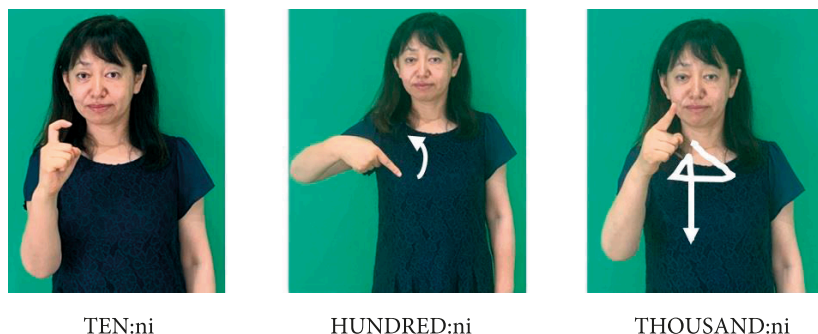


Figure 2. The NI variants for (TEN), (HUNDRED) and (THOUSAND) showing the movement that indicates the base

Each of these movements has a distinct origin:

- For (TEN) the movement entails bending the digits at the knuckle, and this internal movement is thought to be a reduced form of ‘1’ and ‘0’. For larger multiples, such as ‘20’ and ‘30’, all selected digits bend (Figure 3 shows how this works for ‘70’).
- (HUNDRED) is indicated with a change in orientation. According to older JSL users (over 70 years of age) this sign originally entailed the numeral emerging from a wallet represented on the non-dominant hand (shown in Figure 4a), as if a Y100 note is being retrieved. This is corroborated by a dictionary from the late 1960s, showing HUNDRED:ni as a two-handed sign (JFD, 1969, p.35). The non-dominant hand has since been dropped, resulting in a one-handed sign (Figure 4b). This process of a two-handed sign becoming one-handed is described by Frishberg (1975) and Battison (1978), and other examples also occur in JSL (Sagara, 2020).

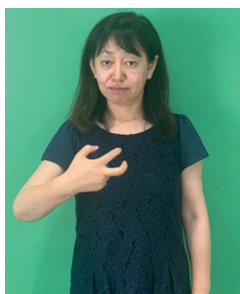


Figure 3. SEVENTY:ni



Figure 4a. SEVEN-HUNDRED (older form)



Figure 4b. SEVEN-HUNDRED:ni (newer form)

- For (THOUSAND), the hand makes a tracing movement based on the shape of the kanji character for ‘thousand’ (千). An older JSL signer in Tokyo, aged 80 years old, said that, originally, this was a two-handed sign, and this has also been attested by a TSL signer in Taipei, aged 78 years old. For this, the dominant hand indicated the multiplier (e.g., seven), and the multiplicand (thousand) was shown with a movement of the non-dominant hand (Figure 5a). The movement and handshape have since become incorporated into a sign shown with one hand (Figure 5b).



Figure 5a. 7000 (older form)



Figure 5b. 7000:ni (newer form)

The NI variant is thought to have originated in Kanto, and it is documented in Mishima and Kaneda (1963), a dictionary based on the signs used in Tokyo. Through the deaf school links outlined in Section 1, it entered TSL and came to be used in the Taipei school; it is now also used in Kansai and Tainan.

2.2 The Z variant

The Z variant uses handshapes with varying numbers of selected digits to show the number of zeros. For example, *TEN:z* includes one selected digit (representing one ‘zero’), while *THOUSAND:z* uses three selected digits. This paradigm can also be used for the numerals *TEN-THOUSAND:z* (four ‘zeros’) and *HUNDRED-MILLION:z* (eight ‘zeros’ shown by the selected fingers of both hands).

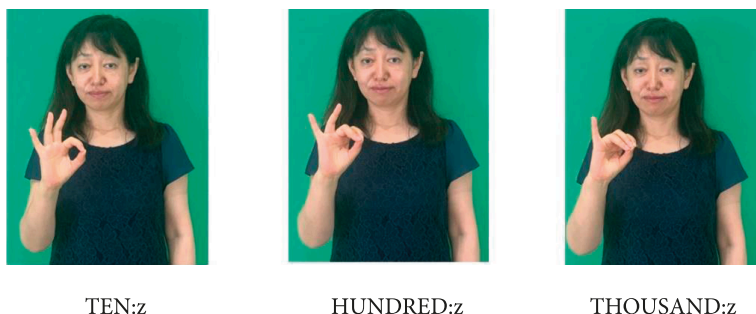


Figure 6. The Z variants for (TEN), (HUNDRED) and (THOUSAND)

While the most salient feature of the Z variant is the number of selected digits, it also exhibits phonological variation in the parameter of movement: it may feature internal movement, as the selected fingers make contact with the thumb one or two times; it can also feature side-to-side movement but no internal movement. Furthermore, some JSL signers have been observed articulating the *THOUSAND:z* handshape with the same path movement as *THOUSAND:ni*, resulting in a mixture of both systems.

Differences have been observed between JSL and TSL in terms of how Z variants are used to construct more complex numerals. For JSL, older signers in Kansai (born before 1940) attest that these variants could be used to form multiples, which means that, for example, 2,500 is signed with four signs (1).

- (1) TWO THOUSAND:z FIVE HUNDRED:z
‘2500’

However, the majority of Kansai signers do not now produce multiples in this way, nor have signers in Kanto been observed to do this for the Z variant. In both places, signers in the data collected for this study produce 2,500 using only NI variants, as in (2).

- (2) TWO-THOUSAND:ni FIVE-HUNDRED:ni
'2500'

It is therefore assumed that the Kansai variety allows signers to use Z variants only for 'bare' numerals, such as 100 and 1,000; these are referred to hereafter as 'simple tokens' of Z, in contrast to 'multiple tokens' (such as 2×100).

The claim that multiple tokens were once allowed in Kansai is strengthened by the fact that TSL signers *do* produce multiple tokens using the Z variant (as can be seen in Section 4.2, this is a productive strategy, especially in Tainan). Given the previous contact between JSL (Osaka) and TSL (Tainan) outlined in Section 1, it is likely that the use of multiple tokens was once common to both varieties and has since fallen out of practice in JSL.

Compared with NI variants, Z variants appear to be older, although the origins of the latter are unclear. A sign language dictionary from the time (Matsunaga, 1937) indicates that, in the 1930s, only Z variants such as TEN:z were used in Kansai, while a later dictionary (Matsunaga, 1964) suggests that it was used at that time in Kansai and Kanto. The current dominance of the NI system in Kanto would seem to suggest that the Z variants have since been displaced there by the NI variants.

This is supported by comments from two older signers in Tokyo, interviewed in 2016, who said that the Z variant is an 'old way', from Osaka, and no longer in use in the Kanto. As we will see in Section 3, the evidence supports this theory, but the idea that the Z variant is 'no longer in use' in the Kanto is not entirely correct. Use of Z variants is known to be common in Tainan, and given the strong usage of these variants in Kansai, it seems likely that they were introduced to the Tainan school by staff from the deaf school in Osaka.

Fischer and Gong (2011, p.28) claim that HUNDRED:z and THOUSAND:z are 'now used in JSL only in the Osaka dialect and only for talking about money'. Certainly the denominations of Japanese yen are in theory conducive to the use of the Z variant, with coins of value ¥1, ¥5, **¥10**, ¥50, **¥100**, ¥500 (since 1982), and notes **¥1,000**, ¥5,000, and **¥10,000**. The denominations in bold can be expressed as single Z variants, and the claim is considered in light of the data in Section 3.3.

2.3 Previous research on variation in JSL

Osugi (2010) presents a map of Japan showing responses to 30 lexical variables, of which three – ¥100, ¥300 and ¥1000 – include numerals. The survey includes responses from an older signer (in their 70s) and a younger signer (in their 30s) in each of Japan's 47 prefectures. Osugi's survey data has limited application to the present study, for several reasons. The three numerals included in the list of elicited items are all specified as money terms, and since only two people are included per prefecture, there would be issues around representation.

Some prefectures in Osugi's study have several variants, in cases where the respondent provided more than one variant, but the passive lexical knowledge of his respondents was not otherwise explored. Furthermore, a small number of prefectures do not have a value because the response was not produced by any other respondent. With these considerations in mind, one must be careful about making generalisations regarding regional patterns that might underlie the expression of these variables.

Nonetheless, Osugi's data contain important insights. Firstly, with the exception of a few rarer strategies, most of the responses to all three numeral terms can be categorised as Z or NI variants. Some of the variants are phonological – for example, seven responses to ¥100 and ¥300 produce a variant of HUNDRED:Z, with the index finger and pinky extended (HUNDRED:Z-b) instead of the ring finger and pinky (this variant has the same iconic basis, of two zeros). Other variants on the map reflect changes to a sign over time, such as 17 responses to ¥100 and ¥300 that are articulated as two-handed NI variants with a 'wallet' hand (shown in Figure 4a).

One can also see from Osugi's map that, in each case, more variants occur across older respondents compared with younger respondents. This is particularly striking for ¥300, as can be seen by comparing the responses from the older and younger signers in Figure 7.

Among the variants produced by older signers is THREE HUNDRED:Z-b, substantiating the theory that the multiplication strategy with the Z variant used to be common to JSL, while 46 of 47 younger respondents produce phonological variants based on the NI strategy for ¥300. Dialect levelling has been observed for some other sign languages too, such as BSL (Stamp et al., 2014), and we consider what our data have to say about dialect levelling in JSL and TSL in Section 5.1.

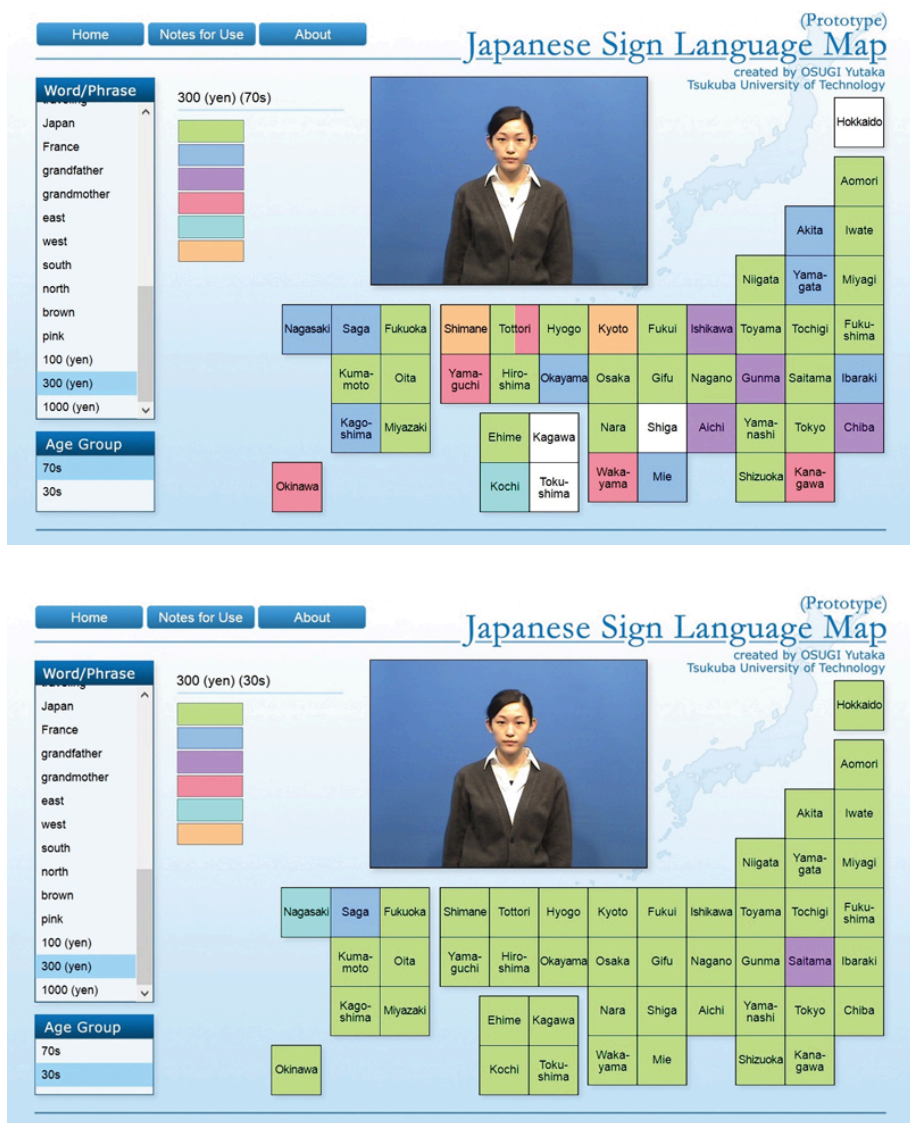


Figure 7. Responses to the stimulus ¥300 from older (above) and younger (below) respondents (from Osugi 2010, screenshots taken from www.deafstudies.jp/osugi/jslmap-en/map.html). Different colours indicate different variants

2.4 Switching between variants within a production

Some of the participants in the data switch between the two variants while producing a single numeral, but there appear to be limitations on how this operates. For example, where a numeral such as 1,100 occurs in the data, it is possible to realise (THOUSAND) using either variant, Z or NI. There are examples for 1,100 where (THOUSAND) is produced with a Z variant and (HUNDRED) is produced with an NI variant, but no examples occur in the other direction. That is, if participants begin to produce a number using the NI system, it seems that they will continue doing so. It is likely that this is because of the greater productivity of the NI variant. With this in mind, only the realisation of (THOUSAND) is included for numerals such as 1,100.

The Z variant is still used by signers in Kansai and Kanto to produce '1000', and also numerals between 1001 and 1999, using a strategy that combines both variants. For example, a signer aged 55 from Kansai signed 1,500 using Z and NI variants (3), while a signer from Kanto, aged 23, produced 1,580 using a similar switch (4).

(3) THOUSAND:Z FIVE-HUNDRED:ni
'1500'

(4) THOUSAND:Z FIVE-HUNDRED:ni EIGHTY:ni
'1580'

3. Numeral variation in JSL

3.1 Method

The realisation of the variables (TEN), (HUNDRED) and (THOUSAND) in JSL are explored in more depth by eliciting data from deaf signers in Kansai and Kanto and analysed using quantitative methods. In addition, the data are examined to identify examples that shed light upon how the two strategies are used.

Given how JSL users report that numerals have changed over time and talk of a link between Kansai and Z variants, it is likely that the realisation of these variables may pattern according to region and age. With this in mind, different age groups were sampled, and participants were aged 18 to 80 at the time of data collection. Participants were recruited from each region on the basis that they had lived in their region for a long time, and those who had travelled extensively around Japan were not recruited, in order to maximise the chances that participants would use variants in a manner typical of their region.

Convenience sampling was used, while bearing in mind the need for as balanced a sample as possible. For three months to January 2013, Data were collected from 36 participants over a period of three months (November 2010-January 2013), 18 from Kansai and 18 from Kanto. Potential participants regarded locally as fluent in sign language were identified with assistance from well-networked sign community members known to the researcher, and support from local deaf associations.

Participants attended one of several deaf schools that now exist in each region. The aim of the study was to sample the sign community, which comprises individuals who acquired sign language at different ages. For a sociolinguistic study such as this, it was not important to consider whether a participant can be regarded as ‘native’ (Palfreyman, 2019, p.86). The stratification of the sample is shown in Table 1.

Table 1. Sample stratification for JSL signers

Age	Kansai		Kanto		
	female	male	female	male	
20s	2	0	1	3	6
30s	2	2	1	2	7
40s	1	1	2	3	7
50s–60s	2	3	1	1	7
70s–80s	2	3	1	3	9
	9	9	6	12	36

Three main tasks were used to elicit the target variables, with the aim of collecting as many valid tokens as possible. Games are considered to be particularly useful here, because they avoid elicitation ‘by rote’, and enable examples to occur in context (Sagara & Zeshan, 2016, p.9). The tasks are as follows:

- *Matching task*
Participants were each given one of a pair of cards, where one has two numbers but the other has only one of those numbers. Participants with the latter card use the number in common to ask their interlocutor for the missing number.
- *Direct elicitation task*
Using PowerPoint slides with a range of different numerals, one participant at a time is asked how they sign these numerals. Use of the same stimuli for each participant enables comparative data, and different units can be elicited.

– *Bargaining task*

Pairs take turns to assume the roles of ‘buyer’ and ‘vendor’, and take a card with an item that is to be sold; the buyer tries to get the cheapest possible price, while the vendor tries to make as much profit as possible. The bargaining task is used to generate spontaneous data of money terms, and participants seem to enjoy playing it.

Each participant was interviewed to allow for the collection of metadata, concerning their age, school, region and so on. These interviews were also checked for cases where the target variables occur.

All comparable instantiations of (TEN), (HUNDRED) and (THOUSAND) were coded in ELAN (Sloetjes, 2014) for variable, variant, exact numeral, gender, age, region and category (no units, money, time, age, other units) (see Figure 8). A unique code was added for each participant, enabling the assignment of a random intercept at the mixed effects modelling stage, based on how much unexplained variance exists for each signer in the model. This way it is possible to be ‘more confident that the trends are not contributed by one or two individuals’ (Dräger & Hay, 2012, p.60).

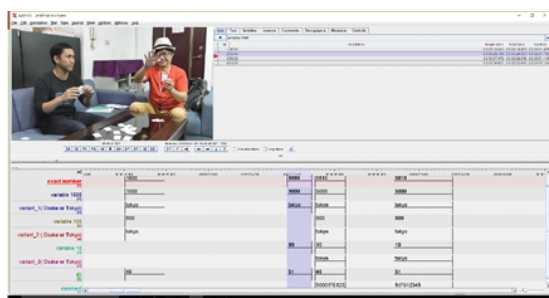


Figure 8. A screenshot of ELAN showing the coding tiers

It is important that contexts for the NI variants and Z variants are equivalent and comparable. As explained in Section 2, ‘multiple tokens’ involving the Z variant (such as ‘200’, TWO HUNDRED:Z) have not been observed for JSL, and indeed, none occur in the data. With this in mind, only ‘simple tokens’ (of values ‘10’, ‘100’ and ‘1,000’) are included for NI variants too, ensuring direct comparability. Numerals between 1000 and 1,999 were included for the (THOUSAND) variable because signers have been observed to use both variants for this as in (3) and (4).

3.2 Findings

In total, 416 tokens occur in the data (see Table 2). For Kansai signers, all three variables are realised with both variants, but prefer Z variants in each case. This preference is very strong (92.4%) for (THOUSAND) but weaker for the other two variables (63.4% and 58.3% respectively).

Table 2. Distribution of the three variables for JSL signers in Kansai and Kanto

		(TEN)		(HUNDRED)		(THOUSAND)		Total
		n	%	n	%	n	%	
Kansai	Z	60	58.3	45	63.4	73	92.4	178
	NI	43	41.7	26	36.6	6	7.6	75
	Total	103		71		79		253
Kanto	Z	0	0	0	0	67	60.4	67
	NI	27	100	25	100	44	39.6	96
	Total	27		25		111		163
GRAND TOTAL		130		96		190		416

On the other hand, Kanto signers only use the NI variant for (HUNDRED) and (TEN), but for (THOUSAND), this trend is reversed, and the Z variant is preferred (60.4%). This creates a categorical context, where signers in the dataset use only one of two variants. The hypothesis that age may be a factor in the distribution of the variable seems to be confirmed when Kansai signers are placed into two age groups with a similar number of members: those aged 46 and older (10 signers) and those aged 45 or younger (eight signers). Figure 9 shows that the younger group uses far fewer Z variants for (TEN) than the older group (4% compared with 76%), while a similar but less pronounced trend occurs for (HUNDRED), with 39% of younger signers using the Z variant compared to 74% of older signers.

To investigate this further, tokens from signers in the Kansai region were analysed using Rbrul (Johnson, 2009). The social factors of age (a continuous variable), sex and category (money term, not a money term) were included alongside the variable – (TEN), (HUNDRED), (THOUSAND) – and signer code was used to control for individual variation. Statistically significant variables are shown in Table 3.

As expected, the variable is found to be a very strong predictor, with (THOUSAND) favouring the Z variant (CFW 0.927) and (HUNDRED) and (TEN) disfavouring this variant. Age is also found to be significant ($p=0.0346$), with older signers favouring the Z variant. The sex of the participant is not statistically significant, nor is the category.

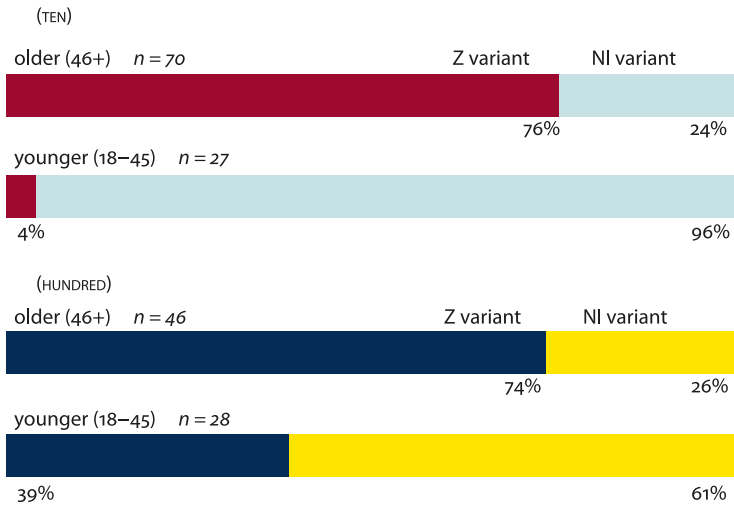


Figure 9. Production by Kansai signers of Z variants and NI variants for (TEN) and (HUNDRED), split into an older and younger group

Table 3. Rbrul run, statistically significant variables for the Kansai region ($n=253$), application value = Z variant

	Tokens	%	Logodds	CFW
Variable ($p<0.0001$)				
(TEN)	103	58.3	-1.884	0.132
(HUNDRED)	70	62.9	-0.663	0.340
(THOUSAND)	80	92.5	2.547	0.927
Age ($p=0.0346$)			0.049	

There is ample evidence that Kansai signers use the Z variant for an extensive range of units, not just for money. The 253 tokens are grouped according to units such as money, time and age. ‘Other units’ includes examples such as ‘nth floor’ of a building, while ‘no units’ refers to simple cardinal numeral. Table 4 shows the frequencies for each grouping according to the variants used.

Table 4. Tokens of all three variables by Kansai signers

Category (Example)	Z variant			NI variant			Total
	(TEN)	(HUNDRED)	(THOUSAND)	(TEN)	(HUNDRED)	(THOUSAND)	
no units (1,000)	11	21	55	14	12	2	115
money (¥100)	5	11	19	2	8	4	49
time (10 o'clock)	28	2	0	15	0	0	45
age (10 years old)	1	0	0	3	0	0	4
other (10%, floor 10)	15	10	0	11	4	0	40
Total		178			75		253

3.3 Patterns of variation in JSL

The prevalence of the Z variant in Kansai is perhaps to be expected, given previous observations, but the strong preference of Kanto signers for realising (THOUSAND) with the Z variant is remarkable, and contradicts previous claims (outlined at the end of Section 2.2) about the contexts in which THOUSAND:Z occurs in JSL. The dispreference of younger Kansai signers for HUNDRED:Z and TEN:Z seems to suggest that these variants are falling out of use. Conversely, it seems likely that the use of THOUSAND:Z will prevail in both dialects.

Regarding the claim in Section 2.2 about the use of Z variants solely for money terms, the use of these variants for other units, and for plain cardinal numerals, disproves this (Table 4). Tokens of HUNDRED:Z and THOUSAND:Z for money terms account for less than a third (30 out of 106) of the overall occurrences of these variants. It is also borne out by the use, in Kansai, of either HUNDRED:Z or HUNDRED:ni when translating Japanese phrases that feature ‘hundred’, such as *hyaku-shunen* (hundred-year-anniversary).

While the use of THOUSAND:Z is not restricted to money, it is likely that the frequency of the (THOUSAND) variable in daily life is linked to its use for money terms. Frequency data are not available to substantiate the observation, but amounts between ¥1000 and ¥2000 (with a respective value of US\$9 – \$18) occur more frequently than amounts between ¥100 and ¥200 (US\$0.90 – \$1.80). As described in Section 2, it is possible to mix NI and Z variants sequentially, in the direction of THOUSAND:Z → X-HUNDRED:ni → X-TEN:ni, allowing for the regular use of THOUSAND:Z.

Furthermore, on occasions when deaf people gather to eat together, Sagara has observed the suggestion that each person contributes ¥1000 to buy food for a meal. This can be expressed by inflecting the THOUSAND:z sign in the sign space, associating the sign with loci representing each deaf person. The minimal internal movement of this variant makes such an utterance felicitous, while using the THOUSAND:ni for such an utterance would lack felicity – the latter variant has a longer path movement that would make it cumbersome to articulate in several locations.

The finding that younger age disfavours the use of Z variants among Kansai signers suggests that, with the exception of THOUSAND:ni, the Z system is in decline. It is likely that attitudes towards language policy and planning have also played a significant role in language change here. As mentioned in Section 1, Z variants appear to be an older system, and schools for deaf children promote the use of NI variants (Yonekawa, personal communication, June 30, 2019). Additionally, NI variants are regarded as the standard across Japan, appearing in most sign language reference materials, and are also used, for example, by television interpreters, underlining the notion that these variants are standard ones.

Almost all JSL users are bilingual to some extent, and it could be that the standardisation of the Japanese, which has played an important role in spoken language change, influenced attitudes towards JSL standardisation. Certainly, the Japanese Federation of the Deaf (JFD) has long promoted standardisation. As early as the 1960s, the JFD claimed that there was too much variation in JSL, making communication difficult, and argued that the use of standardised signs would make for easier communication (JFD, 1969).

Having considered the findings from the JSL data, we turn now to examine an equivalent set of data for Taiwan Sign Language. Firstly, we explain the method for data collection and how we intend to compare the patterns with the JSL data.

4. Numeral variation in TSL

4.1 Method

TSL data were collected by Sagara from mid-October to mid-November 2016, with a sample of 20 people in Taipei and 20 in Tainan. In Taipei, deaf people were recruited locally with assistance from the national deaf association, while in Tainan the local deaf association was able to assist with recruiting signers regarded locally as fluent. Assistance was also given by a local deaf man, Ku Yu Shan, who grew up in Tainan and lives in Taipei – he has been involved with research and is known to deaf people in both cities; he was therefore well-placed to identify potential participants.

Participants were targeted in these respective areas, but as with the JSL data, only those who had remained in that area for a long time were included in the analysis. Therefore, for example, data from signers who had moved from Taipei to Tainan were excluded. As a result, 18 people in Tainan and 18 in Taipei were ultimately included for data analysis. There are three longstanding national deaf schools in Taiwan, in Tainan, Taipei and Taichung; participants attended the school in their city.

The sample is balanced as far as possible for age and gender, although it was quite difficult to find fluent younger TSL signers. Some of the deaf people that Sagara met in Taiwan said that this might be because fewer younger deaf people in Taiwan now learn and use sign language, due to a shift in cochlear implants and mainstream schooling. As with the JSL data, participants are assigned a unique signer code. The sample stratification is shown in Table 5.

Table 5. Sample stratification for TSL signers

	Tainan		Taipei		
	female	male	female	male	
20s–30s	1	2	1	2	6
40s	2	0	3	2	7
50s	3	3	1	5	12
60s	2	1	0	1	4
70s–80s	2	2	2	1	7
	10	8	7	11	36

The matching game and bargaining game were used for TSL data collection, but not the direct elicitation task. Having concluded from the JSL analysis that money may be a factor in the choice of a variant, we decided instead to test this further by collecting two types of tokens: money terms and non-money terms. Tokens from the bargaining game were checked and coded as money terms with the exception of two tokens where the numeral shown in the informant's non-dominant hand refers to quantity (see Figure 12). Tokens from the matching game are not associated with money terms or other kinds of units. The potential influence of money terms on choice of variant is discussed further in Sections 4 and 5.

As mentioned in Section 2.2, Sagara observed during fieldwork that, unlike for JSL, some TSL signers do produce multiple tokens using Z variants (for example TWO THOUSAND:z for '2000') and so all numeral tokens were included in the TSL analysis.

4.2 Findings

Altogether, 688 tokens were identified (see Table 6) and, serendipitously, an equal number of tokens occur for Tainan and Taipei. As with the JSL data, there is a categorical context, in that Taipei signers do not use the Z variant at all for (TEN). More generally, Taipei signers favour NI variants by a considerable margin (84.9%).

The absence of TEN:z in the data from Taipei signers is mirrored to a lesser extent by participants from Tainan. For both (HUNDRED) and (THOUSAND) the Z variant is favoured over the NI variant (75.9% and 64.1%, respectively) but only 16 tokens of TEN:z are produced, compared with 73 tokens of TEN:ni. This represents a notable reversal, a similar pattern in some ways to the switch that occurred in JSL among Tokyo signers in favour of THOUSAND:z, compared with preferences for HUNDRED:ni and TEN:ni.

Table 6. Distribution of the three variables for TSL signers in Tainan and Taipei

		(TEN)		(HUNDRED)		(THOUSAND)		Total	
		n	%	n	%	n	%	n	%
Tainan	Z variant	16	18.0	126	75.9	57	64.1	199	57.8
	NI variant	73	82.0	40	24.1	32	35.9	145	42.2
Taipei	Z variant	0	0	40	28.6	12	10.7	52	15.1
	NI variant	92	100	100	71.4	100	89.3	292	84.9
Total		181		306		201		688	

Given that Taiwanese signers have been observed to use the Z strategy to form multiples, Table 7 shows the distribution of tokens for each variable according to whether the amount shown was a *simple* token, of 10, 100, 1000, or a *multiple* token of values 20–90, 200–900 or 2000–9000.

The distribution in Table 7 proves to be illuminating. There are many multiple tokens for HUNDRED:z in Tainan, but for Taipei signers, only one of the Z variants is a multiple token – the remaining 51 tokens are simple tokens of either HUNDRED:z or THOUSAND:z. This multiple token, produced by a woman aged 48 who is believed to have lived in Taipei all her life, is perhaps the result of contact with signers from other parts of Taiwan such as Tainan, where multiples are more common. The low incidence of multiple tokens in Taipei suggests that multiples have never been a frequent strategy in the Taiwanese capital.

There is also variation across Z variant tokens produced by Tainan signers, with no multiple tokens for TEN:z, and – for THOUSAND:z – a much greater number of simple tokens (47) compared with multiple tokens (10). It is remarkable, therefore, that for HUNDRED:z, Tainan signers produce almost as many multiple

Table 7. Distribution of the three variables for TSL signers in Tainan and Taipei, showing simple and multiple tokens for each variable

		(TEN)		(HUNDRED)		(THOUSAND)		
		10	20–90	100	200–900	1000	2000–9000	
Tainan	Z variant	16	0	66	60	47	10	199
	NI variant	42	31	17	23	22	10	145
	Total	58	31	83	83	69	20	344
Taipei	Z variant	0	0	39	1	12	0	52
	NI variant	49	43	34	66	41	59	292
	Total	49	43	73	67	53	59	344
GRAND TOTAL		107	74	156	150	122	79	688

tokens (60; $n=83$) as simple ones (66; $n=83$). For (HUNDRED), over three times as many Z variants are produced by Tainan signers compared with NI variants.

Another important observation from Table 7 is that the total number of simple and multiple tokens differs more generally across the three variables. For (TEN) and (THOUSAND) there are fewer multiple tokens compared with simple tokens (74–107 and 79–122 tokens respectively) while for (HUNDRED) the number of multiple and simple tokens is broadly similar (150–156 tokens). This is considered further below.

Tokens of (HUNDRED) and (THOUSAND) were analysed using Rbrul, with the social factors of region, age and sex included alongside the variable, the category (money, not money) and a signer code used to control for individual variation. Tokens of (TEN) were omitted due to a categorical context (the absence of TEN:z in Taipei), similar to the one mentioned above for JSL (the absence of TEN:z and HUNDRED:z in Kanto). The findings are shown in Table 8.

As might be expected from the distribution in Table 6, region ($p<0.0001$) is found to be a very strong predictor, with Tainan signers preferring the Z variant. The variable is also found to be significant ($p<0.002$), with (HUNDRED) favouring the Z variant (Centred Factor Weight: 0.607) and (THOUSAND) disfavouring this variant (CFW: 0.393). Interestingly, money is a significant predictor too ($p<0.005$), with money values favouring the Z variant. Sex is not found to favour either variant, and nor is age.

A second Rbrul run focuses only on Tainan signers, because the three variables feature no categorical contexts for this subset of the data. The second run

Table 8. Rbrul run, (HUNDRED) and (THOUSAND) for both regions ($n=507$), application value = Z variant

	Tokens	%	Logodds	CFW
Region ($p<0.0001$)				
Tainan	255	71.8	1.574	0.828
Taipei	252	20.6	-1.574	0.172
Variable ($p<0.002$)				
(HUNDRED)	306	54.2	0.436	0.607
(THOUSAND)	201	34.3	-0.436	0.393
Value type ($p<0.005$)				
Money	224	53.1	0.569	0.639
Not money	283	41.0	-0.569	0.361

includes all of the factors mentioned above except region, which is no longer relevant. The findings are shown in Table 9.

Table 9. Rbrul run for tokens of (TEN), (HUNDRED) and (THOUSAND) as produced by Tainan ($n=344$), application value = Z variant

	Tokens	%	Logodds	CFW
Variable ($p<0.002$)				
(HUNDRED)	166	75.9	1.690	0.844
(THOUSAND)	89	64.0	0.999	0.731
(TEN)	89	18.0	-2.689	0.064
Age ($p<0.002$)			0.077	

Again, the variable ($p<0.0001$) is found to be a very strong predictor, with the Z variant favoured by (HUNDRED) and (THOUSAND) and disfavoured by (TEN). Age is also found to be significant ($p<0.002$), with older signers favouring the Z variant and younger signers disavoursing it. The sex of the participant is not found to be significant, and interestingly neither is the type of variant (money vs. not money). Given that the type of variant *was* significant for the first model, it would seem that data from Taipei signers contribute to that particular pattern.

If money terms sometimes influence the way that signers realise these variables – at least for (HUNDRED) – it makes sense to consider the distribution of money value tokens, and this is shown in Table 10 ($n=311$).

Table 10. The distribution of variables for money value tokens, according to region

		(TEN)		(HUNDRED)		(THOUSAND)		
		10	20–90	100	200–900	1000	2000–9000	
Tainan	Z variant	0	0	25	32	21	2	80
	NI variant	16	24	3	12	3	3	61
	Total	16	24	28	44	24	5	141
Taipei	Z variant	0	0	31	1	7	0	39
	NI variant	11	36	7	31	13	33	131
	Total	11	36	38	32	20	33	170
GRAND TOTAL		87		142		82		311

Unlike the matching gme, where there were constraints on which numerals could be produced, the bargaining task left participants free to decide the values that they produced. A greater number of multiple tokens occur compared with simple ones (174 vs. 137) which is to be expected, given that participants are haggling and need to use a variety of multiples, but it is notable too that there are again more tokens overall for (HUNDRED) than for (TEN) and (THOUSAND). Furthermore, simple money tokens for (HUNDRED) pattern in a distinct way: the vast majority (56 out of 66 tokens, or 84.9%) are Z variants rather than NI variants.

Signers from both regions prefer the Z system for expressing simple money values of (HUNDRED), though not categorically. For Taipei signers, the preference for the Z variant is marked (31 out of 38 tokens) and this is especially remarkable considering that the distributions for simple values of (TEN) and (THOUSAND) fall in favour of NI variants (11/11 tokens and 13/20 tokens, respectively). A regional difference emerges in terms of how signers articulate multiple values of (HUNDRED): while Tainan signers also produce HUNDRED:z on 32 out of 44 occasions, Taipei signers use HUNDRED:ni for all but one token.

5. A comparative sociolinguistic account

5.1 Cross-linguistic comparison of findings

There are remarkable similarities in the findings for JSL and TSL, and several social factors appear to be influential in how the variables are realised: region, age and variable – (TEN), (HUNDRED) or (THOUSAND). The category of the numeral, that is, whether or not it is a money term, is found to be significant for the TSL data when (TEN) is excluded from the data (enabling the inclusion in the analysis of data from

both regions). The influence of social factors investigated in this study are summarised in Table 11.

Note that the statistical values from the Rbrul analysis are not included in the table because they are not strictly comparable. Given the categorical contexts identified in the data, it was necessary to approach each data set differently. For the JSL data, only the Kansai sub-set is used for Rbrul analysis; for the TSL data, the first run features only variables (HUNDRED) and (THOUSAND), while the second run uses only the Tainan sub-set.

The role of region as a factor in the expression of the variables in each language is predictable given the language contact that occurred during the Japanese colonial period (see Section 1). However, the role of age is important, because in Kansai and Tainan younger signers are using the Z variants less frequently. According to the apparent time hypothesis (Bailey, Wikle, Tillery, & Sand, 1991), these findings suggest that – with an important exception in each language – most Z variants are likely to become obsolete.

Table 11. A summary of factors affecting the realisation of variables, with references to relevant tables in Sections 2–4

Factor	JSL	TSL
Region	Kansai signers favour Z variants over NI variants (Table 3)	Tainan signers use more Z variants than NI variants (Table 6)
	Kanto signers in the data do not use the Z variant at all for (TEN) or (HUNDRED) (Table 3)	Taipei signers in the data do not use the Z variant at all for (TEN) (Table 6)
	Kanto signers favour THOUSAND:Z over THOUSAND:ni (Table 2)	Taipei signers favour HUNDRED:Z over HUNDRED:ni for simple tokens (Table 7)
Sex	not found to be significant in the Kansai region when all variables are included	not found to be significant in Rbrul analysis for the TSL data
Age	older signers in the Kansai region favour the use of Z variants (Table 3)	older signers in Tainan favour the use of Z variants; younger Tainan signers prefer NI variants (Table 9)
Variable	(THOUSAND) is marked, and heavily favours the Z variant (Table 2)	(HUNDRED) is marked, and favours the Z variant for simple tokens (Tables 6 and 9)
Category (e.g., money terms)	not found to be significant in the Kansai region when all variables are included	money terms are statistically significant when (HUNDRED) and (THOUSAND) are considered (Table 8)

Furthermore, it is the dominant variant in the respective capitals of the countries where the languages are used, Tokyo and Taipei, that is becoming dominant elsewhere (Kansai and Tainan). In Section 3.3 we noted that, for JSL, this could be connected to perceptions of standard varieties, and more research is needed on the potential influence of attitudes to regional varieties in both languages. What is certain is that younger deaf people in Japan and Taiwan have become ever more mobile which, along with the use of sign language online, has increased contact between regional varieties. Such contact is a general factor in enabling the spread of NI variants in both languages.

The outcome of this language contact, as highlighted by our analysis, is dialect levelling. Younger signers in Kansai and Tainan appear to use the Z variant less, and the NI variant is favoured – although Kanto signers break with this latter pattern when expressing (THOUSAND), and Taipei signers express simple tokens for (HUNDRED) in a different way to the other two variables. Incidentally, this alignment of numeral variables between Kansai-Tainan, and Kanto-Taipei is not unique, and some other lexical variables behave in a similar way across JSL and TSL. For example, variants for ‘name’ and ‘water’ show similar patterns (Tsay, Sagara, & Kikusawa, 2019), although it is not yet clear whether dialect levelling can be observed for these kinds of lexical variables as well.

Osugi’s (2010) JSL data, discussed in Section 2.3, show that, for (THOUSAND), the Z variant is produced by 16 older respondents, but this increases to 35 for younger respondents. This suggests a move in favour of THOUSAND:Z across Japan. It seems unlikely, however, that levelling will occur in the other direction for (THOUSAND) because of the now widespread reliance of JSL users on numeral incorporation for expressing multiple tokens. For this reason, we would highlight the importance of including multiple values in any further work on numeral variation in JSL and TSL.

Given the difference in patterning, it is important to ask is why THOUSAND:Z in JSL and HUNDRED:Z in TSL appear to have attained special status for younger signers. Indeed, these exceptions appear to be socially marked, and there are several reasons why the Z variant may be proving tenacious. In particular, the prevalence of HUNDRED:Z in TSL and THOUSAND:Z in JSL may be linked with frequency of use, although frequency data are needed in order to test this hypothesis.

As noted in Section 3.3, there would seem to be many cases where 1,000 is articulated in a financial context, and this case can also be made for 100 in Taiwan. Indeed, these are the smallest values of banknotes in Japan and Taiwan, respectively, and the Taiwan dollar is currently worth more than the Japanese yen. For the purposes of comparison, in June 2018, a Big Mac cost roughly 65 New Taiwan Dollars (NT\$) and ¥370 – to pay, one might therefore require a NT\$100 banknote or a ¥1,000 banknote (both of these are the lowest denomination notes in the respective currencies).

5.2 Linguistic differences between NI and Z variants

Given that Z variants are not as productive as NI variants, one might wonder why Z variants are still used at all. One possible reason is that there is a strong systematic element to Z variants. In JSL, several values can be expressed in this way: 10, 100, 1000, 10,000 and 100,000,000. Could it be that, cognitively, the underlying systematic nature of these iconic Z variants favours their tenacity – at least compared with a single lexical item? If so, then the existence of a paradigm of Z variants might reinforce their ongoing use in isolated contexts.

A second difference between the Z and NI variants lies in their ability to be articulated in the space. As described in Section 2, the NI variants can inflect for multiples, which means that complex numbers can be conveyed with a minimal number of movements. Compared to the Z variant strategy in TSL, for example, the NI strategy is more efficient, which may help to explain part of the reason for its popularity.

However, HUNDRED:ni and THOUSAND:ni feature internal movement and path movement, respectively, and these movements are not felicitous for spatial inflection. That is, if signers wish to associate the value with different objects or people, one strategy for achieving this is to produce the sign in different parts of the sign space. This is more difficult to achieve with many internal movements or path movements. Conversely, HUNDRED:z and THOUSAND:z have a small internal movement that is conducive to spatial inflection. This can be seen in Example (5), which comes from the JSL data ('RH' is right hand, and 'LH' left-hand; the dashed line represents a hold).

- (5) RH: APPLE ONE APPLE HUNDRED:ni
 LH: APPLE-----
 RH: APPLE HUNDRED:z HUNDRED:z#circle SIX-HUNDRED:ni
 LH: APPLE----- AGREE
 'One apple is ¥100, so [six apples] at ¥100 each is ¥600, agreed?'

In (5), there is a switch from the NI variant to the Z variant and back again. The price of an apple is ¥100 (HUNDRED:ni), and the signer then produces HUNDRED:z with a circling path movement to indicate the price of *each apple* (this specific movement is particular to this context but operates according to standard spatial conventions in JSL). The motivation for this switch appears to be the ability of the Z variant to inflect spatially, as it relies on a handshape rather than – in the case of HUNDRED:ni – an internal movement. The internal movement of HUNDRED:ni means that more effort would be required to repeat it in different parts of the sign space. Were it not for this affordance of HUNDRED:z, it seems reasonable to suppose that the participant would have retained the NI variant for the entire utterance.



Figure 10. The movement of articulation for HUNDRED:z#circle

The ability of the Z variant to inflect spatially can be seen in certain signs that have become lexicalised. For example, the JSL sign DEPARTMENT-STORE (*hyakkaten*, 百貨店) is a compound meaning, literally, ‘100-item-shop’. This concept appeared in the 1920s or 1930s at a time when the idea of a shop selling 100 items was ground-breaking (Yonekawa, 2009). The JSL sign DEPARTMENT-STORE (Figure 11a) traces the shape of a building and uses the handshape of the HUNDRED:z sign. It would not be felicitous to trace this shape using HUNDRED:ni because of its internal movement.

Remarkably, TSL has a different but related sign for ‘department store’, because the concept was introduced to Taiwan by the Japanese. The TSL sign is also based on the spoken word *hyakkaten*, and also uses the HUNDRED:z handshape, but traces a diagonal path to represent escalators, with the hands opening as they move upwards (Figure 11b). It is not known whether these signs emerged in isolation or through some form of language contact.

Other examples of lexicalised signs are linked to ‘10’, and include ‘tenth floor’, ‘October’ (tenth month), ‘10 o’clock’ (tenth hour) and ‘decade’ (ten years). For all of these signs it is possible in Kansai JSL to use either the TEN:z or TEN:ni, while Kanto signers seem to use only TEN:ni.³ Ultimately, though, if variants with the TEN:z handshape survive, it is likely that they will survive as fossilized forms, with signers unaware of their provenance.

The availability of Z and NI variants in both Kansai JSL and TSL has presented examples of signers using the variants contrastively for different purposes. Besides the example of ‘six apples’ for JSL in (5), above, a second example occurs in the bargaining game as that discussed above – selling apples – in the TSL data.

3. In the case for the latter, a segment of internal movement – the bending of the select finger – is elided.



Figure 11a. The JSL sign DEPARTMENT-STORE



Figure 11b. The TSL sign DEPARTMENT-STORE



Figure 12. A signer simultaneously shows TEN:ni ('ten apples') on his left hand and HUNDRED:z ('NT\$100 each') on his dominant right hand

Figure 12 shows part of an utterance where the participant states that NT\$ 100 for ten apples is cheap. This is expressed with the quantity (ten apples) on the left hand, using TEN:ni, and the price is then foregrounded on the dominant right hand (NT\$ 100), using TEN:z. This may be partly due to the prevalence of the Z variant for showing money values (see for example the discussion about the

NT\$ 100 banknote, above). However, there is also clearly a contrastive element to this simultaneous expression.

A similar example is known to occur in South Korean Sign Language (SKSL), a sign language that received similar input from JSL in colonial times (Sasaki, 2007). In SKSL, 10 o'clock can be shown in the non-dominant hand using the Z variant and the number of minutes is shown with an NI variant (Sagara, 2014). For example, the time 10:10 can be expressed contrastively by juxtaposing TEN:Z and TEN:ni.

5.3 A social meaning for variants?

A final consideration that may help to explain the findings is the possible indexical role of variants. A further possibility is that the Z system has social meaning as a referent to Kansai identity. The Z variants seem to be associated with Kansai, and the use of TEN:Z and HUNDRED:Z – at least by some Kansai signers – may have indexical value as a means of asserting regional identity. Heinrich (2018, p.173) notes that, for spoken Japanese, 'speaking dialect was seen as a personal short-coming, an embarrassment' in the mid-twentieth century, but that 'young speakers in Kansai have remained active speakers of the local dialect'.

Meanwhile, preliminary data collected in 2016 by the author from Kagoshima, in the far south-west of Japan, suggests that almost all signers use NI variants. However, a few younger signers have met with other younger signers from Kansai, for example through national sports events, and have adopted THOUSAND:Z alongside THOUSAND:ni. This could be an example of what Heinrich (2018, p.176) describes as *nise hogen*, or 'fake dialect'. For Japanese, he shows how younger speakers are playing with dialects, using them in different ways, and 'no longer simply [as] a way of indexing one's regional background'.

6. Summary

This comparative sociolinguistic study examines the realisation of variables for (THOUSAND), (HUNDRED) and (TEN) in JSL and TSL. The historical links attested in the literature between the deaf schools in Osaka and Tainan explain the long-standing preference of TSL signers in Tainan for the Z variant, but what is particularly striking is the way that one of the variants – THOUSAND:Z for JSL and HUNDRED:Z for TSL – have become widely accepted, even while the Z variant more generally shows signs of decreasing usage over time.

It is perhaps curious that the Z variants have retained such influence, given that they are less productive than the NI variants. Some of the potential reasons

suggested for the popularity of the Z variants include the availability of a set of signs based on a similar iconic strategy, the ability of Z variants to inflect in the sign space easily, and perhaps the social indexical value, for younger signers, of a variant linked with the Kansai, that is not associated with their own dialect.

In terms of the actuation of this language change, several factors must be considered. Undoubtedly the historic isolation of deaf schools and deaf communities gave way to increasing language contact between varieties, as deaf people became more mobile. We do not know why the appearance of Z variants in multiple constructions fell out of use in JSL, but the decreasing productivity of the Z variant contrasts sharply with the high productivity of the NI variant, which can be used to express more complex numbers quickly. Indeed, given that Z variants still appear in multiple constructions in TSL, but are still falling out of use, it could be the relative speed of the numeral incorporation strategy that won out.

The dominance of varieties based around Tokyo (for JSL) and Taipei (for TSL) – both associated with power and prestige – almost certainly had a role to play in the spread of the NI variants associated with these capital cities. For JSL, the use of NI variants in the education system, on television, and in literature created by the Japanese Federation of the Deaf, along with the push towards standardisation since at least the 1960s, were surely also influential.

We have found that use of Z variants is not restricted to money terms, as has been claimed in the literature, but we argue nevertheless that the context of use is an important consideration. Is it simply a coincidence that THOUSAND:Z is so common in JSL, and HUNDRED:Z in TSL, given that ¥1000 and NT\$100 are the most common and lowest values of paper money in the respective currencies of their countries of use? We contend that the frequency of use of these terms can help to explain the differential outcomes in each language.

Using a corpus of data from two cities in each sign language, this study has combined statistical analysis with consideration of particular contexts in the data in order to elucidate the behaviour of the three numeral variables. It has not been possible to conduct identical statistical studies due to the need to accommodate categorical contexts in each case, but the social factors of region, age, the variable – (THOUSAND), (HUNDRED) or (TEN) – and, in some cases, the category, have been found to be influential for each sign language.

Finally, the difficulty of finding younger TSL signers has been a matter of some concern. It is one thing to say that younger signers are less likely to use Z variants, but it seems that the use of TSL by younger deaf Taiwanese people in general is decreasing rapidly. This will almost certainly have implications for the future vitality of TSL, and highlights the urgency of linguistic and sociolinguistic documentation in the region.

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Abstract (Japanese Sign Language)

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Abstract (Japanese)

日本手話および台湾手話における数詞「10」「100」「1000」には様々な表現があり、これら両言語は、歴史的に関連性のある言語である。日本統治時代において、日本手話は台湾手話に広く接触し、現在においてもその影響が保たれているが、複雑な社会言語学的な状況のもと、各場面で異なった実情が生じている (Fischer, 2014; Sagara, 2014)。本稿での比較・社会言語学的な分析は、日本手話では関西と関東、台湾手話では台南と台北における、計72名の話者によって表出された1100例からなる2つのデータセットに基づくものである。混合効果モデルによって、話者の年齢や地域のような社会的因子が、その変異幅がどのように生み出されるのかについて大きな影響を持つということを明らかにした。本研究では、注意深く通言語学的な比較を行うことによって、言語接触のある手話間および言語内における変異を明らかにし、ある言語の地域変種が別の言語の地域変種にどのように影響するのかを示している。日本手話、台湾手話、バリエーション、数詞、類型論

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