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The morphology and phonology of Taiwan Sign Language*

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Abstract. This chapter introduces in detail the morphology and phonology of Taiwan Sign Language. Inflectional morphology (including verb inflection, noun inflection) and derivational morphology (including affixation, serial compounding, parallel compounding) of Taiwan Sign Language are demonstrated and discussed. Agreement for grammatical relation, predicate classifier, and gender and number agreement are found in TSL. Aspect markings for perfective, progressive, and protractive aspects are also attested. Regarding Taiwan Sign Language phonology, the following aspects are illustrated and discussed: phonemic inventory, allophonic variation, feature cooccurrence restrictions, alternations, and word-internal prosodic structure. Data and analysis reported here can be used for cross-linguistic comparison for future studies.

1. Introduction

Nowadays, people do not doubt about sign languages having morphology and phonology. However, it still seems more difficult to conceptualize about the morphology and phonology of sign languages. We hereby introduces in details the morphology and phonology of Taiwan Sign Language (TSL).

Forty some years of research shows that sign languages are natural languages, and one piece of evidence for this is the existence of sign language morphology, that is, a

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system for associating form and meaning within words. Sign language words are often made out of meaningful form units, including free roots, bound roots, and affixes, formed via compounding and affixation processes that are used for both derivation and inflection.

Like all natural languages, sign languages also have phonology. There are both functional and formal reasons for recognizing sign language phonology. On the functional side, any communication system requires special mental processes and representations for handling the mental/physical interface. (For previous arguments that TSL phonology is processed the same way as spoken language phonology, see Myers, Lee, and Tsay, 2005.) On the formal side, structural analyses show that the operations and representations used in the interface systems of spoken and signed languages are deeply similar. (For previous formal analyses of TSL phonology, see Smith and Ting 1979, 1984; Smith 1989; Ann 1992, 1993, 1996, 2006; Lee 2003.)

The term *phonology* is thus justified, differing from its etymology (literally "study of sounds") no more than *morphology* (literally "study of form") or *syntax* (literally "arranged together"). Although the term *cherology* (literally "study of hand") was once proposed by Stokoe, Casterline, and Croneberg (1965), nobody uses this term anymore.

Sign languages are indeed more iconic than spoken languages, but that does not mean they do not also have formal structure, just as the Chinese character 能 (*neng* "be able to") is supposed to look like a bear (or 熊 xiong, "bear"), but still has purely formal pieces that also appear in other Chinese characters 公 (*gong* "public"), 朋 (*peng* "friend"), 北 (*bei* "north"). Also, some signs have become less iconic over time in order to conform to formal principles (see examples below).

Like spoken phonology, sign phonology also involves phonemic contrast, allophonic variation, feature cooccurence restrictions, alternations, word-internal prosodic structure, intonation, and interaction with morphology.

Section 2 below introduces various aspects of TSL morphology, including two types of morphological operations: inflection (verb inflection, noun inflection) and derivation (affixation, serial compounding, parallel compounding).

2. TSL morphology

The morphological operations in TSL might seem more complicated than spoken language because of the simultaneity of signed language (i.e., morphemes overlapping in

time), but they can be classified systematically.

2.1. Types of morphological operations

Morphological operations can be categorized according to three basic parameters: morpheme type (root vs. affix), phonological form (serial vs. parallel vs. reduplication), and function (derivation vs. inflection). TSL has most of the possible combinations (assuming that reduplication and inflection must be inherently affixal).

(1) Morphological operations found in TSL

Morpheme		Root (compounding)		Affix		
Form		Serial	Parallel	Serial	Parallel	Redup.
Function	Inflection	NA	NA		✓	✓
	Derivation	✓	✓	✓?	✓	✓?

As in other sign languages (see e.g. Aronoff, Meir, and Sandler 2000), there is a strong tendency for derivational morphology in TSL to be expressed through compounding rather than through affixation, and for inflection to be expressed through parallel (i.e. nonconcatenative) affixation, rather than through serial (i.e. concatenative) affixation.

2.2. Inflection

Inflection can be roughly defined as morphology that interacts with the syntax (Anderson 1992), and can by categorized by whether it occurs on verbs or nouns and whether it involves agreement with other words in the sentence, or marks inherent properties of a word that other words in the sentence can refer to.

2.2.1. Verb inflection

The classic work on TSL verb inflection is Smith (1989). Verb inflections in TSL include agreement and aspect markers, but apparently not tense markers.

Agreement includes subject-object agreement (usually simultaneous /nonconcatenative), verb-subject agreement (using predicate classifier), gender agreement, and number agreement. Aspect marking includes perfective, progressive, and durational

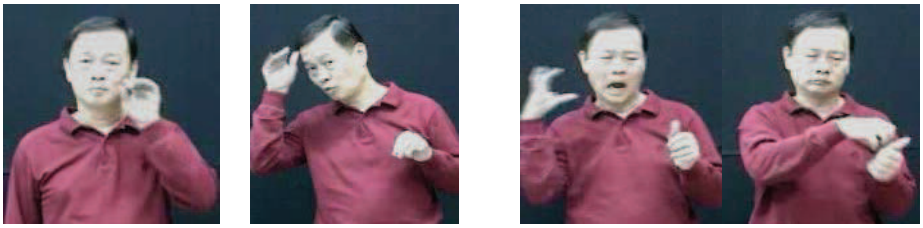
aspect which indicates prolonged status and/or intensity and frequency.

Agreement

Here are some general observations about agreement in TSL. First of all, agreement showing a grammatical relation is marked by nonconcatenative morphology, specifically by moving the hand away from the subject and/or towards the object. This appears to be a sign language universal (Aronoff, Meir, and Sandler 2000) leading some to question whether this should be understood as grammatical agreement at all, rather than an iconic representation of relations between entities in some mental space (e.g. Liddell 2003).

In the following example "The dog bit the cat," the verb BITE moves from the agent DOG (co-indexed with j) towards the patient CAT (co-indexed with i).[1] (Note that the patient CAT is signed first, possibly due topicalization or a topic-comment structure.)[2]

(2) The dog bit the cat.



CAT_i DOG_j $BITE_{j \rightarrow i}$

Secondly, some verbs also show agreement with the subject via the use of (predicate) *classifiers* (though again Liddell 2003 and Chang, Su, and Tai 2005 disagree with this analysis).

In the following example "The dog entered the house", $HOUSE_i$ is mentioned first (3a). Then the subject DOG_j is signed in full form in (3b), but in the form of an animal

[1] The notation convention in this paper follows mostly MacLaughlin 1997. Glosses of signs are written with capital letters. A dotted marker is used in a multiword gloss, as in SHOW.UP or RUN.INTO. "^" is used between parts of a compound sign. e.g., MARRY (MALE^FEMALE). "⊞" marks simultaneous signing with both hands.

[2] Pictures in this paper are from the TSL Database of the Sign Language Research Team at the National Chung Cheng University, Taiwan, unless otherwise noted. The demonstrator is Mr. Yushan Gu. .

classifier DOG_{pro} being inflected on the verb $ENTER_{j\rightarrow i}$ as in (3c) (This kind of predicate classifier is considered a "proform (pro)" in Chang, Su, and Tai, 2005.)

(3) The dog entered the house.

a. $HOUSE_i$

b. DOG_j

c. $HOUSE_{pro}$ + DOG_{pro} − $ENTER_{j\rightarrow i}$

Thirdly, there also appears to be agreement with gender and number features. Gender agreement (if used) is also indicated by predicate classifiers. In the following example "Tell her," the third person singular pronoun, indicated by the left position, is marked with the female classifier, the pinky. (Note that the default form of the sign TELL uses the thumb. See example TELL (one person) (8) below.)

(4) Tell her.

WOMANpro+TELL

Number agreement is only indicated by classifiers for a lexically restricted set of subjects. A more productive way to indicate number is to reduplicate that subject's standard classifier (proform) in the verb.

In the following example, "There are three birds in the tree," TREE in (5a) is the full form, while in (5b) it is a proform (pro) which also represents the Ground (G) that is present till the end of the sentence. BIRD in proform in (5c) is repeated three times (+++)

indicating that there are three birds (at/in the tree). The number is emphasized again in (5d).

(5) There are three birds in the tree.

a. TREE b. BIRD c. $TREE_{pro}$+$BIRD_{pro}$ — at/in +++ d. THREE

Plural agreement is one type of number agreement. It may appear on verbs, as a fully simultaneous affix, with subjects that are seen as a collective of multiple exemplars of the same type of entity. Phonologically this morpheme is realized in a way similar to nonspecific number agreement (e.g. THEY rather than THEY-TWO), namely as an arc path movement.

As with other sign languages, this morpheme interacts with aspect marking in that the articulation of the verb (in particular its handshape change, if any) can either be spread across the entire arc path, indicating that the process affects all entities at once, or else the articulation of the verb can be repeated as the arc path is followed, indicating that the process is repeated separately for each entity. In other words, it is either the entity or the event that is pluralized. Note that plural agreement here can only be with the object, not the subject. Examples are given below. Plurality (PL) is noted as an arc path (usually from left to right for right-handed signers).

(6) Examples of plural (object) agreement

a.	TELL — PL (arc path)	"tell (many people)"
b.	TURN.ON (the light) — PL (arc path)	"turn on (all the lights)"
c.	TURN.OFF (the light) — PL (arc path)	"turn off (all the lights)"
d.	ASK — PL (arc path)	"ask (many people)"

As illustrated below, ASK is signed with the extended palm (facing sideways)

moving forward towards the classifier for "person (singular)" (7a). When inflected for plurality, the movement is along a horizontal arc, meaning "asking person (plural)" (7b).

(7) ASK (person) vs. ASK (person, plural)

a. ASK

b. ASK—PL (arc path)

TELL is another example similar to ASK. It is signed with closed fingers moving forward and opening the fingers towards the object (8). When inflected for plurality, the movement of opening the fingers is repeated along a horizontal arc as in the above example ASK, meaning "telling person (plural)".

(8) TELL

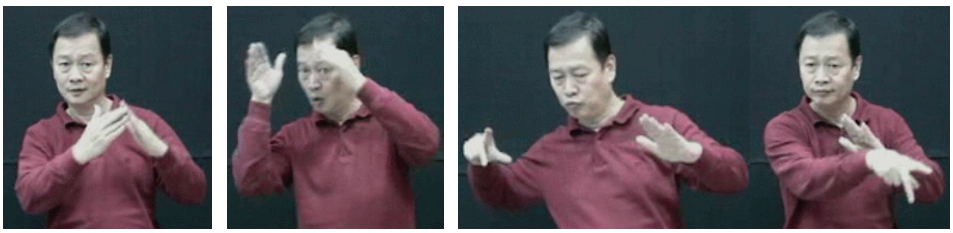
As to distributive plurality, it is expressed by reduplication. For example, TELL+distributed means tell each one (of several persons) and PUT+distributed means put at each place (of several places).

(9) TELL each one (of several people)

Aspect marking

Regarding aspect marking, we also have some observations. First, TSL marks perfective aspect on verbs of motion by holding the final position at the end of the verb, similar to what Sandler (1993) observed for ASL. In the following two examples, there is a hold at the end of each sentence marking the termination of the action.

(10) The dog ran (has run) into the room.



a. HOUSE b. DOG c. $HOUSE_{pro}$+DOG_{pro} — $run.into_{[hold]}$

(11) He went (has gone) to Kaohsiung from Taipei by train.

a. HE b. $Kaohsiung_i$ c. $Taipei_j$ d. TRAIN — $move_{j \rightarrow i\ [hold]}$

A more common way of expressing perfective is adding a morpheme "finished,

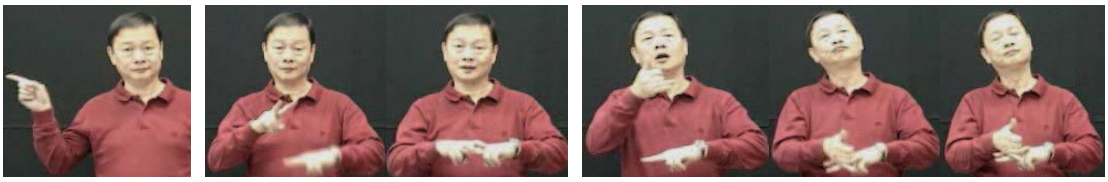
terminated" after the verb. However, this statement could be controversial and this morpheme might be suspected to be affected by Chinese which uses a perfective marker LE after the verb.

(12) He has come (arrived).

a. HE b. COME c. FINISH

Second, progressive is marked by holding in state verbs (13) and by reduplication in dynamic verbs (14), again, similar to ASL.

(13) He is sitting on the chair.



a. HE b. CHAIR c. $CHAIR_{pro}$ +$HUMAN_{pro}$ — $SIT_{[hold]}$

(14) The dog is running in the room.

a. HOUSE

b. DOG

c. $HOUSE_{pro}$ +DOG_{pro} — RUN++ (repeated circling)

Third, protractive aspect is marked by trilled movement on some verbs (e.g. wiggling the fingers in LOOK-AT or GAZE). Durational aspect also includes intensity and frequency. It could be marked by prolonged duration, circular movement, or reduplication.

For example, SEE is signed with the extended index and middle fingers moving outward from the eyes, while GAZE (look longer) is signed exactly the same way with the movement prolonged (with a bit of wiggling).

(15) SEE

Intensity and frequency are often marked by reduplication. For example, in the following examples, the reduplication does not only indicate the repetition (i.e.

frequency), it has a connotation of getting more annoying (intensity).

(16) Intensity and frequency marked by reduplication

a. ASK-ASK-ASK	"keep asking"
b. TELL-TELL-TELL	"keep telling"
c. SCOLD-SCOLD-SCOLD	"keep scolding"

Reduplication with a simultaneous raise of the hand(s) also indicates the increase of degree or intensity in either quality or quantity. For example, ADD is signed with the side of one fist (facing outward) touching the side of the other fist (facing inward). When the movement in ADD is reduplicated together with the reduplicated raise of the two hands, it means "keep increasing."

(17) Intensity and frequency marked by reduplication

a. ADD (reduplication + raising the hands)	"keep increasing"
b. QUARREL (reduplication + raising the hands)	"keep quarreling (getting more and more serious)"
c. ARGUE (reduplication + raising the hands)	"keep arguing (getting more and more intensive)"

2.2.2. Noun inflection

There does not seem to be any noun inflection. Inherent nominal properties such as number and class are only marked on the verb (if at all). Number agreement is only indicated by classifiers for a lexically restricted set of subjects. A more productive way to indicate number is to reduplicate that subject's standard classifier in the verb, as mentioned in (5) in Section 2.2.1 above. Note that there are cross-language differences: number agreement is found in American Sign Language (ASL), but not gender agreement (Smith 1989).

2.3. Derivation

In this section, derivational affixation is discussed first, following by serial compounding and parallel compounding. Nominalization is also one of the mechanisms

in noun derivation.

2.3.1. Derivation other than compounding

While ASL and other sign languages seem to have at least some derivational affixation, we have only found one weak possibility in TSL. This is an apparently bound form, similar but not identical to the sign for EYE, that appears before predicates (verbs and adjectives) to form semantically related verbs. Intriguingly, Israeli Sign Language has a very similar prefix (Aronoff, Meir, and Sandler 2000).

(18) EYE (bound form) as a prefix
  a. BELITTLE = EYE + FEW or EYE + DISAPPEAR
  b. RESPECT = EYE + HEAVY

The following examples show affixational derivation where negation morpheme Negation (a bound form signed with opening the hand) is added to LIKE form an antonym DISLIKE. As shown in (19), LIKE is signed with thumb and index touching the face (together with a positive/pleasant expression), while DISLIKE in (20) is signed as LIKE－NOT in (20). Note that there is also a contrast in facial expression in LIKE in this pair of antonyms.

(19) LIKE

LIKE

(20) DISLIKE (LIKE ─ opening the hand)

a. LIKE

b. opening the hand (affixed on LIKE)

A similar sign NO is also found in the following pair of antonyms CLEAR (21) and UNCLEAR (CLEAR^NO) (22). However, the negation sign NO in UNCLEAR might better be analyzed as a root morpheme in a serial compound, instead of suffix. (See next section for discussion of serial compounding.)

(21) CLEAR

(22) UNCLEAR (CLEAR^NO)

a. CLEAR

b. NO (root morpheme)

2.3.2. Serial compounding

Compounding differs from affixation in that more than one root morpheme is involved. There are many examples of serial compounds in TSL, which are distinguished from phrases by the order of the morphemes (sometimes reverse of that found in phrases), semantic opacity, and phonological simplification. Below we illustrate the first two of these diagnostics (originally established for ASL by Liddell and Johnson 1986; see also Smith 1982).

Noun phrases in TSL usually have the order [noun^modifier]. So the [modifier^noun] or [noun^noun] structure suggests compounding. Examples in (23) illustrate non-phrasal morpheme order.

(23) Serial compounds: [modifier^noun] or [noun^noun]
  a. APPLE = RED^FRUIT
  b. JUDGE = LAW^MALLET
  c. PERSONALITY = PERSON^HABBIT
  d. HEARSE = COFFIN^CAR

Examples in (24) illustrate semantic opacity (also illustrated by some examples above, and the following examples also show non-syntactic morpheme order).

(24) Serial compounds: semantic opacity
a. COFFEE = BROWN^STIR
b. ONE O'CLOCK = TIME^ONE
c. DEFICIT = RED^HIGH LEVEL
d. SURRENDER = WHITE^FLAG

Some serial compounds seem to follow templates. For example, [X^PLACE] and [Y^LEADER] are productive compounding templates, as shown in the following examples.

(25) Serial compounds with template [X^PLACE]
a. TRAIN STATION = TRAIN^PLACE
b. COURT = LAW^PLACE
c. POLICE OFFICE = POLICE^PLACE

(26) Serial compounds with template [Y^LEADER]
a. PRESIDENT = NATION^LEADER
b. PRINCIPAL = SCHOOL^LEADER

2.3.3. Parallel compounding

We differ somewhat from previous analyses of sign morphology in positing this category. Some of our examples may be historically derived from serial compounds through fossilized phonological operations. Others are standardly treated as if they were monomorphemic, though this seems to us to miss some important observations.

For example, in MARRY, one hand with the sign MALE and the other hand with the sign FEMALE move simultaneously to meet each other in front of the chest (27), while in DIVORCE, the hand with the sign MALE and the other hand with the sign FEMALE move simultaneously apart from each other (28). ("∪" indicates that the two roots are produced simultaneously, i.e. parallel compound.)

(27) MARRY = MALE∪FEMALE (hands moving to meet each other)

a. MALE∪FEMALE－together

(28) DIVORCE = MALE∪FEMALE (hands moving away from each other)

a. MALE∪FEMALE－separate

Another pair is BUY and SELL. In BUY, one hand, with the sign of MONEY, moves outward as if giving out money, while the other hand, with the open palm facing up, moves simultaneously inward as if accepting goods being purchased. In SELL, the movements have the opposite direction, with the hand of MONEY moving inward as if receiving money, and the other hand moving outward as if giving out goods.

(29) BUY = HAND (moving inward)∪MONEY (moving outward)
(30) SELL = HAND (moving outward)∪MONEY (moving inward)

Interestingly, parallel compounds may be contained with in serial compounds, while

the reverse is apparently impossible. This is consistent with phonological arguments (given below) that different compound types may be "ordered differently" in a lexical phonology analysis (or in equivalent constraint-based analyses). In WIFE and HUSBAND, MARRY (a parallel compound with MALE∪FEMALE) is signed followed by FEMAIL and MALE, respectively.

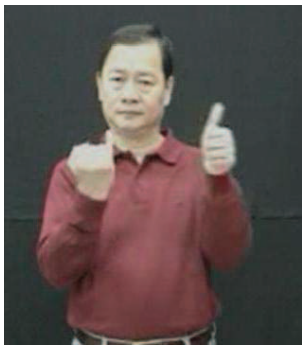
(31) WIFE = MARRY (MALE∪FEMALE) ^ FEMALE

a. MARRY

b. FEMALE

(32) HUSBAND = MARRY (MALE∪FEMALE) ^ MALE

a. MARRY



b. MALE

The notion of "parallel/simultaneous compounding" allows us to analyze many iconic signs into component morphemes, even if these forms are somewhat like *cranberry morphs* (i.e., forms like English *cran* that are not reused by other words, making their morphemic status unclear). Here are some iconic signs that may possibly be

polymorphemic.

For example, BANANA is signed with the middle finger of one hand pointing up representing the banana, while the other hand acts as if peeling it.

(33) BANANA = PEEL∪oblong object

SUNRISE is signed with one hand (index and thumb curved to form a semi-circle) representing the sun and the other arm put horizontally representing the ground. The "sun" hand rises from below to above the "ground/horizon."

(34) SUNRISE = SUN∪ground

TELEVISION is signed with one hand forming the half-square as the TV screen and the other hand, palm facing inward, moving up and down behind the screen.

(35) TELEVISION = moving picture∪screen

2.3.4. Nominalization by reduplication

Nominalization can be made by reduplicating the movement in the verb. For example, in OPEN (a lock), one hand in the shape of holding a key with the thumb and the index finger turns once as if turning the key in a lock. When the turning action is reduplicated, it becomes KEY. Similar processes are found in SIT and SEAT. SIT is signed with the extended index and middle fingers (representing the buttock) hitting one time the other hand's index and middle fingers (representing the surface of the chair). If the hitting movement is repeated, it becomes SEAT. (cf. Wu 2007 for a different view.)

(36) OPEN (a lock)(turn once) vs. KEY (turn twice)

(37) SIT (hit once) vs. SEAT (hit twice)

3. TSL phonology

In this section, we introduce various aspects of TSL phonology, including phonemic inventory (section 3.1), allophonic variation (section 3.2), feature cooccurrence restrictions (section 3.3), alternations (section 3.4), and word-internal prosodic structure (section 3.5).

3.1. Phonemic inventory

A physical aspect of language is *phonemic* if it serves to indicate lexical contrasts (i.e. unpredictable from other aspects of physical form). This property of *duality of patterning* (Hockett 1960) is fundamental to human phonology. TSL Signs can differ phonemically along several parameters, including handshape, location, path movement, local movement, hand orientation, and nonmanual features, as have been proposed in studies on sign language phonology (Stokoe et al. 1965, Liddell and Johnson 1989, Sandler 1989, Corina and Sandler 1993, Uyechi 1996, Brentari 1998, Sandler and Lillo-Martin 2006, among others).

3.1.1. Handshape inventory in TSL

Updating Smith and Ting (1979, 1984), Lee (2003) claims that TSL has 57 phonemic handshapes. (See Appendix 1 for the list of handshapes from Smith and Ting 1984, and Appendix 2 for the list of handshapes Chang, Su, and Tai, 2005).[3] For convenience, TSL handshapes usually are named after the signs in which they appear, but they are *not* themselves morphemes. The following are some examples.[4]

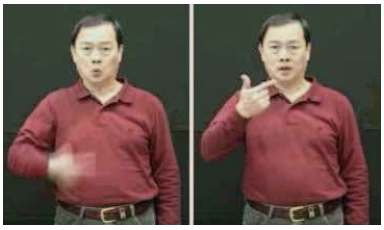
[3] Handshapes are named in Chinese characters following Smith and Ting, 1979, 1984. Handshape names in Mandarin Pinyin, a romanization system for Mandarin, are also given next to the Chinese characters for easier access for non-Chinese readers. Some handshape names, though distinct in Chinese characters, might become identical in Pinyin because they are homophones, e.g. /同 (tong)/ and /童 (tong)/ .

[4] Handshape pictures are from Lee (2003) and handshape examples in drawing are from Smith and Ting (1979 or 1984).

(38) Handshape /六 *(liu)*/

(39) SIX and FAST contain the same handshape /六 *(liu)*/

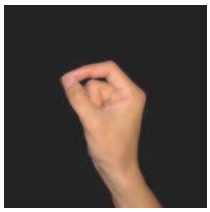
a. SIX



b. FAST

RICE contains two handshapes, /呂 *(lyu)*/ and /一 *(yi)*/; the former also appears in LYU, a surname, and the latter in NEW YEAR.

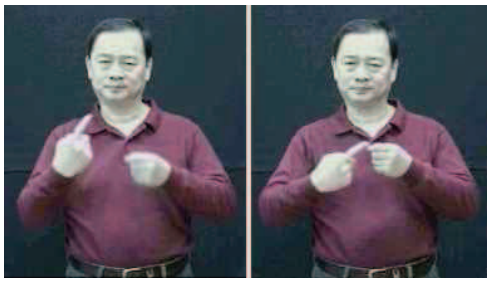
(40) Handshapes /呂 *(lyu)*/ and /一 *(yi)*/



a. /呂 *(lyu)*/

b. /一 *(yi)*/

(41) RICE, LYU, and NEW YEAR



a. RICE (right hand with /一 *(yi)/* and left hand with /呂 *(lyu)/*)

b. LYU (a surname) (both hands with /呂 *(lyu)/*)

c. NEW YEAR (both hands with /一 *(yi)/*)

Regarding handshapes, TSL has some *marginal phonemes* that only appear in a single morpheme, for example:

(42) Handshapes */語 (yu)/* and */飛機 (feiji)/*

a. */語 (yu)/*

b. */飛機 (feiji)/*

Handshapes */語 (yu)/* only appears in SPEECH (written as *語* and */飛機 (feiji)/* only appears in AIRPLANE (written as *飛機*).

3.1.2. Other phonemic parameters in TSL

In addition to handshape contrast, there are also contrasts in location, path movement, local movement, hand orientation, and non-manual features.

Phonemic contrast in location

PLEASE vs. YES is a pair of signs that contrast in location. They both use the handshape */胡 (hu)/* (43a), with the palm parallel to the center plane of the body. The index finger of the hand in PLEASE makes contact on the forehead (43b), while in YES, contact is on the chin (43c).

(43) Phonemic contrast in location: PLEASE vs. YES

a. */胡 (hu)/*

b. PLEASE

c. YES

Phonemic contrast in path movement

COLOR vs. SKY is a pair of signs that contrast in path movement. Both signs move

across in front of the chest with the handshape */七 (qi)/* (44a), with the palm facing outward, but COLOR moves across horizontally in a straight line (44b), and SKY in a convex-arc path (44c)

(44) Phonemic contrast in path movement: COLOR vs. SKY

a. */七 (qi)/*

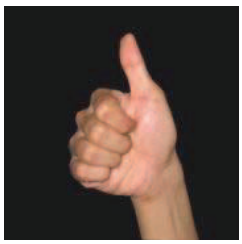
b. COLOR

c. SKY

Phonemic contrast in local movement

MALE vs. THANK is a pair of signs that contrast in local movement. Both signs use the handshape */男 (nan)* (45a)*/*, but in MALE, the hand rotates back and forth at the wrist (45b), while in THANKS, the thumb repeatedly bends (45c).

(45) Contrast in local movement: MALE vs. THANK


a. */男 (nan)/*

b. MALE

c. THANK

Phonemic contrast in hand orientation

NOW vs. CALM-DOWN is a pair of signs that contrast in hand orientation. They both use the handshape */手 (shou)/* (46a) on both hands, and both start with the hands palm-downward and involve downward movements, but in NOW, the fingertips of both hands point forward away from the body(46b), while in CALM DOWN they point

towards each other (46c)

(46) Contrast in hand orientation: NOW vs. CALM-DOWN

a. /手 *(shou)*/

b. NOW

c. CALM DOWN

Phonemic contrast in nonmanual features

BRAIN vs. UNDERSTOOD is a pair of signs that contrast in nonmaual features. They both involve the handshape /一 *(yi)*/, with the index tip contacting the temple, but with BRAIN no facial expression is made, while in UNDERSTOOD, the mouth is rounded and sucks in air, and the head moves backward at the same time.

(47) Contrast in nonmanual features: BRAIN vs. UNDERSTOOD

a. /一 *(yi)*/

b. BRAIN

c. UNDERSTOOD

3.2. Allophonic variation

Some handshape variants seem to be predictable from their phonetic environment (i.e. their articulatory context) and thus should not be analyzed as phonemic. To describe such allophonic forms, we describe hand configuration using the labels *T* (thumb), *I* (index), *M* (middle), *R* (ring), and *P* (pinky), and *spread*, *closed*, *extended*, *bent* (finger straight but bent at first joint, i.e. knuckle), or *curved* (finger bent at all joints, but not totally closed).

3.2.1. Allophonic variation in extended fingers due to hand orientation

The extended fingers of handshapes like /一 *(yi)*/ and /六 *(liu)*/ become bent in a small set of environments involving hand orientation.

(48) Finger bending triggered by pointing fingertips downward

Phonemic Handshape	**Allophonic change**	**Signs**
/一 *(yi)*/	I bent	DEEP, CASSETTE-TAPE
/六 *(liu)*/	I bent	DOWN, WEST, SOUTH, TIME

(49) Finger bending triggered by pointing fingertips inward toward the body

Phonemic Handshape	**Allophonic change**	**Signs**
/一 *(yi)*/	I bent	I, YESTERDAY, EYE, MONDAY
/六 *(liu)*/	I bent	FATHER, SATURDAY

3.2.2. Allophonic variation due to contact

Above we described the handshapes *[手 (shou)]* and *[胡 (hu)]* as if they were phonemically contrastive, but they in fact seem to be predictable allophones. The basic form seems to be */手 (shou)/*, since it is easier to describe the context in which *[胡 (hu)]* appears: with contact or near contact to another body part anywhere along the thumb side of the hand.

(50) Thumb bending in the articulation of */手 (shou)/*

Phonemic Handshape	**Allophonic change**	**Context**	**Signs**
/手 (shou)/	T bent (i.e. *[胡 (hu)]*)	Outer side of T contacted	DOOR, START, SKATE, LAKE
/手 (shou)/	T bent (i.e. *[胡 (hu)]*)	Outer side of I contacted	NONSENSE, PLEASE, YES

3.2.3. Handshape variation due to iconicity

Handshape variation due to iconicity does seem to happen. For example, as pointed out by Lee (2003), the three handshapes *[瓜 (gua)]*, *[果 (guo)]*, and *[同 (tong)]* listed in Smith and Ting (1979, 1984), which differ only in the degree of flexion of the fingers, are not contrastive with each other in the usual way. Instead, they only contrast when used as iconic classifiers for differently sized and shaped objects.

(51) Handshapes *瓜 (gua)*, *果 (guo)*, and *同 (tong)* listed in Smith & Ting (1984)

a. *瓜 (gua)*

b. *果 (guo)*

c. *同 (tong)*

Such phenomena are reminiscent of sound-symbolic phonetic modifications in spoken languages, such as English “high” [hai^{55}] vs. “low” [low^{11}], or “big” [bɪ::g].

3.3. Feature cooccurrence restrictions (handshape constraints)

Just as in spoken languages, there are phonetically motivated restrictions on feature combinations within segments, such as *[+nasal, -voice] (see Archangeli and Pulleyblank 1994), so there are constraints on combinations of finger articulations within a handshape, as shown by Ann (1993, 1996, 2006) using data in Smith and Ting (1979, 1984).

As can be seen from the table in (52), the number of signs for each finger differs quite drastically, with thumb and index finger being the most common in one-finger-handshape signs.

(52) Number of signs in TSL with one-finger handshapes with the indicated postures

Finger	Extended	Curved	Bent
T	101	6	101
I	196	28	196
M	0	0	4
R	0	0	3
P	20	5	20

It is also clear, as shown in (53), that the combination of thumb and index (TI) and the combination of index and middle finger (IM) are the most common combinations in two-finger-handshape signs.

(53) Number of signs in TSL with two-finger handshapes with the indicated postures

Fingers	Extended	Curved	Bent
TI___	54	25	17
T_M__	0	0	0
T__R_	0	0	0
T___P	32	0	32
_IM__	67	19	67
_I_R_	0	0	0
_I__P	1	0	1
__MR_	0	0	0
__M_P	0	0	0
___RP	0	0	0

While such constraints appear to be primarily articulatory, a “deeper” sort of

constraint is revealed by the much smaller inventory of handshapes allowed for the *weak hand* of two-handed signs (i.e. the nondominant hand of the signer). In fact, in most such signs, the weak hand handshape comes from a set of just two handshapes: the totally closed fist */拳 (quan)/* (as in the sign for the surname LIN) or the flat open hand */手 (shou)/* (as in the sign for TIME). Interestingly, these handshapes seem to be the simplest possible handshapes according to Ann's articulatory model (Ann 1993, 1996, 2006).

(54) */拳 (quan)/* and */手 (shou)/*

a. */拳 (quan)/*

b. */手 (shou)/*

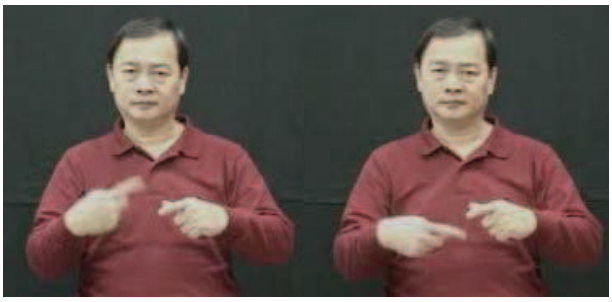
(55) LIN and TIME

a. LIN (surname)

b. TIME

Apparent examples of native, monomorphemic signs with more complex weak hands include LEAF (weak hand */六 (liu)/*), which, interestingly, is iconic. The signing of LEAF involves the index finger of one hand rotating from the wrist up and down between the curved thumb and the curved index of the other hand, i.e. handshape */六 (liu)/* (tracing out the shape of the leaf).

(56) LEAF



LEAF

However, phonology can also trump iconicity, as in a language change noted by Lee (2003): the complex handshape described by Smith and Ting (1979) for the sign GINGER has since been replaced by a much simpler handshape.

(57) Handshape change over time

a. handshape in GINGER (Smith & Ting 1979)

b. handshape in GINGER (Lee 2003)

Moreover, Lee, Tsay, and Myers (2001) show that character signs, which attempt to imitate the shape of Chinese characters, obey basically the same physiologically motivated constraints as native signs.

3.4. Alternations

TSL morphemes may change form depending on the phonological context. We are still collecting data, but some major generalizations stand out:

(i) Assimilation is the most common type of phonological process.
(ii) Handshape almost always spreads from right to left, while orientation and location almost always spreads from left to right.
(iii) The weak hand is indeed "weak", being subject to total assimilation or deletion.
(iv) Is there any lexical (as opposed to postlexical) phonology?

3.4.1. Assimilation

Both total handshape assimilation and partial handshape assimilation are found in TSL.

Total handshape assimilation

One example of total handshape assimilation is I NO, meaning "I didn't." In citation, I is signed with handshape */一 (yi)/* pointing to the chest, and NO is signed with handshape */同 (tong)/* (open hand) changing into handshape. */萬 (wan)/* (closed hand with bent fingers)

(58) I NO

a. I (in citation)

b. NO (*/同 (tong)/* → */萬 (wan)/*)

In I NO meaning "I didn't", the handshape */一 (yi)/* in I is assimilated to */同 (tong)/* triggered by the */同 (tong)/* sign in NO. So, instead of pointing to the chest with the index finger, the handshape */同 (tong)/* replaces the index finger in I and points to the chest with the open hand. The following table lists more examples that involve total handshape assimilation.

(59) Examples for total handshape assimilation (targets are boxed; "+" represents a word-internal morpheme boundary; and ">" represents a morpheme-internal handshape change)

Example	**Gloss**	**Trigger handshape**	**Target handshape (original)**	**Target handshape (change)**	**Direction**
I NO	I didn't	*/萬/*(>*/同/*)	*/一/*	*/萬/*	Right to Left
ENOUGH NO	not enough	*/萬/*(>*/同/*)	*/錢/*	*/萬/*	Right to left
I NOT-BE	it's not me	*/六/*	*/一/*	*/六/*	Right to left
WHITE (+) COLOR(B)	white	*/七/*	*/一/*	*/七/*	Right to left
OUT + COUNTRY	foreign	*/同/*	*/手/*	*/同/*	Right to left
NO PROBLEM	no problem	(*/萬/*>)*/同/*	*/手/*	*/同/*	Left to right

(60) An autosegmental representation of I NO

Partial handshape assimilation

Examples of partial handshape assimilation are given below.

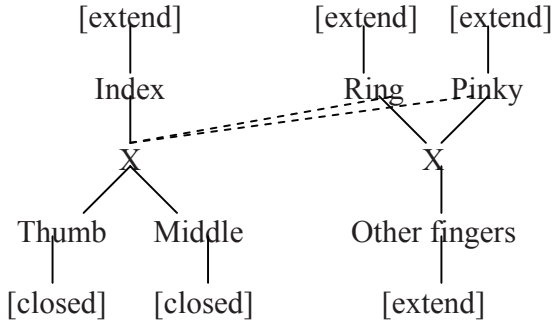
(63) Examples of partial handshape assimilation (a superscript "$^{>}$" indicates a modification of a standard phonemic handshape)

Example (target highlighted)	**Gloss**	**Trigger handshape**	**Target handshape (original)**	**Target handshape (change)**	**Direction**
HE HAVE	he has	*/手/* TIMRP extended	*/一/* I extended; TMRP closed; TM contact	*/借/* IRP extended; TM closed; TM contact	Right to left
LOOK NO	didn't look	*/萬/*(>*/同/*) T contacts IM; TIMRP bent	*/錢/* TI curved contact; MRP extended	*[˃萬]* TI curved contact; MRP bent	Left to right

In the example HE HAVE, the handshape in HE is */一 (yi)/* (i.e. with the index finger pointing to a person) and the handshape in HAVE is */手 (shou)/* (i.e. with an open palm). After partial assimilation, the HE in HE HAVE becomes a partially open palm with the index finger still pointing out as in the handshape */借 (jie)/*.

(64) */借/*

(65) An autosegmental representation of HE HAVE:



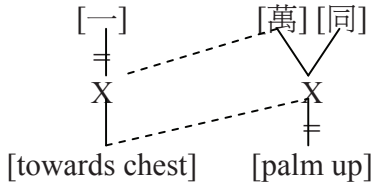
In contrast to handshape assimilation (total or partial), orientation always seems to spread from left to right, as given in (66).

(66) Examples of orientation assimilation

Example (target highlighted)	**Gloss**	**Trigger orientation**	**Target orientation (original)**	**Target orientation (change)**	**Direction**
I NO	I didn't	towards chest	palm up	towards chest	Left to right
NO PROBLEM	no problem	towards chest	palm up	towards chest	Left to right

An autosegmental representation of I NO with palm orientation change is given below.

(67) Autosegmental representation of I NO (with palm orientation change)



3.4.2. The phonology of the weak hand

When a two-handed sign appears before or after a one-handed sign, the one-handed sign is often articulated with the nondominant hand totally assimilating the features of the weak hand of the two-handed sign.

(68) Right-to-left assimilation of the weak hand in one-handed/two-handed sign sequences

Example	**Gloss**
FEMALE^FRIEND	girlfriend
YESTERDAY^YEAR	last year

(69) Left-to-right assimilation of the weak hand in two-handed/one-handed sign sequences

Example	**Gloss**
TRAIN^PLACE	train station
SCHOOL^LEADER	principal
MARRY^MALE	husband
NAME^WHAT	what name?

Some two-handed signs have an alternate form without the weak hand. In most of these, both hands have identical features (e.g. PRACTICE, HAPPY). This means that the alternation could be analyzed as either deletion or as insertion + cross-hand assimilation.

In two-handed signs with nonidentical hands that allow an alternation like this (e.g. ASK, TELL, HIT, GIVE), the "droppable" hand always has the handshape /男 (nan)/, and it seems to serve as an incorporated object in the verb. Thus the alternation here seems to be morphological, not phonological (cf. ASK (one person) in (7a) in section 2.2.1).

3.4.3. Lexical vs. postlexical phonology

None of the above alternations seem to require analysis as a lexical rule: the same basic phenomena can occur both across word boundaries and within words, and allophonic handshapes may be created.

So far, preliminary findings suggest that the best potential candidates for lexical alternations are those occurring within compounds (see also Smith 1982). However, their special characteristics may be due the interplay between prosodic structure and morphology, rather than directly between the alternations and morphology.

3.5. Word-internal prosodic structure

The analysis of word-internal structure is quite controversial in sign phonology. Competing claims hold that signs are best analyzed as segment-sized whole units (e.g. Stokoe, Casterline, & Croneberg 1965; Channon 2002), as sequential strings of segment-sized units (e.g. Liddell & Johnson 1985; Sandler 1989), as syllables containing moras (e.g. Perlmutter 1992), or as hierarchical structures similar but distinct from spoken language prosody (e.g. Uyechi 1996). Here we describe some relevant TSL data using the sonority-based position-movement (PM) notation of Perlmutter (1992).

Segments in spoken languages can be ranked by sonority (energy), from the minimum in a voiceless stop like /p/ to the maximum in a low vowel like /a/, and this allows for a definition of a *syllable*: a sonority profile with a single peak. In signs, fully motionless portions are less sonorous (energetic) than portions where the hand doesn't change position but there is local movement (including handshape change), which are in turn are less sonorous than portions where the hand has path movement with or without local movement.

We represent this four-way sonority scale as $P < P^{+} < M < M^{+}$ (where "P" = position = no path movement, prototypically with a hold at a specified location; "M" = movement along a path; "+" = presence of local movement). A sign syllable is then a sonority profile with a single peak, e.g. PM, MP, PMP, P^{+} (Tsay 2007).

3.5.1. Syllables and morphemes

Virtually all monomorphemic signs in TSL are monosyllabic by the above definition. The only nonsyllabic signs seem to be clitics, namely numbers like ONE, TWO, THREE, which also often appear within words (e.g. NEW YEAR, cited above).

(70) Examples of monosyllabic signs

Sequence type	**Signs**
P^+	MALE, THANK, DOG, CHILD
M	SKI, CITY, EXPENSIVE
M^+	SWIM, WALK
MP	HAVE, SIT, NOW, GOOD
M^+P	SOUND
PM	COMMEMORATE, JUMP
PM^+	DREAM
PMP	STOP, GROW UP
PM^+P	THING

Just as noted by Perlmutter (1992) for American Sign Language, TSL syllable structure obeys constraints against adjacent segments that are too close in sonority. Thus there are no syllables with the structures *MP^+, *P^+M, *P^+MP^+, etc.

As noted above, movement can include handshape change, specifically what is sometimes called *handshape contour* (see Liddell and Johnson 1989, Liddell 1990, Corina 1993, Brentari 1996): the change involves a fixed set of fingers that all change posture the same way, always from open to closed or the reverse; the other fingers do not change posture, and must remain all closed or all open. Thus one handshape in a contour is predictable from the other.

(71) Examples of monosyllabic signs involving handshape contour (note that the set of active fingers is the same across the whole sign)

Sequence type	**Signs**	**Handshape change**
P^+	SMART	/呂 *(lyu)*/ TI closed > /六 *(liu)*/ TI open
M^+	FISH	/手 *(shou)*/ TIMRP open > /九 *(jiu)*/ TIMRP curved
M^+P	BEAN	/呂 *(lyu)*/ TI closed > /六 *(liu)*/ TI open
PM^+	FORGET	/拳 *(quan)*/ TIMRP closed > /手 *(shou)*/ TIMRP open

By contrast, *handshape cluster* is handshape change in which the handshapes at the beginning and end of the sign do not have any strict relationship with each other. Such signs almost always contain more than one morpheme.

(72) Examples of polymorphemic signs involving handshape cluster (note that the set of active fingers changes from the beginning to the end of the sign)

Signs	**Gloss**	**Handshape change**
MONTH^ONE	one month	/呂 *(lyu)*/ TI > /一 *(yi)*/ I
READ^PERSON	student	/五 *(wu)*/ TIMRP > /民 *(min)*/ TP
THINK^GREAT	clever	/一 *(yi)*/ I > /男 *(nan)*/ T

Note that the difference between handshape contour and handshape cluster supports the claims that (i) sign morphemes are naturally monosyllabic; (ii) handshape contour defines a single syllable; (iii) specifying a syllable does not require specification of a sequence of features. Conclusion (iii) supports arguments that sign "syllables" are really more like spoken language segments, like affricates.

Note also that the necessity for local movement on single-handshape signs without path movement provides further support for the claim that a handshape is itself *not* a sign, but merely an element of a full sign. That is, handshapes represent phonological content that must be licensed within phonological structure (prosody).

There are a small number of apparently monomorphemic signs that have more than one syllable. Interestingly, all but one of them have the same handshape in both syllables, suggesting the existence of a morpheme-internal "handshape harmony" constraint.

(73) Examples of monomorphemic signs with more than one syllable

Sequence type	**Cross-syllable feature change**	**Signs**
MPMP	No change: reduplication	WORK, PHYSICAL EDUCATION, NOW, HELP
MPMP	Location (movement, handshape, orientation unchanged)	ALTHOUGH, FROG, BUTTONS
MPMP	Location and orientation (movement, handshape unchanged)	PAPAYA, ROOM
PMPMP	Location, orientation, movement (handshape unchanged)	TABLE
MPMP	Handshape and orientation (movement, location unchanged)	MOSQUITO

There is as yet no evidence for an onset-rime distinction in sign "syllables".

3.5.2. Syllables and compounding

As Goldsmith (1990) and others have noted, in spoken language lexical phonology, "level 1" morphology is associated with phonology that creates forms consistent with monomorphemic prosodic constraints, while "level 2" morphology violates such constraints. For example, level 1 suffixes in English shift stress, while level 2 suffixes do not (e.g. órigin ~ oríginal both obey monomorphemic stress patterns, while télephoning does not).

This would seem to predict that "level 1" compounding should create outputs that are more like monomorphemic forms, i.e. monosyllabic. We have tried to explore this hypothesis by looking at the relationship between diagnostics of lexical level like transparency and frequency, and the number of syllables. Note some interesting contrasts, such as "geography" vs. "prepare".

(74) Semantics and number of syllables in compounds

Compound	**Gloss**	**Number of syllables**
EXAMINE^HELP	take care of	2
MONEY^SUBTRACT	discount	2
CITY^LEADER	mayor	2
CALCULATE^GOOD	worthy	2
SOIL^WAY	geography	2
MARRY^MALE	husband	1
WHO^NOT	unfamiliar	1
BEFOREHAND^WAY	prepare	1
ENOUGH^NOT	not enough	1
FATHER^MOTHER	parents	1

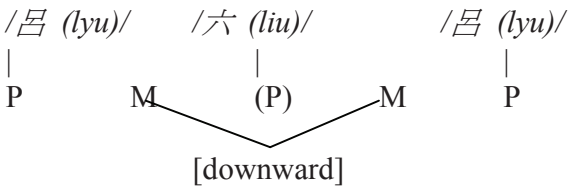
3.5.3. Syllables and iconicity

A fascinating example of abstract phonology trumping iconicity has been pointed out by Lee (2003). In Smith and Ting (1979), the sign for MOON is described as very iconic:

(75) MOON (Smith and Ting, 1979)

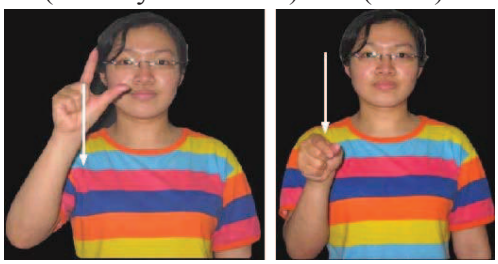
The problem is that this would then be a morpheme containing three handshapes but only one path movement, violating syllable structure:

(76)

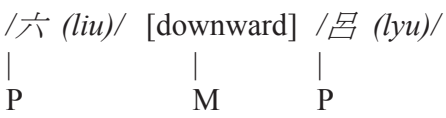


Lee (2003) discovered that signers (whether young, old, native, or nonnative) do not use this iconic form in everyday conversation, but instead use a monosyllabic form:

(77) MOON (monosyllabic form) Lee (2003)



(78)



4. Conclusions

This paper has given a brief sketch of the morphology and phonology of Taiwan Sign Language. Like spoken languages and other sign languages that have been described,

TSL has both inflection, primarily agreement and aspect marked on the verb, and derivation, including both category-changing affixation and compounding. Morphological properties cross-linguistically typical of sign languages (though not necessarily typical of spoken languages) include the apparent lack of tense marking, agreement for both subject and object, and parallel (simultaneous) compounding; more unusual features include agreement for gender and number. TSL phonology follows mostly typical patterns as well, with an inventory of handshapes and other phonemic elements that overlaps largely, though not completely, with those of other sign languages. Alternations and constraints on handshapes and prosodic structure are also typical, as is the ambiguous role of iconicity in sign phonology: signs tend to mimic real-world referents, yet often differ from them in order to obey phonological constraints.

The tendency for the morphology and phonology of sign languages to be very similar may follow from their relative youth, since there has been less time for them to deviate from some kind of default (Aronoff et al. 2000). However, further data collection and deeper analyses may reveal unique properties of TSL at a more subtle level.

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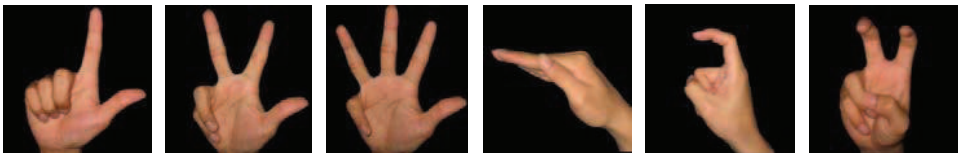
Appendix 1 TSL handshapes in Smith and Ting (1984)

〇	十	方	姊	副	龍
一	廿	欠	虎	棕	薑
二	卅	句	果	童	蟲
三	四十	兄	胡	菜	臂
四	八十	民	很	筆	難
五	百	瓜	飛機	博	WC
六	千	同	隻	像	
七	萬	守	拳	語	
八	女	男	借	鴨	
九	手	呂	紳	錢	

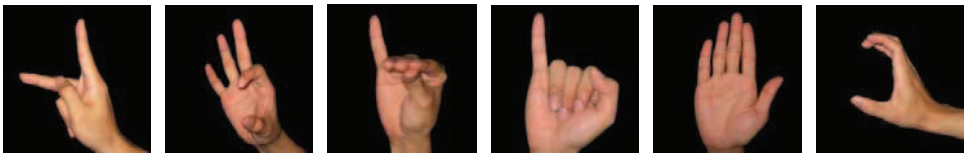
Appendix 2 TSL handshapes in Chang, Su, and Tai (2005)

零 一 二 三 四 五
LING YI ER SAN SI WU

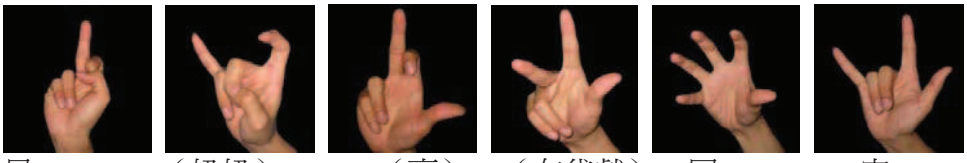


六 七 八 九 十 二十
LIU QI BA JIOU SHI ER-SHI

三十 四十 五十 六十 七十 八十
SAN-SHI SI-SHI WU-SHI LIU-SHI QI-SHI BA-SHI



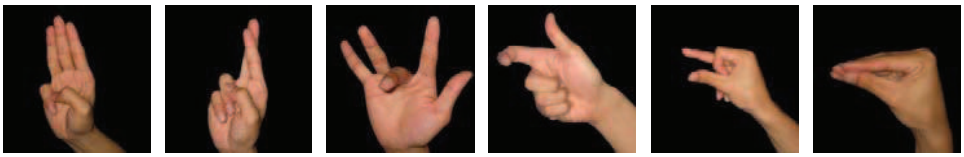
(K) WC 千 女 手 方
(K) WC QIAN NY SHOU FANG



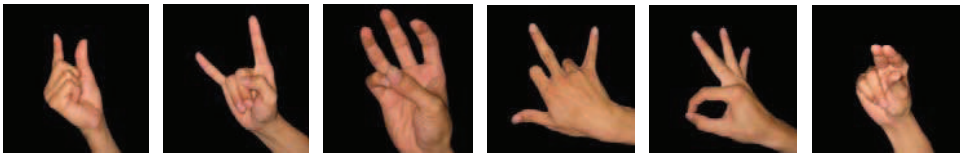
兄 （奶奶） （高） （布袋戲） 同 守
XIONG (GRANDMA) (GAO) (BUDAIXI) TONG SHOU

呂 男 姐 果 很 胡
LY NAN JIE GUO HEN HU

借 拳 隻 紳 博 棕
JIE QUAN ZHI SHEN BO ZONG



童 筆 菜 （爺） （矮） 萬
TONG BI CAI （IE） (AI) UAN



像 語 （細） 飛機 錢 鴨
XIAN YU (XI） FEI-JI QIAN IA

龍 薑 蟲 雞 （鵝） 難
LONG JIANG CHONG JI （E） NAN

Note: Handshapes in parentheses are those that are not listed in Smith and Ting (1984).

台灣手語的構詞與音韻

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摘要

本文將近幾年對台灣手語的構詞和音韻的研究做一系列詳盡的介紹。台灣手語的構詞和口語一樣也可區分爲語法屈折變化構詞和語詞衍生變化構詞。語法屈折變化構詞包括動詞類屈折變化和名詞類屈折變化；語詞衍生變化構詞包括加綴法、序列性複合詞和同時性複合詞。語法屈折變化構詞主要探討台灣手語的呼應方式和動貌標記。呼應方式包括語法關係、性別、和數的呼應；動貌系統包括完成貌、進行貌、延伸貌等標記。另外，有關台灣手語的音韻系統的介紹包括音素成份、同位手形變異、音韻徵性共現限制、音韻轉換和詞彙內部的韻律結構等方面。本文關於台灣手語的語料與分析可以作爲未來進行跨語言比較的基礎。