Hong Kong Sign Language numerals

Interaction of syntactic processes and the movement-parameter

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Syntactic processes trigger changes in the movement-parameter of Hong Kong Sign Language (HKSL) numeral signs. Though HKSL cardinal numerals by default do not contain movement and are produced in neutral space, under specific circumstances, the movement-parameter can be altered from [∅] to specifications for both path- and hand-internal movement. This creates four types of numerals: (1) event numerals, (2) transfer numerals, (3) conjunction numerals, and (4) list numerals. I analyze the syntactic structures of these four numerals as follows: Firstly, event numerals quantify the number of times an event denoted by V has occurred and in syntax the numeral is located in a FreqP in Spec,VP. Secondly, transfer numerals show transfer of ownership and are within the DP complement of V^{o}. Thirdly, the conjunction numeral indicates that all items of a set are included and the numeral is located within ConjP. Finally, the list numeral is the head of a NumeP with a [list]-feature within DP.

Keywords: agreement, conjunction phrase, Hong Kong Sign Language, movement-parameter, numeral morphology, verbal classifiers

1. Introduction

The present paper offers a description and an analysis of numeral morphology in Hong Kong Sign Language, more specifically how syntactic processes trigger changes in the movement-parameter of numeral signs. Previous linguistic research on numerals across sign languages has focused mainly on numeral incorporation into other signs (e.g., Liddell 1996; Fischer et al. 2011; Jones 2013; Ktejik 2013; Burkova et al. 2019; Semushina & Mayberry 2019, among others), descriptions of numeral subsystems (Fuentes & Tolchinsky 2004), or the typological as well as regional variation in the realization of numeral signs (e.g., Fuentes et al.

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2010; Sagara 2014; Zeshan & Palfreyman 2017), but the line of research pursued in the present paper has not yet been explored.

1.1 Hong Kong Sign Language

Hong Kong Sign Language (HKSL) is the visual-manual language used by members of the Deaf and Hard of Hearing community in Hong Kong. The origins of HKSL can be traced back to when a Deaf signing couple moved from Shanghai and Nanjing (China) to Hong Kong after World War II. They brought local varieties of Chinese Sign Language with them to teach the Hong Kong Deaf community at the signing school they established. Prior to this, local signing must have existed in Hong Kong which interacted with the Shanghai/Nanjing signs used in educational settings (Woodward 1993; Sze et al. 2013). HKSL subsequently developed into an independent language.

According to research by Sze (2015), the most frequently attested word order in HKSL is SVO, attested in 65% of the data, followed by SOV in 16.5% of the data. The SOV word order is mostly used in clauses containing agreement verbs of classifier predicates.

Within noun phrases (NPs), the noun precedes all modifying elements, as illustrated by the examples in ((10) and (2)).

(1) a. DOG THREE
'three dogs'

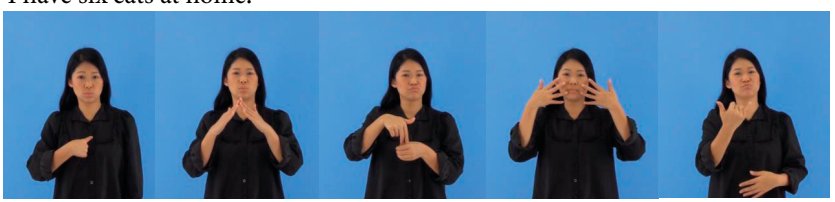
b. DOG BLACK
'a/the black dog'

c. DOG BLACK THREE
'three black dogs'

d. DOG BLACK MANY
'many black dogs'

e. HAVE [$_{NP}$ DOG BLACK YOUNG CUTE]
'There is/They have a dog which is black, young, and cute.'

(2) 'I have six cats at home.'



IX$_1$ HOUSE RAISE CAT SIX

Some variation in the word order of modifying elements within the NP is possible. This word order depends on the preference of the signer and what information they decide is most important. For instance, next to the order in (1c), the order in (3) is also attested.

(3) DOG THREE BLACK
'three black dogs' (i.e., there were three dogs, all three were black)

1.2 HKSL numerals

HKSL cardinal numerals are one-handed signs produced in neutral space, see Figure 1 below. These cardinal numeral signs have no movement, neither hand-internal movement nor path movement of the entire sign. In these cardinal numeral signs, the orientation-parameter is important, as the signs ONE through SIX and EIGHT are produced with the palm of the hand facing the signer, whereas in the signs SEVEN, NINE and TEN, the palm faces the contralateral side and is tilted slightly inward.

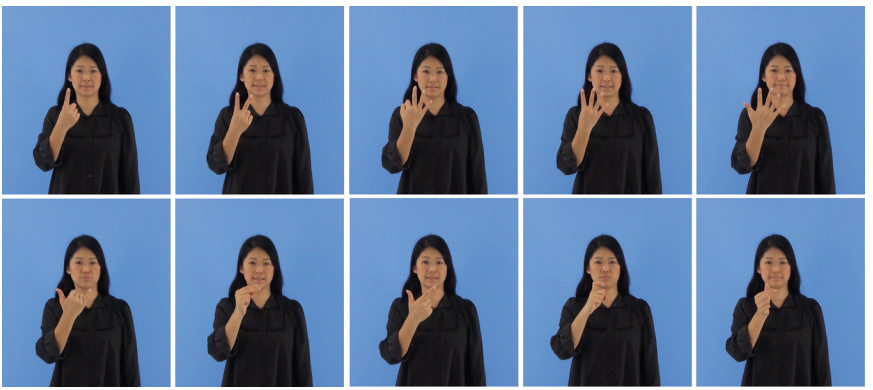


Figure 1. HKSL cardinal numerals ONE through TEN

As mentioned above, the HKSL cardinal numeral signs ONE through TEN have no movement. However, under certain circumstances, HKSL numerals do show specific movements, be it hand-internal and/or path movement of the sign as a whole. Figure 2 below shows the four types of movement found in the data I collected in an experimental setting (see Section 2). In the figure, the numeral TWO is used to exemplify these types of movement. Figure 2a shows the neutral sign TWO. Figure 2b shows TWO with a contralateral arch-movement and selected fingers sequentially opening. Figure 2c shows TWO with movement of the forearm towards the signer. Figure 2d shows TWO with all selected fingers opening simul-

taneously. Finally, Figure 2e shows TWO with all selected fingers opening while the arm moves into neutral space with a contralateral arch-movement.



Figure 2. Numeral TWO, neutral in (a) and with modified movements in (b–e)

The purpose of the present paper is to describe under which specific circumstances the movement-parameter of the numerals ONE through TEN can be altered.

1.3 Syntax of numerals

There is discussion in the literature about the syntactic position of numerals. They are either argued to be the head of NumP, selecting NP as complement, or they are assumed to be maximal projections that occupy a specifier position (Danon 2012).

According to Danon (2012), the syntactic position of numerals can be different both cross-linguistically as well as language-internally. For example, in Hebrew, there is a distinction between bound and free numerals, both show different syntactic behaviors and should therefore receive a different syntactic analysis. This hypothesis is further supported by the fact that bound and free numerals cannot be coordinated. Danon (2012) argues that bound numerals have the same morphophonological properties as nominal heads in construct states. Furthermore, bound numerals cannot be separated from the following noun. The conclusion is therefore that Hebrew's bound numerals occupy a head position and free numerals a specifier position.

Evidence that supports a head-position for numerals is the presence of morphological case. If the case of a noun depends on the numeral, the numeral must be a head which selects an NP complement. In languages such as Inari Sami (Nelson & Toivonen 2000), Russian, and Standard Arabic (Shlonsky 2004; Zabbal 2005), the case marking on nouns is dependent on the numeral. Secondly, if numerals are heads, word order restrictions dictate that numerals precede nouns in head-initial languages, but follow nouns in head-final languages (Danon 2012: 1288).

Though it is necessary to conduct more research on the HKSL NumP in the future, for the remainder of this paper, I will follow the argumentation of Danon (2012), which means HKSL numerals most likely occupy a specifier position. This working hypothesis is based on the fact that HKSL does not mark morphological case, which implies that there is no necessity for numerals to be heads. Additionally, since HKSL is head-initial but numerals follow nouns, it does not abide by the word order restrictions dictated if numerals were in a head-position.

1.4 Hypothesis

I argue that the different signs for TWO in Figure 2 are in fact the same lexical item, however, depending on where they are merged in the syntactic structure, they are assigned different features which in turn cause the movement-parameter to change from [∅] to something else. Anticipating the analysis below, I argue that Figure 2b shows an *event numeral*, NUM(event), where the numeral is located in a Frequency Phrase (FreqP) in Spec,VP. This numeral is used to quantify the number of times an event denoted by V has occurred. Figure 2c shows a *transfer numeral*, NUM(trans), where the numeral is part of the complement DP and agrees with V°. This numeral indicates transfer of ownership. Figure 2d shows a *conjunction numeral*, NUM(coor), which translates as 'both', indicating that all items of a set are included. This numeral is located within ConjP. Finally, Figure 2e

shows a *list numeral*, NUM(list), which is a numeral that preempts a listing of items. This numeral is the head of a NumeP with a [list]-feature within DP.

I thus argue that syntactic structures influence numeral morphology. In the context of sign languages, there is no clear distinction between phonemes and morphemes. This is due to the fact that the five phonological parameters of sign languages – location, movement, handshape, orientation, and non-manuals – are, though sub-lexical, not altogether meaningless. For example, any sign with a location specified for *forehead* likely has to do with the mind, the brain, or the head. It is also these parameters that are modified in processes of derivational and inflectional morphology. The division between phonemes (the smallest meaningless, sub-lexical units in a language) and morphemes (the smallest meaningful components in a language) is therefore blurred, and the five parameters mentioned here are often referred to as phonomorphemes (e.g., Johnston & Schembri 1999). Arguably, this is related to the high level of iconicity in sign languages, meaning that phonological components have meanings and are therefore also morphemic. Though some might argue that since the movement-parameter is part of sign phonology, a phonological analysis of the signs would be more fitting, I would like to invoke the fact that all five sign parameters are as much phonological as they are morphological. In that light, analyzing the changes in the movement-parameter as morphological changes is justified. In future research, I might add a phonological analysis of these morphological changes.

1.5 Contents of this paper

This paper is organized as follows: In Section 2, I discuss the method of data collection used for this research. The function, form and sentential and syntactic context of the above-mentioned four types of numerals – (1) event numeral, (2) transfer numeral, (3) conjunction numeral, and (4) list numeral – will be analyzed in Sections 3, 4, 5, and 6, respectively. The first of these four, which I have coined the "event numeral", enumerates the number of times an event or action has taken place. The second, the "transfer numeral", indicates transfer of ownership. The third, the "conjunction numeral", points at the inclusion of all listed referents in the predicate. The fourth, the "list numeral", sums up a list of referents. Only cardinal numerals ONE through TEN occurred in my data. All these numerals can be modified in their movement component to become event, transfer, or count numerals. The exception is the conjunction numeral, which is restricted to the numeral TWO. The reason for this restriction of the conjunction numeral to the numeral TWO is subject to future research. Complex numerals and cardinal numerals higher than ten fall outside the scope of this paper. Section 7 concludes this paper by summarizing my main arguments.

2. Methodology

The participants of my study were eleven Deaf native signers of HKSL between the ages of 30 and 45 years old. All eleven participants were born to two Deaf parents and acquired HKSL as their native language. Due to the age range, the pool of participants was limited to eleven. I felt it was necessary to apply this restriction because sign languages develop rather rapidly between generations, and inviting participants from different generations would possibly have made the data harder to interpret. The reason I chose this specific age range is because the Deaf signers of that generation are the sign language teachers at Hong Kong universities for hearing adults and in the schools that offer bimodal bilingual education to Deaf children. Most hearing sign language interpreters as well as the Deaf children (of hearing parents) leaving school have thus been taught by the Deaf signers of this generation. These signers are therefore confident in their signing and form a homogeneous group.

The study the participants participated in was the second round of a two-part study on another topic unrelated to numerals and numeral movement. The finding of these four types of numerals was accidental and unexpected. In an interview setting, participants were shown a video in which my native signer informant signed an utterance. Participants were then asked to score the utterance on a scale of 1 to 5. In an instructional video preceding the task, participants were told that a score of 1 would mean that the utterance was completely ungrammatical and unacceptable; a score of 2 meant that the utterance was odd and not natural signing; a score of 3 meant that the utterance was acceptable, though they would not sign it the same way themselves; a score of 4 meant that the utterance was grammatical; and a score of 5 meant that the utterance was grammatical, natural signing, and that they would also sign the sentence the same way themselves. I then conducted a post hoc interview with the signers to collect retrospective data. For example, if they had given the utterance a low score, I would ask them why they had given a low score and how they would sign the sentence themselves. Responses were recorded using video recording equipment and transcribed afterwards.

There were a total of 51 stimuli. 25 of the stimulus sentences contained numerals. These numerals were always in the neutral form, i.e., without movement. The participants, when correcting the mistakes in the stimuli, would often add movement to the numerals. Sometimes they did so consciously, pointing out why movement needed to be added to the numeral in order for the sentence to be grammatical, and sometimes they did so unconsciously, spontaneously adding movement to the numeral while actually focusing on correcting another part of the stimulus sentence. Because the setting of the study was an interview, I was able

to ask the participants why they had decided to add movement to the numerals, and their native intuitions are what guided me in identifying the usages attributed to the four types of numerals. Their intuitions also clarified the semantic contexts in which these numerals may occur, e.g., the event numeral occurs when someone wants to emphasize how often an event has occurred.

The data contained 17 tokens of event numerals, 51 tokens of transfer numerals, 5 tokens of the conjunction numeral, and 12 tokens of the list numeral, all produced by various signers as all eleven participants made use of the different types of numerals in their signing. Since the experimental setting was not set up to elicit these numerals, and they were actually found accidentally, this paper will not provide a statistical analysis of the data, but instead a syntactic account (see the Appendix for the list of stimuli that received a numeral other than the neutral numeral in the participants' answers).

Though the experimental data contain many examples of how signers have opted to replace a neutral numeral by one of the four numerals mentioned above, for each stimulus the eleven participants were shown, there was still considerable variation among the answers. For example, whereas some participants might have chosen to replace the neutral numeral by a transfer numeral, others opted to leave out the numeral altogether, maintain the neutral form, or use an event numeral. This shows that the interpretation of a sentence differs from person to person, as is the case for all natural languages. The present paper only attempts to demonstrate what the syntactic structures which underlie all the different numerals look like; ultimately, the choice of which numeral to use is up to the signer. The inter-signer variation attested in my data also shows the limits imposed by the initial experimental setting, as it was not designed to elicit numerals, and the findings reported here were a by-product. I hope to explore the topic of variation in a follow-up study.

In addition to the experimental data, I have also asked my Deaf informant about her intuitions regarding the usage of these numeral movements and if she could produce sentences containing them. The participants of my study have signed an agreement to remain anonymous, and therefore their data will only be shown in transcription; however, my informant has given permission to use her image.

3. Event numerals

When enumerating the number of times an event or an action has taken place, signers can use NUM(event). This numeral is characterized by a sideways "coming-in"-movement of the dominant hand, meaning that the dominant hand

moves contralaterally to a more centralized position in neutral space. During this path movement, the fingers open one by one until the desired numeral is reached. For example, if an event has occurred four times, the index, middle, ring, and pinky finger will open sequentially until the path movement has ended and the hand has reached center-neutral space (see Figure 3).

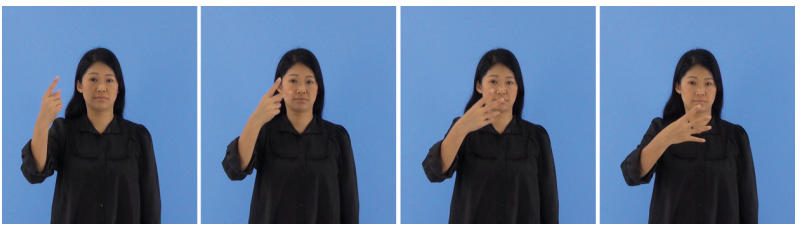


Figure 3. FOUR$_{(event)}$

This sequential opening of the fingers is a way to count the number of occurrences of an event before arriving at the final numeral.

If a numeral is higher than five, either the sequence of unfolding fingers will be less clearly pronounced before arriving at the desired numeral, as in Figure 4 below, or the unfolding of the fingers will be skipped altogether, as in Figure 5 below. For the latter, the selected fingers of the target numeral have a closed aperture at the beginning of the sign, and this aperture changes to open at the end of the movement.

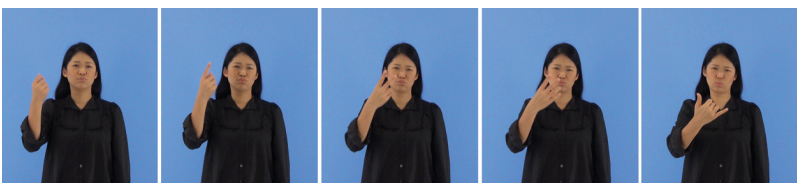


Figure 4. SIX$_{(event)}$

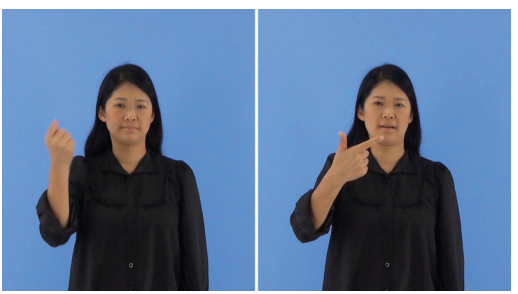


Figure 5. EIGHT$_{(event)}$

As seen in Figure 5, the selected fingers of the numeral EIGHT are the index and the thumb. At the beginning of the sign, index and thumb are held together in closed aperture, and they open during the movement of the sign to form EIGHT.

3.1 Event numeral interpretation

Examples of event numerals found in the experimental data are shown in (4–6) below.

(4) IX_3 LAST-NIGHT WASABI EAT $\text{FOUR}_{(\text{event})}$
'He ate four bites of wasabi last night.'
(literally: 'He took a bite of wasabi four times last night.')

(5) IX_3 AFTERNOON MALE IX_3 EAT-NOODLES $\text{EIGHT}_{(\text{event})}$
'This afternoon that man ate eight bowls of noodles.'
(literally: 'This afternoon that man ate a bowl of noodles eight times.')

(6) IX_1 GO HIKE EXPERIENCE $\text{THREE}_{(\text{event})}$
'I've been hiking three times.'

In (4), the event denoted by the verb EAT is enumerated by the signer as to have occurred four times, i.e., the taking of a bite of wasabi happened four times. In (5), EIGHT does not indicate the number of bowls consumed, but rather the acts of eating those bowls of noodles. If the signer wanted to mention the number of bowls, they would have signed BOWL-PL EIGHT, without the morphological event-movement. (6) is an interesting case because EXPERIENCE can be both a noun, (7), as well as a verb, (8).

(7) IX_2 WORK EXPERIENCE FEW
'You have little work experience.'

(8) FLY AMERICA IX_1 EXPERIENCE
'I've been to America.'

In (7), EXPERIENCE appears in a compound with the noun WORK, furthermore the noun compound is modified by the adjective FEW/LITTLE – this indicates that EXPERIENCE in (7) is a noun. In (8), EXPERIENCE follows the subject IX_1 'I', and (8) can thus be translated more literally as 'Flying to America, I have experienced that'.

The data show that in the presence of a numeral, signers prefer to interpret EXPERIENCE as a verb, as they changed the neutral numeral THREE to $\text{THREE}_{(\text{event})}$ in their reproductions of the test stimuli, as can be seen in (9) and (10).

(9) EXPERIENCE THREE$_{(event)}$
'I've done that three times.'

(10) EXPERIENCE THREE$_{(event)}$ ENOUGH NOT
'It's not enough to have done that (only) three times.'

The event numeral cannot follow a noun, as shown by the ungrammaticality of the examples in (11).

(11) a. * WORK EXPERIENCE THREE$_{(event)}$
'three (pieces of) work experience'
b. * DOG THREE$_{(event)}$
'three dogs'

The data also contain some instances where I did not expect to see an event numeral, see (12–13); however, the signers clarified why they chose to use an event numeral.

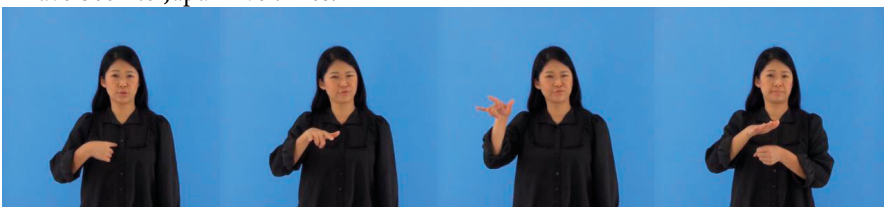
(12) USE OIL USE NINE$_{(event)}$, ABSURD
'He used oil nine times, it was really absurd.'

(13) BUY GREEN BRACELET BUY FIVE$_{(event)}$
'Buy five jade bracelets.'

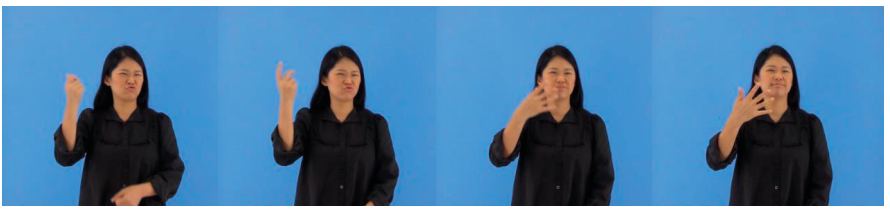
In (12), the signer interpreted the stimulus sentence as meaning that the person poured oil into the pan nine times. This is in contrast with other participants' interpretation that the person used up a total of nine bottles of oil while cooking. As for (13), the signer explained that they imagined the person mentioned in the stimulus sentence would buy five jade bracelets, but this could be on separate occasions or at separate shops.

In addition to the experimental data discussed above, the utterances (14) and (15) below are also examples of environments in which event numerals may be used. Since the participants of my study have to remain anonymous and their data can only be shown in transcription, I asked my informant to produce some examples of sentences in which she would use the event numeral to provide the reader with examples to further illustrate its usage.

(14) 'I have been to Japan five times.'

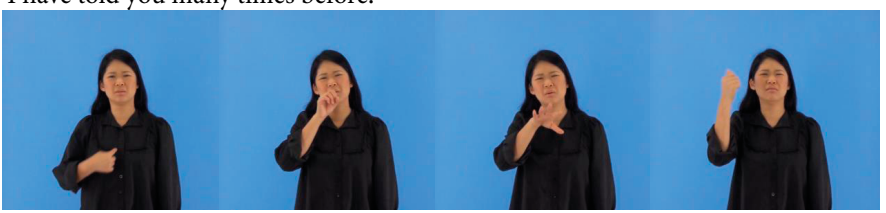


IX$_1$ FLY-TO JAPAN

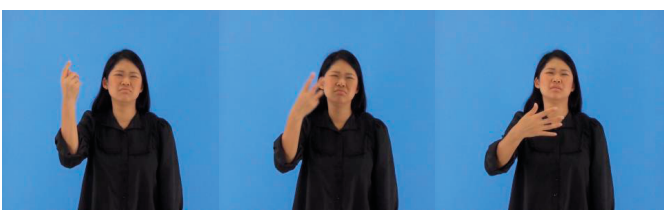


FIVE$_{(event)}$

(15) 'I have told you many times before.'



IX$_1$ $_1$TELL$_2$ SEVERAL$_{(event)}$



3.2 Quantification of verbal events

HKSL event numerals resemble the verbal classifier phrases found in languages such as Cantonese, Japanese, and Mandarin, but also English adverbial quantifiers like *twice* or *two times*. The movement component of the HKSL event numeral resembles the classifier morpheme in such classifier phrases. In the Examples (16–18) below, the classifiers *chi*, *kai*, and *cì* quantify the verbal domain, i.e., they quantify how often an event has taken place.

(16) 我 話 咗 佢 知 三 次
ngóh wah jó kéuih jī sāam **chi**
I tell PF him know three **CL:time**
'I've told him three times.' (Cantonese)

(17) John-wa senshuu bentoo-o san-**kai** katta
John-TOP last week lunch box-ACC 3-**CL** bought
'John bought a lunch box three times last week.'
(Japanese, Kobuchi-Philip 2021: 172)

(18) 大林 曾經 看過 那 部 電影 三 次
Dàlín céngjīng kàn-guò nà bù diànyǐng sān **cì**
Dalin before see-PRF that CL movie three **CL:time**
'Dalin saw that movie three times before.' (Mandarin, Zhang 2017: 14)

In Paris' (2013) definition, there is a distinction between strong and weak verbal event classifiers. The latter only combines with the numeral *yi* 'one', as shown in (19ab), whereas the former can combine with a full range of numerals as well as the quantity-denoting lexical element *ji* 'some', as in (20ab).

(19) a. 他 罵 了 張三 一 頓
tā mà le Zhāngsān yi dùn
he scold PF Zhangsan one CL:a while
'He gave Zhangsan a good scolding.'
b. * 他 罵 了 張三 兩 頓
tā mà le Zhāngsān liǎng dùn
he scold PF Zhangsan two CL:a while
'He gave Zhangsan two good scoldings.' (Mandarin, Paris 2013: 272)

(20) a. 他 看 了 你 一 眼
tā kàn le nǐ yi yǎn
he look PF you one CL:eye
'He cast a glance at you.'
b. 他 看 了 你 幾 眼
tā kàn le nǐ ji yǎn
he look PF you several CL:eye
'He cast a glance at you several times.' (Mandarin, Paris 2013: 271)

The event numeral in HKSL combines with a full range of numerals as well as the HKSL equivalent to the Mandarin *ji* 'some/several', namely SEVERAL, as has been shown in Example (15) above. This means that HKSL event numerals align with Paris' strong verbal event classifiers.

Donazzan (2012) shows that verbal event classifiers can be further divided into event-related and occasion-related counting. For example, in the English *John gave two knocks at the door* (Donazzan 2012: 227), *two* does not indicate that the event occurred twice, but simply that a total of two knocks on the door were given. In contrast, in *John knocked at the door twice, each time for a few minutes* (Donazzan 2012: 227), the knocking was done at two different occasions. However, it appears that HKSL event numerals may function as both event-related as well occasion-related verbal classifiers. For example, in (4) above, the HKSL event numeral is used to indicate that four bites of wasabi were taken, but this was at one single occasion. In contrast, in (6) the event numeral indicates that the signer has been hiking three times, each on separate occasions.

3.3 FreqP in Spec,VP

In their analysis of Mandarin, Huang et al. (2009) argue that verbal classifiers (heading Frequency Phrase, FreqP (FP)) are best analyzed as adjuncts to V', as shown in Figure 6 (Huang et al. 2009: 92).

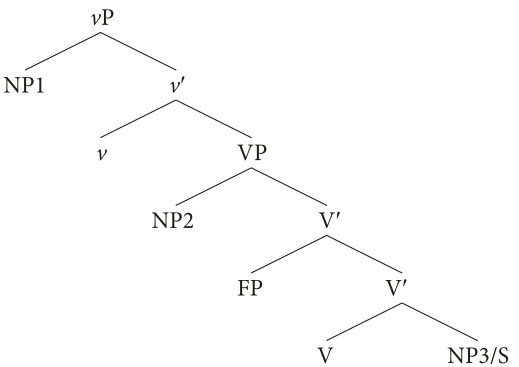
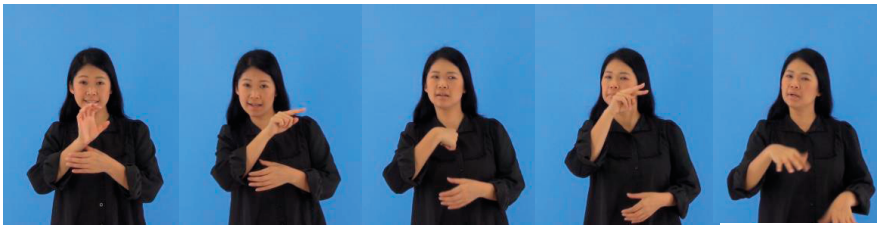


Figure 6. The location of FreqP (FP) within vP (Huang et al. 2009: 92)

According to Zhang (2017), event- and occasion-related readings of verbal classifiers translate to different syntactic structures in Mandarin. However, in the HKSL data, the event numeral always follows the verb of which it enumerates the events, (21), unlike Mandarin, where the constituent can take different positions (22).

(21) 'I have seen that movie three times.'

a.



MOVIE IX$_{obj}$ (=movie), IX$_1$ SEE FINISH



THREE$_{(event)}$

b. * MOVIE IX$_{obj}$ (= movie), IX$_1$ THREE$_{(event)}$ SEE FINISH

c. * MOVIE IX$_{obj}$ (= movie), THREE$_{(event)}$ IX$_1$ SEE FINISH

(22) a. 大林 曾經 看過 那 部 電影 三 次
Dàlín céngjīng kàn-guò nà bù diànyǐng **sān cì**
Dalin before see-PRF that CL movie **three time**

b. 大林 曾經 三 次 看過 那 部 電影
Dàlín céngjīng **sān cì** kàn-guò nà bù diànyǐng
Dalin before **three time** see-PRF that CL movie

c. 大林 曾經 看過 三 次 那 部 電影
Dàlín céngjīng kàn-guò **sān cì** nà bù diànyǐng
Dalin before see-PRF **three time** that CL movie
'Dalin saw that movie three times before.' (Mandarin, Zhang 2017: 14)

HKSL event numerals are not the only event-modifying elements that obligatorily follow the verb (phrase). Lexical verbal adverbs also modify the verb and follow it:

(23) a. IX$_1$ ELDER-BROTHER BE-LATE **ALWAYS**
'My brother is always late.'

b. IX$_1$ EVENING COOK **SOMETIMES**
'I only cook dinner occasionally.'

c. FATHER $_3$HELP$_1$ APPLY **DEFINITELY**
'Father will definitely help me apply.'

d. IX$_3$ MALE UNDERSTAND **FEW**
'That man only understood a little bit.'

Since, in HKSL, the verb or the verb and its complement – the VP – often occur clause-finally, the verbal adverbs are also clause-final, similar to event numerals.

The lack of flexibility shown in (21) suggests that syntactic accounts of Mandarin do not necessarily suit the HKSL data and rather that the position of the event numeral within VP is fixed. In Mandarin, adjuncts can be attached to any bar-level within VP, as (22) shows. For a HKSL example like (5), repeated here as (24), it is possible to propose the following syntactic account:[1] the numeral phrase enters the syntactic derivation as the complement of FreqP in Spec,VP, as shown in Figure 7.

(24) IX_3 AFTERNOON MALE IX_3 EAT-NOODLES EIGHT$_{(\text{event})}$
'This afternoon that man ate eight bowls of noodles.'

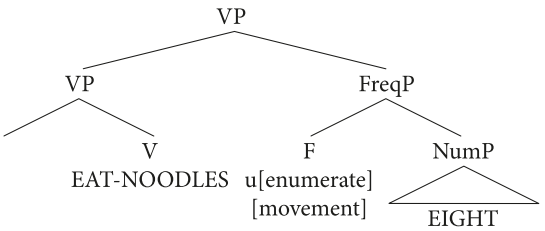


Figure 7. FreqP in Spec,VP

FreqP (cf. Paris's (2013: 270) MeasureP (MP)) in Spec,VP is headed by Freq° with an unvalued [enumeration]-feature. This enumeration feature seeks to quantify the number of times the event denoted by the verb has taken place and can be valued by a numeral. Therefore, it selects a Numeral Phrase (NumeP) as its complement and through agreement values its own [enumeration]-feature according to the value of the numeral. As a consequence of the agreement, the movement-parameter of the numeral changes from [∅] to [+arch-and-sequential-opening-selected-fingers], as shown in Table 1.

To sum up, the lexical numeral EIGHT is the complement of Freq° and it values Freq°'s u[enumeration]-feature. Freq° contains a movement feature which changes the movement-parameter of EIGHT. The function of FreqP is to quantify the number of times the event denoted by V has taken place.

1. I would like to thank an anonymous reviewer for suggesting a more straightforward analysis of event numerals.

Table 1. Changes affecting the movement-parameter of the event numeral

EIGHT$_{(neutral)}$		EIGHT$_{(event)}$	
handshape	 (selected fingers: thumb and index)	handshape	 (selected fingers: thumb and index)
location	neutral space	location	neutral space
orientation	palm facing signer	orientation	palm facing signer
movement	∅	movement	path: contralateral arch aperture: opening sequentially

4. Transfer numerals

The second type of numeral with a movement element added to its phonological make-up is what I call the transfer numeral, NUM(trans). Transfer numerals move from a locus in neutral space towards the signer, see Figure 8 below, as though the numeral is "transferred" to the signer. The meaning this movement adds to this numeral is that of a transfer of ownership or a transfer of location.

There are two variants of NUM(trans), transfer1 and transfer2, respectively. The movement of transfer1 is a movement of the entire forearm, as shown in Figures 2c and 8. Transfer2 involves a smaller movement, see Figure 9 below, namely only a flick of the wrist towards the signer. Native signers confirm that the difference between Figures 8 and 9 is only phonetic, and that they are interchangeable (cf. (25) and (26)).



Figure 8. NUM(trans1)

(25) YESTERDAY IX$_{3}$ $_{3}$ASK$_{1}$ WATER CUP THREE$_{(trans1)}$ WANT-NOT-WANT
'Yesterday he asked me whether or not I wanted three cups of water.'

(26) YESTERDAY IX$_{3}$ $_{3}$ASK$_{1}$ WATER CUP THREE$_{(trans2)}$ WANT-NOT-WANT
'Yesterday he asked me whether or not I wanted three cups of water.'



Figure 9. NUM(trans2)

(25) and (26) show different answers of different signers to the same stimulus sentence. Though there were several other participants who also used NUM(trans1), there was one who used NUM(trans2). This suggests that in the same environment, transfer1 and transfer2 convey the same meaning. In fact, after asking the participants follow-up questions, they confirmed that they would be ok with interchanging transfer1 for transfer2 and vice versa.

4.1 Transfer numeral interpretation

Examples of transfer numerals as found in the experimental data are shown in (27–31) below:

(27) REMIND$_1$ TOMORROW BUY CHEESE$_a$ THREE$_{(trans1)a}$ APPLE$_b$ THREE$_{(trans1)b}$ MUST
'Remind me that I should buy three pieces of cheese and three apples tomorrow.'

(28) LAST-WEEK IX$_1$ BUY INSURANCE FILE THREE$_{(trans1)}$, DANGER$_a$, SECONDLY SICKNESS, THIRDLY RETIREMENT SAVE, THREE IX$_{THREE}$
'Last week I bought three types of insurance: insurance for hazards, secondly health insurance, and thirdly for retirement savings. These three.'

(29) $_2$HELP$_1$ SEARCH INFORMATION TWO$_{(trans2)}$?
'Can you help me search for two pieces of information?'

(30) FRIEND YESTERDAY GO-TO APPLY WELFARE TWO$_{(trans1)}$, APPLY$_a$ 10.000$_a$, APPLY$_b$ 5000$_b$
'Yesterday a friend went to apply for two types of welfare. He applied for the 10.000 HKD scheme and for the 5000 HKD scheme.'

(31) RICE BOOK TWO$_{(trans1)}$
'Give me rice and a book.'

In (27) and (28), it is the verb BUY that elicits the transfer numeral, since buying an item would mean the transfer of ownership as well as the physical transfer of items into the buyer's possession. In (29), the transfer of ownership is implied by the agreement on the verb HELP and its combination with the verb SEARCH. Since the addressee is asked to help the speaker search for something, this means that whatever the object of the search is, it will be handed over to the speaker. In (30) the subject of the verb APPLY hopes to obtain two types of welfare, implying that those types of welfare are transferred into his possession. Note that the movement of the transfer numeral in (30) is still directed towards the signer even though the welfare was applied for by the signer's friend (i.e., a third person). This is possible due to role-shift: the signer has assumed the role of the referent FRIEND with their own body and, as though in direct speech, the signer has "become" the referent, therefore movement of the transfer numeral to the signer represents a transfer to the referent FRIEND.

(31) is an interesting example because it has dropped the verb GIVE_1 from the stimulus sentence (RICE BOOK GIVE_1 'give me the rice and the book') and replaced it with $\text{TWO}_{(\text{trans1})}$ (see also Section 4.3). A total of three participants replaced the verb with NUM(trans). This means that the transfer numeral itself is sufficient to express transfer of ownership. However, NUM(trans) need not necessarily express immediate transfer of ownership, it can also imply that this transfer has occurred at some point in time, and that an item is now belonging to the speaker. This can be seen in (32), which was elicited using a similar yet distinctly different stimulus sentence to that used to elicit (31). Whereas, the stimulus sentence used to elicit (31) contained the verb GIVE, the stimulus sentence for (32) contained the verb HAVE, meaning that the speaker was already in possession of rice and a book. Again, three participants responded using a transfer numeral in their answers, like in (32).

(32) RICE_a BOOK_b $\text{TWO}_{(\text{trans1})ab}$
'I have two (bags of) rice and two books.'

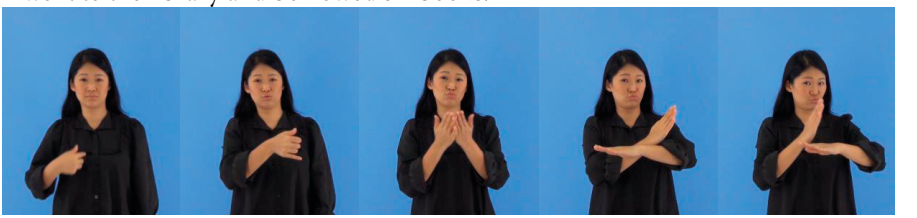
Similarly, in (33) the verb HAVE was dropped in favor of NUM(trans):

(33) BANANA_a $\text{ONE}_{(\text{trans2})a}$ OIL_b CL:bottle_b
'I have one banana and a bottle of oil.'

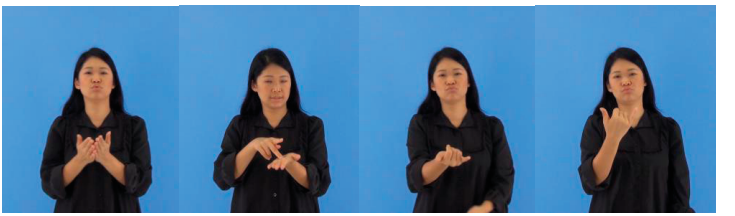
HAVE does not inherently imply transfer of ownership, yet signers explained their choice for the transfer numeral by stating that they must have in the past bought or received the rice and the books or the banana and the oil, and therefore, these items belonged to them, hence the movement of the sign towards the signer.

In addition to the experimental data, the following two utterances are also examples of sentences in which the transfer numeral may be used:

(34) 'I went to the library and borrowed six books.'

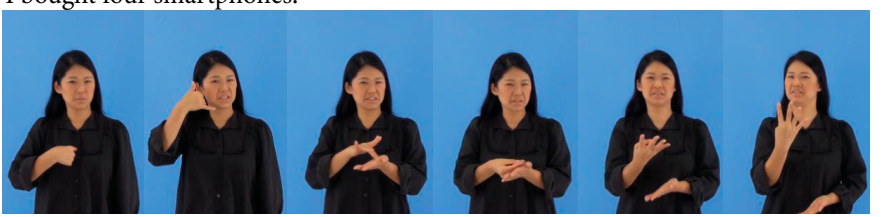


IX$_1$ GO-TO LIBRARY



BOOK BORROW SIX$_{(trans1)}$

(35) 'I bought four smartphones.'



IX$_1$ SMARTPHONE BUY FOUR$_{(trans1)}$

4.2 Spatial agreement

The movement of NUM(trans) seems to closely resemble the type of movement showcased in spatial agreement, a topic often discussed in sign linguistic research (e.g., Quer 2011; Wilbur 2013; Pfau et al. 2018, among others). The movement of the numeral towards the signer is similar to that of agreement verbs, for example $_2$GIVE$_1$ 'you give me', where the sign GIVE moves from the addressee's locus to that of the signer. Similarly in transfer numerals, the movement of the numeral is towards the signer's locus, i.e., it appears to show agreement with the first person: from x-locus to locus-1. The aim of the discussion in this section is not to take a position in the debate among researchers whether sign language agreement is the same as spoken language agreement, or even whether we should call this sign language phenomenon "agreement" at all. Instead, I will only try to argue that although transfer numerals show similarities with spatial agreement verbs, they are in fact numerals within DP.

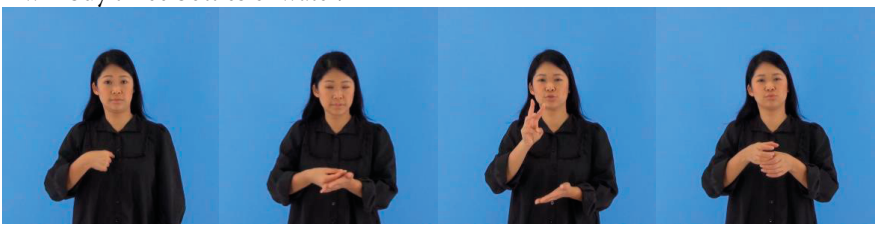
An important difference between the movement of transfer numerals and that of agreement verbs is that there is no strictly assigned locus where the movement starts. The movement of transfer numerals starts somewhere in neutral space and is not tied to any specific referential loci, as would be the case with agreement verbs.

The German Sign Language (DGS) example in (36) shows that the agreement verb VISIT starts at locus-3a, the locus associated with the mother, and moves to locus-1, the signer's – i.e., first person's – locus.

(36) YESTERDAY POSS_1 MOTHER INDEX_{3a} $_{3a}\text{VISIT}_1$
'Yesterday my mother visited me.' (DGS, Pfau et al. 2018: 4, Example (1a))

Liddell (1995) argues that the movement between spatial loci as seen on verbs is not a grammatical feature, but rather that it is gestural in nature. This means that the signer makes use of mental spaces (cf. Fauconnier 1985, 1997), which is a cognitive act and an action similar to co-speech gesturing as seen in spoken languages. But despite the fact that spoken language users may make use of co-speech gestures – and thus make use of mental space when referencing discourse referents – many scholars still argue that the spatial modification of verbs in sign languages is a grammatical, more specifically, a morphosyntactic process (e.g., Padden 1983). However, it has been noted for several sign languages that object agreement is marked more often than subject agreement (e.g., Meier 1982; Padden 1983; Lillo-Martin & Meier 2011). Pfau et al. (2018) note that this primacy of object agreement "is a modality-specific property of SL [sign language] agreement" (2018: 6). The HKSL transfer numeral data show that agreement marking for the addressee of the implied transfer of ownership, i.e., the signer, is more evident than for the starting point referential loci. For HKSL transfer numerals, it would make no difference for the meaning of the sentence whether the starting point of $\text{THREE}_{(\text{trans1})}$ was as in (37a) or as in (37b).

(37) 'I will buy three bottles of water.'



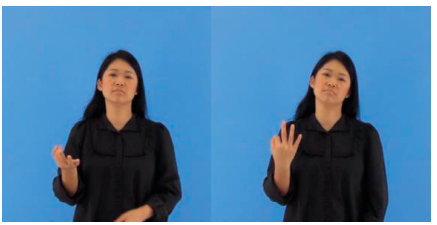
IX$_1$ BUY WATER BOTTLE

a.



THREE$_{(trans1)}$

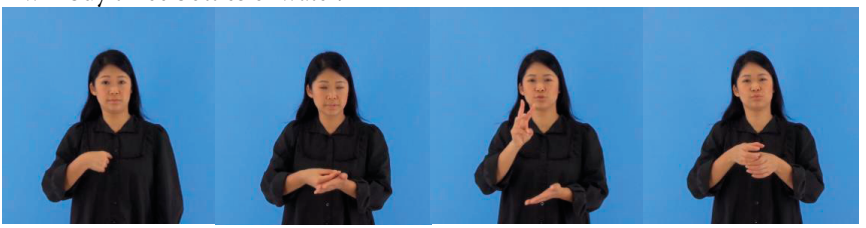
b.



THREE$_{(trans1)}$

However, it would be ungrammatical to have the end-point of the movement of the transfer numeral be anywhere but the locus of the signer, as shown in (38a–c).

(38) 'I will buy three bottles of water.'



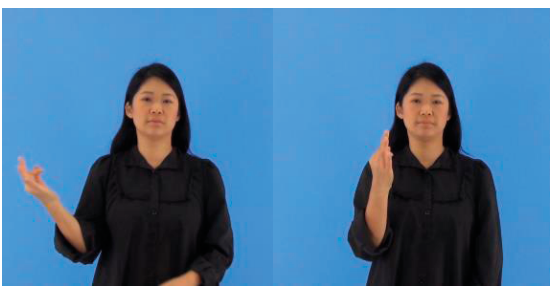
IX$_1$ BUY WATER BOTTLE

a. *



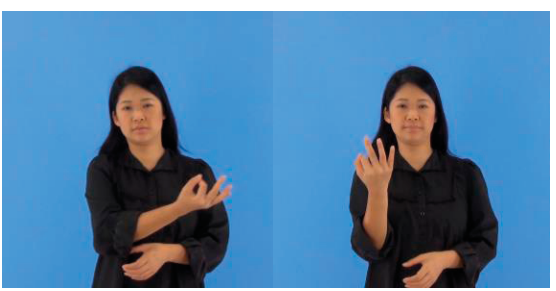
THREE$_{(trans1)}$

b. *



THREE$_{(trans1)}$

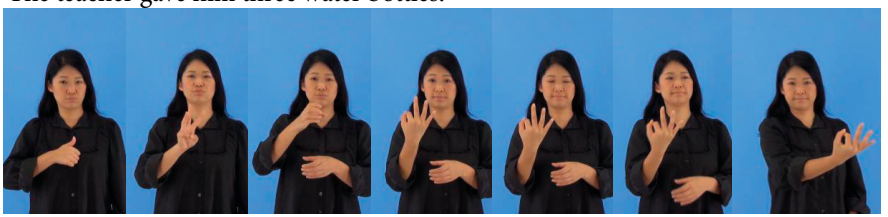
c. *



THREE$_{(trans1)}$

It is worth asking whether transfer numerals can show agreement between two third-person referents, as in (39) below.

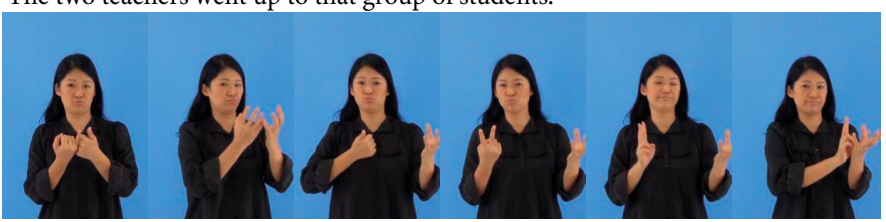
(39) 'The teacher gave him three water bottles.'



TEACHER WATER BOTTLE THREE **blink** $_{3a}$THREE$_{3b}$

Though (39) is grammatically correct, it is also structurally distinct from all the above examples of sentences containing transfer numerals. I would not argue against the fact that in (39), there is indeed a transfer of ownership of three water bottles from the teacher with the assigned locus-3a to another third person with the assigned locus-3b. However, the sign that moves between the two loci is no longer a numeral but it is a classifier handshape (𝌆) attached to a verb root. Evidence for this claim is the blinking of the signer between introducing the referent WATER BOTTLE THREE and signing the predicate $_{3a}$THREE$_{3b}$. The non-manual marker indicates a prosodic break – a cut – between the two parts. What that means is that the handshape of the numeral THREE and the handshape THREE used in (39) look the same; however, the numeral THREE, as used in (37), is located within DP where it enumerates the N°, similar to the English noun phrase *three bottles of water*, while in (39), it is the classifier handshape THREE that is attached to a verb root and serves as the predicate. Literally, (39) can thus be translated as 'Three bottles of water, the teacher gave him those three'. The structure of (39) is similar to (40):

(40) 'The two teachers went up to that group of students.'



STUDENT GROUP$_{3b}$ TEACHER TWO **blink** $_{3a}$TWO$_{3b}$

In (40), after the referents – i.e., the two teachers TEACHER TWO – have been introduced into the discourse, the predicate follows. In the predicate, the classifier handshape TWO (𝌆) attaches to the verb root GO-TO. This verb root shows agreement with the locus at which the teachers originally are (locus-3a) and the locus

of the group of students where they go to (locus-3b). This TWO-handshape is not a numeral: at a morphological level, the two selected fingers each represent one of the teachers (see below for further discussion). Similar to (39), in (40), the signer signs TEACHER TWO, followed by the predicate. (40) is thus best translated as 'Two teachers, those two went to the group of students'. (39) and (40) are thus actually better glossed as in (41) and (42), i.e., as involving classifier predicates.

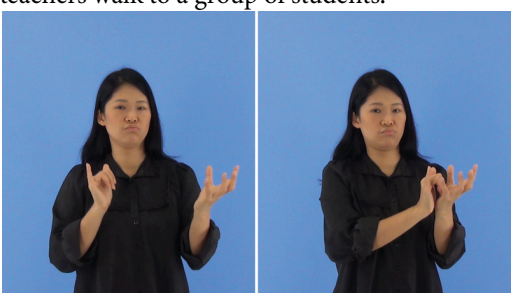
(41) TEACHER WATER BOTTLE THREE $_{3a}$GIVE+CL:three_long_vertical_object$_{3b}$
'The teacher gave him three water bottles.'

(42) STUDENT GROUP$_{3b}$ IX$_{3b}$ TEACHER TWO
$_{3a}$GO-TO+CL:two_animate_beings_walking_upright$_{3b}$
'The two teachers went up to that group of students.'

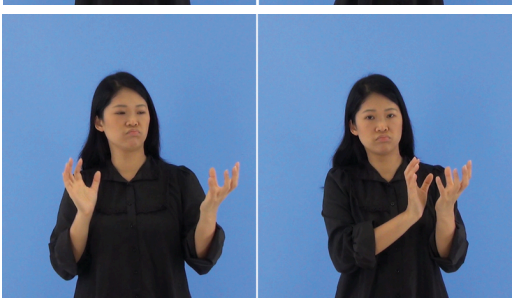
Another piece of evidence that (39) and (40) differ from all the above examples involving transfer numerals is related to the morphological complexity of classifier handshapes. In (40), the classifier handshape attached to the verb root is morphologically complex, as each selected finger represents one of the teachers (see Zwitserlood (2003) for more discussion on the morphological complexity of classifier handshapes). They are thus classifiers for these animate beings, who move from one place to another. Similarly, in (39), the three selected fingers in the predicate each represent a bottle of water. Compare the questionable grammaticality of use of the -handshape in (43a):

(43) 'Six teachers walk to a group of students.'

a.



b.



The handshape of six () is very different from that of two (), as it does not iconically represent the number of entities, and it can therefore not be attached to the verb root in the same way. The -handshape of SIX cannot represent animate beings as a classifier attached to a verb root because in order to be used as a classifier, the handshape needs to physically resemble upright entities, i.e., the animate beings it classifies, and the -handshape happens to look nothing like that. According to the native signer advising me on this subject, (43a) will therefore not be accepted as grammatical by all signers. She interpreted (43a) as a form of numeral incorporation, rather than a spatial predicate. The proper classifier for a group consisting of more than five people is the handshape used in (43b).

4.3 Complement to V°

Having established that NUM(trans) is in fact a numeral and not a spatial agreement verb, in this section, I would like to propose what the syntactic structure is that provides the change in movement-parameter for transfer numerals. I assume that transfer numerals are the heads of NumP within a DP, as, for example in (44) below, the DP WATER BOTTLE THREE 'three water bottles'. The DP being the object of the verb BUY and receiving its theta role from the verb must be the complement of V°, (45), as shown in Figure 10.

(44) $_{2}$HELP$_{1}$ BUY WATER BOTTLE THREE$_{(trans1)}$
'Please help me buy three bottles of water.'

(45) [$_{VP}$ [$_{V}$ BUY] [$_{DP}$ WATER BOTTLE THREE]]

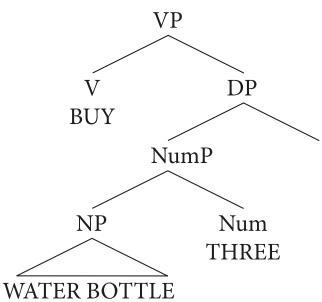


Figure 10. The numeral in the DP complement to V°

Since the numeral is within the c-command domain of V°, the movement feature [+towards-signer] is added to the phonological make-up of the numeral, as shown in Table 2. Only verbs that are lexically specified as entailing a transfer of ownership carry the movement feature.

Table 2. Changes affecting the movement-parameter of the transfer numeral

THREE(neutral)		THREE(trans)	
handshape	(selected fingers: middle, ring, and pinky)	handshape	 (selected fingers: middle, ring, and pinky)
location	neutral space	location	neutral space
orientation	palm facing signer	orientation	palm facing signer
movement	∅	movement	path: towards signer / flick of the wrist

In cases such as (32), repeated here as (46), there is no overt verb in V°. However, the feature [+transfer-ownership] is present in V° and lends the movement-feature to the numeral (see Figure 11).

(46) RICE_a BOOK_b $\text{TWO}_{(\text{trans1})ab}$
'I have two (bags of) rice and two books.'

(47) $[_{VP}\ [_{V}\ \varnothing]\ [_{DP}$ RICE BOOK TWO$]]$

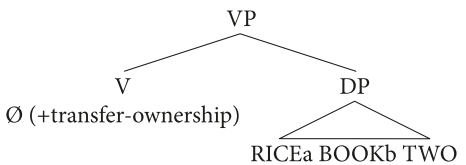


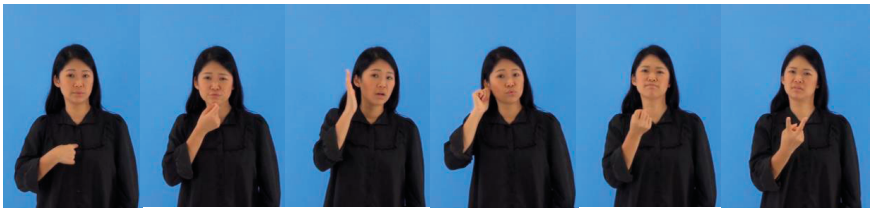
Figure 11. No overt verb in V°

In sum, transfer numerals are located within DP to enumerate N°. When they are within the c-command domain of V° with a [+transfer-ownership]-feature, the movement-parameter of the numeral sign is altered under influence of V°.

5. Conjunction numerals

The third type of numeral is the conjunction numeral, NUM(coor). This numeral is characterized by hand-internal movement where all selected fingers open simultaneously. The meaning expressed by the conjunction numeral is that "both" of the listed items are included in the predicate as, for instance, in (48).

(48) 'I like both men and women.'



IX$_1$ LIKE MALE FEMALE TWO$_{(coor)}$

5.1 Conjunction numeral interpretation

NUM(coor) only occurred in the participants' answers for two of the stimulus sentences. The first of those was IX$_1$ RICE BOOK HAVE, 'I have rice and a book'. Three participants added TWO$_{(coor)}$ to their answer.

(49) IX$_1$ HOUSE HAVE IX$_{loc(=house)}$ RICE$_a$ BOOK$_b$ TWO$_{(coor)}$
'I have both rice and books at home.'

(50) IX$_1$ RICE$_a$ BOOK$_b$ TWO$_{(coor)}$ HAVE
'I have both rice and books.'

(51) IX$_a$ BE-LOCATED+CL:item RICE$_a$ IX$_b$ BOOK$_b$ IX$_1$ IX$_{a\text{-}b}$ HAVE TWO$_{(coor)}$
'Rice and books, I have both those things.'

The subscripts a and b in the above examples (and in examples in preceding sections) indicate a *body lean*, i.e., the physical act of signers leaning their bodies slightly towards the location in space assigned to a certain referent. A body lean is a grammatical device used in sign languages for various purposes. It can be used for role-shift (e.g., for direct quotation) and spatial agreement. In the case of (50), the signer leans slightly to the left when signing RICE and then shifts slightly to the right to sign BOOK, indicating that these are two distinct referents by assigning them these respective spatial locations.

The stimulus sentence was intended to check the level of grammaticality of a sentence in which two items – the rice and the book(s) – were in conjunction without a body lean. Indeed, the sentence received a very low grammaticality score, and when signers showed how they would sign it themselves, all answers contained body leans for RICE and BOOK. However, three out of the eleven participants added the conjunction numeral as well in order to further clarify that both those items were in their possession.

The second stimulus sentence that rendered answers containing NUM(coor) was IX$_2$ $_2$GIVE$_1$ PRESSURE TWO$_{(neut)}$ ALWAYS: WORK, DATE ('You always give me two kinds of pressure, namely pressure to date as well as work pressure'). Though most

participants opted to remove the numeral TWO from their answers altogether, two participants used $\text{TWO}_{(coor)}$, as shown in (52) and (53).

(52) $\text{IX}_2\ {}_2\text{GIVE}_1$ PRESSURE DATE_a WORK_b $\text{TWO}_{(coor)}$
'You give me both pressure to date and pressure to work.'

(53) ${}_2\text{GIVE}_1$ PRESSURE ALWAYS, DATE_a, IX_b WORK_b, $\text{TWO}_{(coor)}$
'You give me both pressure to date and pressure to work.'

The intended purpose of the stimulus sentence was to check the grammaticality level of an abstract noun, PRESSURE, in direct combination with a numeral. As expected, the sentence received a very low grammaticality score. As mentioned above, the participants overwhelmingly left out the numeral, and used a body lean for DATE and WORK instead to distinguish between the two types of pressure given to them by the addressee. However, two participants decided that the sentence could contain a numeral if it were a conjunction numeral, and if it were directly following the two nouns that were in conjunction, DATE and WORK.

5.2 Inside ConjP

In (49–53) above, the conjunction numeral follows the two items that are in conjunction, RICE and BOOK in (49–51), and DATE and WORK in (52–53). For the latter two examples, this is in contrast to the neutral numeral in the stimulus sentence which was in the DP headed by the noun PRESSURE. The usage of the numeral strongly resembles that of conjunction words such as the English *both* in 'both rice and books' and 'both date and work (pressure)'. According to Johannessen (2005), conjunction words – or correlatives – such as *both*, *either*, and *neither* are focus particles. There is an absolute dependency between a correlative and the following conjunction. These correlatives head their own projections and select a complement ConjP (Johannessen 2005: 421, Example (3)).

(54) ... [$_{\text{ConjP}}$ both [$_{\text{ConjP}}$ [DP][and] rice and beans]]

The correlative in the higher ConjP selects the lower ConjP based on the requirement of its head; in the case of *both*, it requires a ConjP complement that is specified for [and]. Both conjoined elements of the conjunction are located in the specifier and complement of the second ConjP (based on Johannessen 2005: 420, Example (2)).

(55) [$_{\text{ConjP}}$ [$_{\text{DP}}$ rice] [$_{\text{Conj'}}$ [$_{\text{Conj}}$ and] [$_{\text{DP}}$ beans]]]

Though the correlative enters the derivation as the head of the higher ConjP, it then moves to CorP, which is adjoined to ConjP, as shown in the Norwegian example in (56).

(56) Regine trengte derfor [$_{CorP}$ *både$_i$* [$_{DP}$ ny [$_{ConjP}$ t$_i$ [$_{ConjP}$ lever og tarm]]]]
Regine needed therefore both new liver and intestines
'Regine therefore needed both a new liver and new intestines.'
(Norwegian, Johannessen 2005: 428, Example (39) – The Oslo Corpus)

Johannessen's analysis of conjunction words suits the HKSL data. I would argue that when the numeral is used to form a conjunction between two (or more) items, it is merged as the head of the higher ConjP and moves to the specifier of CorP – as, for instance, in the HKSL example RICE$_a$ BOOK$_b$ TWO$_{(coor)}$, as shown in Figure 12 and (57) below.

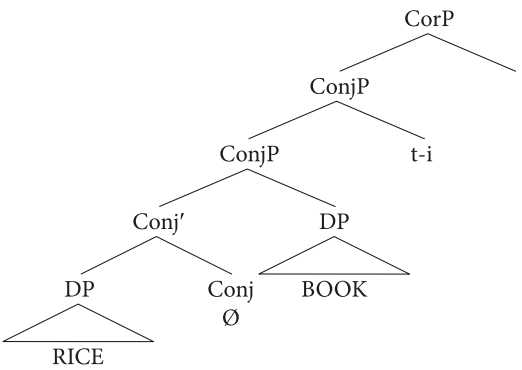


Figure 12. The numeral as correlative

(57) [$_{CorP}$ TWO$_i$ [$_{ConjP}$ t$_i$ [$_{ConjP}$ [$_{DP}$ BOOK] [$_{Conj'}$ [$_{Conj}$ ∅] [$_{DP}$ RICE]]]]]

Though Conj° of the lower ConjP is null, the body leans added to the DPs are a realization of Conj°. I further propose that the change in movement-parameter on the numeral sign, shown in Table 3, is the result of features of the higher ConjP, which are given to the numeral when it merges in that position.

6. List numerals

The final numeral to be discussed in this paper is the list numeral, NUM(list). The purpose of this numeral is to indicate that there will be a list of items summed up, similar to the use of the list of names in the English sentence in (58).

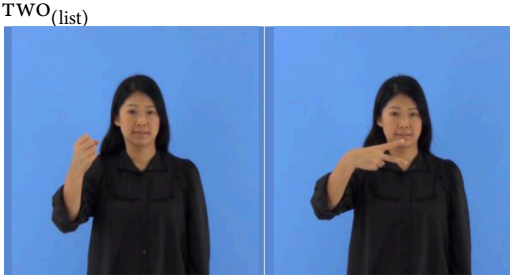
Table 3. Changes affecting the movement-parameter of the conjunction numeral

TWO(neutral)		TWO(coor)	
handshape	 (selected fingers: index and middle)	handshape	 (selected fingers: index and middle)
location	neutral space	location	neutral space
orientation	palm facing signer	orientation	palm facing signer
movement	∅	movement	aperture: selected fingers open simultaneously

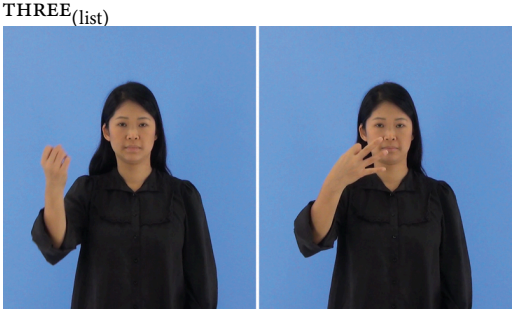
(58) There were four men in the room: Adam, David, Brian, and Eric.

In HKSL, the movement that characterizes NUM(list) contains both a path movement as well as hand-internal movement. The path movement is a contralateral arch, i.e., the signer's hand moves sideways towards the contralateral side with an arch-shaped movement. At the same time, the selected fingers of the sign open. See (59) and (60) for examples of list numerals.

(59) TWO(list)



(60) THREE(list)

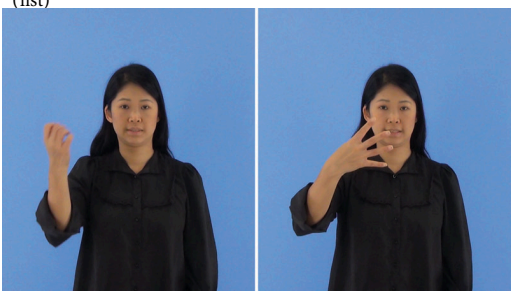


There exists a slight phonological variation, where NUM(list) still contains the path-movement, but not the hand-internal movement, this means that the

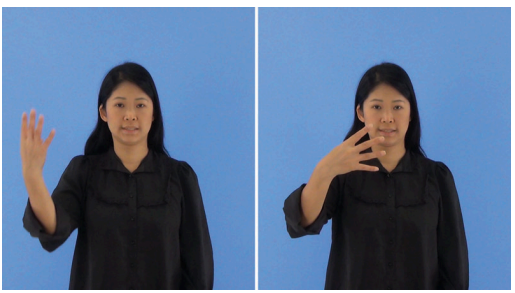
selected fingers are already open at the beginning of the sign when the path-movement begins, compare the two variants of FOUR$_{(list)}$ illustrated in (61ab).

(61) FOUR$_{(list)}$

a.



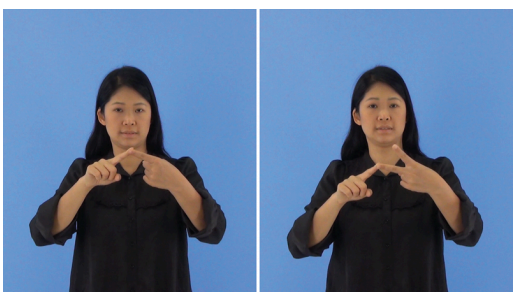
b.



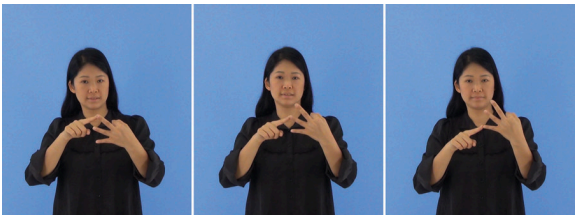
According to HKSL native signers, the two variants are interchangeable and do not bring about a change in meaning.

After the number of items has been introduced in the first part of the utterance, the sentence will continue by listing these items. During this part of the utterance, the signer will use the non-dominant hand to hold the numeral in space, while using the dominant hand's index finger to point at the fingers of the numeral on the non-dominant hand. For example, as shown in (62), when the numeral is TWO, the signer will first point at the index finger, 'firstly', then at the middle finger, 'secondly', and mention the items on the list (in (63), the same is illustrated for the numeral THREE). This strategy is known in the existing literature as *list buoys* (see Liddell 2003; Hendriks 2007; Liddell et al. 2007).

(62)



(63)



6.1 List numeral interpretation

The following are examples of the use of the list numeral from the experimental data. Whenever the transcription contains "…", it means that the signer did not know what to list exactly, similar to the usage of *blablabla* or *etcetera* in spoken English.

(64) $_{1}$SAY$_{3}$ MOTHER IX$_{1}$ IDEA HAVE TWO$_{(list)}$, IX$_{two(index)}$ …, IX$_{two(middle)}$ …
'I told my mother I have two ideas: firstly … , and secondly ….'

(65) IX$_{1}$ FEEL FREEDOM IMPORTANT THREE$_{(list)}$: …
'I think there are three important freedoms: …'

(66) IX$_{3}$ MALE WORK FOUR$_{(list)}$ HAVE: …
'That man has four jobs: …'

For (64–66) above, the stimulus sentence did not contain the list of items the numeral quantified. Signers decided not only to change NUM(neutral) into NUM(list) but also to add the listing by pointing at the numeral on the non-dominant hand, as illustrated in (62) and (63) above.

For (67–69) below, the stimulus sentence did contain the list of items referred to by the numeral. For example, the stimulus sentence for (68) was POLICE $_{3}$SAY$_{1}$ IF WANT IX$_{3a}$ ARREST$_{a}$ EVIDENCE THREE$_{(neut)}$ NEED : FINGERPRINT$_{a}$, DNA$_{b}$, CCTV-FOOTAGE$_{c}$ ('The police told me that if they want to arrest that person, they need three types of evidence, namely fingerprints, DNA, and CCTV footage'). Though the stimulus sentence lists the three types of evidence needed, the signers added the listing index signs on the non-dominant hand's numeral. The same is true for (69).

(67) YESTERDAY NEWS IMPORTANT THREE$_{(list)}$: ECONOMY$_{a}$, …$_{b}$, …$_{c}$
'There were three important news items yesterday: about the economy, …, and ….'

(68) POLICE $_3$SAY$_1$ ARREST$_a$ gesture(=come-on) EVIDENCE THREE$_{(list)}$, IX$_{three(middle)}$ DNA, IX$_{three(ring)}$ FINGERPRINT, IX$_{three(pinky)}$ CCTV-FOOTAGE
'The police told me that if I want them to arrest that person, I'll have to muster up three types of evidence: firstly, DNA evidence, secondly, fingerprints, and thirdly, CCTV footage.'

(69) IX$_3$ FEMALE YOUNG-TO-OLD TAKE-IN EDUCATION TWO$_{(list)}$, IX$_{two(index)}$ GOVERNMENT SCHOOL, IX$_{two(middle)}$ INTERNATIONAL SCHOOL
'That woman has received two kinds of education growing up: firstly, public school, and secondly, international school.'

For the stimuli that elicited (67–69), the sentence contained the list of those items quantified by NUM(neutral). However, there were control-group stimuli that did not list these items. So, participants belonging to group A were shown (70), while those in group B were shown (71).

(70) POLICE $_3$SAY$_1$ IF WANT IX$_{3a}$ ARREST$_a$ EVIDENCE THREE$_{(neut)}$ NEED: FINGERPRINT$_a$, DNA$_b$, CCTV-FOOTAGE$_c$
'The police told me that if I want them to arrest that person, they will need three (types/pieces of) evidence, namely fingerprints, DNA evidence, and CCTV footage.'

(71) POLICE $_3$SAY$_1$ IF WANT IX$_{3a}$ ARREST$_a$ EVIDENCE THREE$_{(neut)}$ NEED
'The police told me that if I want them to arrest that person, they will need three (types/pieces of) evidence.'

Though the original purpose of the research study was to measure whether (70) would receive a higher grammaticality score than (71), for the discussion of the present paper, it should be noted that participants in both groups A and B opted to replace the neutral numeral by a list numeral. This means that even if they were not given a list of items in their stimulus sentence, they still chose to use a list numeral and set up for listing items. This is the same as we saw in data Examples (64–66). Now consider (72) and (73).

(72) $_2$HELP$_1$ GATHER INFORMATION TWO$_{(list)}$, IX$_{two(index)}$ PHOTO, IX$_{two(middle)}$ ESSAY
'Could you help me gather two pieces of information? Firstly, photos, and secondly, essays.'

(73) LAST-WEEK IX$_1$ BUY INSURANCE THREE$_{(list)}$, IX$_{three(middle)}$ MEDICAL, IX$_{three(ring)}$ TRAVEL, IX$_{three(pinky)}$ …
'Last week I bought three types of insurance. Firstly, health insurance, secondly, travel insurance, and thirdly …'

Similar to (70) and (71), participants of group A and group B were shown different stimuli. For example, for the stimulus [INFORMATION TWO], participants were either shown (74) or (75).

(74) $_{2}$HELP$_{1}$ GATHER INFORMATION TWO$_{(neut)}$ CAN?
'Could you help me gather two pieces of information?'

(75) $_{2}$HELP$_{1}$ GATHER INFORMATION TWO$_{(neut)}$ CAN? STATISTICS$_{a}$, QUESTIONNAIRE$_{b}$
'Could you help me gather two pieces of information? Namely statistical information and questionnaires.'

The participants who produced (72) and (73) had actually seen stimuli of the type illustrated in (74). They thus added their own listing and replaced the neutral numeral by a list numeral.

6.2 [list]-feature on Nume°

Of all four numerals discussed in this paper, the list numeral perhaps warrants the most straightforward explanation. I propose that the numeral is located within DP as the head of NumeP.

(76) [$_{DP}$ [$_{NumeP}$ [$_{Nume'}$ [$_{NP}$ EVIDENCE] [$_{Nume}$ THREE]]]]

However, in sentences that quantify and then list items, Nume° contains a [list]-feature which translates into the [+controlateral-arch]-movement feature. Once the numeral is merged with Nume°, this [list]-feature alters the movement-parameter of the numeral (see Table 4).

(77) [$_{DP}$ [$_{NumeP}$ [$_{Nume'}$ [$_{NP}$ EVIDENCE] [$_{Nume}$ [list] THREE]]]]

Table 4. Changes affecting the movement-parameter of the list numeral

THREE$_{(neutral)}$		THREE$_{(list)}$	
handshape	(selected fingers: middle, ring, and pinky)	handshape	 (selected fingers: middle, ring, and pinky)
location	neutral space	location	neutral space
orientation	palm facing signer	orientation	palm facing signer
movement	∅	movement	path: contralateral arch aperture: opening simultaneously

7. Conclusion

To sum up the contents of this paper, I argue that HKSL numerals in the lexicon are all specified as having no movement. However, depending on the syntactic structure – and thus the function the numeral serves – the movement-parameter of numerals may be altered. I have discussed four types of numerals. Firstly, the *event numeral*, which enumerates the number of times an event or action has taken place. This numeral has a contralateral arch-movement and an aperture change since the selected fingers open sequentially. I argue that the lexical numeral is the complement of Freq° in Spec,VP where it values the unvalued enumerate-feature on Freq°. Features of Freq° alter the movement-parameter of the lexical numeral. Secondly, the *transfer numeral*, which indicates a transfer of ownership, is characterized by a movement of the forearm towards the signer. The lexical numeral merges as the head of NumeP within DP, which is the complement of V°. If V° has a [+transfer-ownership] feature and the numeral is within its c-command domain, the movement-parameter of the numeral is altered. Thirdly, the *conjunction numeral* shows hand-internal movement, namely the simultaneous opening of the selected fingers. This numeral is used to express that all listed items are included in the predicate, similar to English *both* or *all four*. The lexical numeral is merged as the head of ConjP. The features on this head cause the change in movement-parameter for the conjunction numeral. Finally, the *list numeral*, characterized by contralateral arch-movement and simultaneous opening of the selected fingers, indicates that there will be a list of items to be summed up. The lexical numeral is merged as the head of NumeP within DP. If Nume° contains a [list]-feature, the movement-parameter of the numeral is altered.

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Appendix

The table below contains the list of stimuli that received a numeral other than the neutral numeral in the participants' responses. Since the tokens are out of a total of 11, that means that the other numerals elicited for each stimulus were neutral.

No. of tokens (/11)	**Event**	**Transfer**	**Conjunction**	**List**
Stimulus				
IX$_1$ RICE BOOK HAVE. 'I have rice and a book.'			3	
REMIND$_1$ TOMORROW BUY CHEESE APPLE THREE MUST. 'Please remind me to buy cheese and three apples tomorrow.'		8		
IX$_1$ RICE BOOK TWO HAVE. 'I have rice and two books.'		3		
RICE BOOK GIVE$_1$. 'Give me rice and a book.'		3		
IX$_1$ BANANA$_a$ OIL$_b$ HAVE. 'I have a banana and oil.'		2		
$_1$SAY$_3$ MOTHER IX$_1$ IDEA NEW TWO HAVE. 'I told mother I have two new ideas.'		1		1
IX$_1$ FEEL FREEDOM THREE IMPORTANT. 'I think there are three important (types of) freedom.'		1		1
EXPERIENCE THREE ENOUGH NOT. *'Three experiences is not enough.'	4			
IX$_3$ MALE WORK FOUR HAVE, IX$_3$. 'That man has four jobs.'				2
SOLVE METHOD TWO HAVE, IX$_2$ KNOW, IX$_2$? 'Did you know there are two ways to solve this?'		1		
YESTERDAY NIGHT IX$_1$ BUSY TYPE ARTICLE SUMMARY TWO.		1		

No. of tokens (/11)	Event	Transfer	Conjunction	List
'Last night I was busy writing two article summaries.'				
$_{2}$HELP$_{1}$ GATHER INFORMATION TWO CAN? 'Can you help me gather two (types/pieces of) information?'		1		1
$_{2}$HELP$_{1}$ GATHER INFORMATION TWO CAN? STATISTICS, QUESTIONNAIRE. 'Can you help me gather two (types/pieces of) information? Statistical information and a questionnaire.'		2		
FRIEND YESTERDAY $_{3}$TELL$_{1}$ NEWS THREE IMPORTANT: ABOUT ECONOMICS$_{a}$, ABOUT CORONA-VIRUS$_{b}$, ABOUT AMERICA VOTE$_{c}$. 'A friend yesterday told me three important pieces of news: about the economy, about the coronavirus, and about the American elections.'				2
IX$_{1}$ FRIEND RECENTLY GO-TO GOVERNMENT IX$_{loc}$ APPLY WELFARE TWO. 'My friend recently went to the government to apply for two types of welfare.'		1		
RECENTLY HAVE WEATHER THREE CHANGE-REPEATEDLY: RAIN, SUNNY, SNOW. 'Recently the weather has been changing constantly: it's raining, or it's sunny, or it's snowing.'		1		1
IX$_{3}$ FEMALE YOUNG-TO-OLD TAKE-IN EDUCATION TWO HAVE. 'That girl has had two types of education growing up.'				1
IX$_{3}$ FEMALE YOUNG-TO-OLD TAKE-IN EDUCATION TWO HAVE: PUBLIC$_{a}$, INTERNATIONAL$_{b}$. 'That girl has had two types of education growing up: public school and international school.'				1
LAST-WEEK IX$_{1}$ BUY INSURANCE THREE. 'I bought three (types of) insurance last week.'		1		
LAST-WEEK IX$_{1}$ BUY INSURANCE THREE: HEALTH$_{a}$, CAR$_{b}$, TOOTH$_{c}$.		4		

No. of tokens (/11)	Event	Transfer	Conjunction	List
'I bought three (types of) insurance last week: health insurance, car insurance, and dental insurance.'				
IX$_{2}$ $_{2}$GIVE$_{1}$ PRESSURE TWO ALWAYS: WORK, DATE. 'You always give me two types of pressure: pressure to date and work pressure.'		2	2	
POLICE $_{3}$SAY$_{1}$ IF WANT IX$_{3}$ ARREST$_{a}$, EVIDENCE THREE NEED. 'The police told me that if I want them to arrest him, they need three types of evidence.'		1		1
POLICE $_{3}$SAY$_{1}$ IF WANT IX$_{3}$ ARREST$_{a}$, EVIDENCE THREE NEED: FINGERPRINT$_{a}$, DNA$_{b}$, CCTV$_{c}$. 'The police told me that if I want them to arrest him, they need three types of evidence: fingerprints, DNA evidence and CCTV footage.'		1		1
PLEASE GIVE$_{1}$ SAND THREE. 'Please give me three (units of) sand.'		1		
LAST-NIGHT IX$_{3}$ EAT WASABI FOUR. 'They ate four (units of) wasabi last night.'	2	2		
TOMORROW IX$_{1}$ GO-TO SUPERMARKET BUY WASABI FOUR. 'Tomorrow I'll go to the supermarket to buy four (units of) wasabi.'	1	3		
ABSURD, IX$_{3}$ USE OIL NINE. 'It's absurd, they used nine (units of) oil.'	2	2		
YESTERDAY IX$_{3}$ $_{3}$ASK$_{1}$ WATER THREE WANT-NOT-WANT. 'Yesterday they asked me if I wanted three (units of) water.'		3		
IX$_{1}$ HOUSE HAVE WOOL THREE. 'I have three (units of) wool at home.'		2		
MOTHER $_{3}$SUMMON$_{1}$ $_{1}$HELP$_{3}$ BUY JADE FIVE. 'Mother told me to help her buy five (pieces of) jade.'	2	6		
AFTERNOON IX$_{3}$ MALE EAT-NOODLES EIGHT.	6			

No. of tokens (/11)	Event	Transfer	Conjunction	List
'In the afternoon that man ate three (bowls of) noodles.'				
Total:	17	51	5	12

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