Towards a Phonological Model of Czech Sign Language: A Case Study of Lexical Variants

Hana Strachoňová[a] and Lucia Vlášková[b]

Masaryk University, Brno, Czech Republic [a]hana.strachonova@muni.mail.cz;

[b]lucia.vlaskova@phil.muni.cz

Abstract: This paper brings some modifications of the phonological Hand-Tier model proposed by Sandler (1986, 1987a, 1987b, 1989, 2006) for American Sign Language. Based on Czech Sign Language data, we refined Sandler's latest version of the model as follows: (i) we added the features for planes into the handshape category; (ii) we specified the application of the repetition feature; (iii) we added a feature and refined a feature ([back] and [wrist], respectively) within the orientation set of the handshape features; (iv) we removed a redundant feature for the thumb positions ([opposed]); and (v) we redefined the feature [arm] as a complex subcategory by adding a set of orientation features. This work has been initially motivated by the need for variant/synonym distinction during the lemmatization process in the first online Czech Sign Language dictionary (*Dictio*).

Keywords: sign language; phonology; variants; lexicography; Czech Sign Language

1. Introduction

This paper aims to propose an adaptation of a phonological model of American Sign Language (ASL), namely the Hand-Tier model (HTM) by Sandler (2006), to the data from Czech Sign Language (český znakový jazyk; ČZJ). The secondary goal is to present a lexicographic application of the phonological model to categorize lexemes into variants and synonyms.[117]

This paper is structured as follows: Section 2 introduces Sandler's HTM and briefly mentions other phonological models proposed for sign languages (SLs). Section 3 turns to the data source of this paper, *Dictio*, the largest electronic database of ČZJ

[117] The authors would like to thank the anonymous reviewer, the editorial board and also the audience of The Olomouc Linguistics Colloquium (Olinco) 2021 for the helpful comments and suggestions that improved this article.

All the exemplified signs with their URLs as well as the models in the Appendix can be found in an online repository at: muni.cz/go/CZJ+HTM_materials.

The handshape fonts are created by CSLDS, CUHK.

up to date. Section 4 presents the three main categories of the HTM and our modifications based on ČZJ data. Section 5 summarizes the contributions of the paper.

2. The Hand-Tier Model

This section introduces the HTM and gives a general overview of its feature categories elaborated in more detail in Section 4. We briefly mention a few alternative approaches to SL phonology and justify our choice of HTM.

It is crucial to note that there are several distinct versions of HTM (Sandler 1986, 1987a, 1987b, 1989, 2006). In each version, there are slightly different sets of features in the individual categories. We have based our proposal on the newest version of the model, which is, at least to our knowledge, Sandler (2006).

The model distinguishes three main phonological categories of a sign: hand configuration (or handshape), place of articulation, and movement. The three categories are linked together in a way that recognizes the simultaneous nature of the signs while preserving their sequential characteristics (for example, the place category can be branched into two locations). Figure 1a below visualizes the categories of the HTM, while Figure 1b exemplifies the phonetic realization of these categories on the ČZJ sign DEAF. As seen from the corresponding colours, the hand configuration category, marked in green, is realized by  -handshape. Place of articulation, marked in blue, is the head, while the initial and final locations (in darker blue) are the ear and the chin, respectively. Finally, the movement between the two locations is indicated by pink.

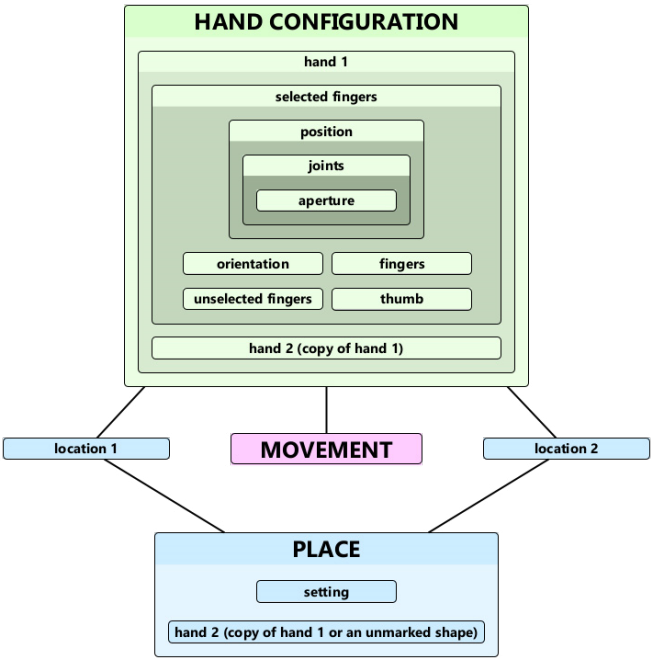

Figure 1a. HTM.

Figure 1b. DEAF.

The features within each category are further divided into classes and subclasses. The model obeys the principles of Feature Geometry (Clements 1985; Sagey 1986), by which the features that control articulatory parts close to each other should also be treated as related and behave as a feature class. The classes, and in some cases also individual features, are in a hierarchical position, which emulates the advantages of Dependency Phonology (Durand 1986; Anderson and Ewen 1987; van der Hulst 1989).

The category of *hand configuration* can be divided into subclasses of *selected fingers*, *orientation*, *position*, and *aperture* (applied to different finger joints). The five fingers are then divided into *fingers* and the *thumb*. The last subclass is *unselected fingers*, the specification dependent on the position of the selected fingers, and therefore, hierarchically subordinate. The other category within *hand configuration* is *non-dominant hand* (hand 2 or h2), which is specified in two-handed symmetrical signs. Hand 2 in this type of signs behaves as a copy of the dominant hand (h1).

Place of articulation can be defined by a set of features describing one of the main areas of the signing space (the neutral space, the head, the trunk, the arm, or, in two-handed asymmetrical signs, the non-dominant hand). These can be combined with the features from a setting subcategory specifying the concrete location of the signing within the main area. The setting features can be branched into two sets, corresponding to two locations within a sign. Moreover, a sign's initial and final location can be linked to individual position and orientation features from the hand configuration category.

The *movement* category is the simplest one, from the hierarchical point of view. It groups a set of features specifying the shape or repetition of the movement(s). The categories and features mentioned above will be further described in Section 4, where their motivation and application in modeling concrete signs will be further elaborated. However, it is important to note that all qualities and refinements to the model are posited to represent data from ČZJ and that these could differ wrt other SLs.

Sandler's HTM presents just one way how to approach SL phonology. The Move-Hold model was put forward by Liddell (1984, 1990) and Liddell and Johnson (1989

[1985]) and built for American Sign Language (ASL). It is the first one that rejects the purely simultaneous nature of a sign (Stokoe 1960) and recognizes a sequential structure composed of two types of segments: movements (the hands move) and holds (the hands hold still). The Prosodic model proposed by Brentari (1989) also works with ASL. Its main characteristic is the non-sequential representation of the movement category. The main reason for our choice of HTM was the lexicographic task at hand: distinguishing variants from synonyms. We needed to work with a notion of a main phonological parameter of a sign (traditionally understood as the handshape, the place, and the movement of a given sign). The models described above were not suitable for such an approach since the MoveHold did not recognize the autosegmental category of the handshape, and the Prosodic model did not distinguish an individual movement parameter. Other phonological models, such as the Moraic model (Perlmutter 1992, 1993), the model of van der Hulst (1993) and Channon (2002a, 2002b), or van der Kooij (2002), were not suitable for independent reasons, but discussing them would exceed the scope of this article.

3. Data

This section introduces the lexicographic task that initially motivated our need for an exact phonological representation of ČZJ lexemes. The second part of the section presents essential information about *Dictio*, the largest online database of ČZJ, that provides all examples quoted in this paper.

3.1 Lexicographic Task

The primary motivation for developing a phonological model of ČZJ was a practical lexicographic task of distinguishing lexical variants from synonyms in a multilingual online dictionary *Dictio* developed at Masaryk University, Brno, Czech Republic.

It is often the case that what has been already described in spoken languages causes problems in the visual-spatial modality, and merely adopting the same terminology and methodology is not enough. When it comes to distinguishing lexical variants from synonyms, we cannot depend on the reliable methodology known from spoken languages, where two variants share a common root and differ in affixes or some pieces of phonology (Czech gender variants as *brambor-0* 'potato' masculine vs. *brambor-a* 'potato' feminine), whereas a pair of synonyms can have different roots which vary, for example, in their etymology (Czech examples *fotbal* 'football' foreign origin vs. *kopaná*
'football' native origin).[118]

Typologically, SLs are an unusual combination of the analytic and the polysynthetic language types. They almost lack sequential morphology; on the contrary, they exhibit a great richness in the simultaneous plane of articulation,

[118] More details in Čermák (1995) or Filipec (1995).

namely within the classifier subsystem, verb modification, numeral incorporation, and spatial agreement (Aronoff et al. 2004). However, focusing on the variant/synonym problem, we cannot rely on any simultaneous morphology. The issue of variant classification was brought to the phonological level by Fenlon et al. (2015, 201), who state that the pairs of signs that "differ in one parameter are likely to be variants". However, it was not always clear what was meant by that difference. This vagueness leads us to base our decision process on a relatively strict phonological model and posit the One Parameter Criterion; in (1).

(1) **The One Parameter Criterion**

A pair of lexemes with equal meaning is classified as variants if their (possibly multiple) differing phonological features fall within only one of the three main categories in the Hand-Tier Model: handshape, place of articulation, or movement. In other cases, a pair of lexemes are classified as synonyms.

Let us look more closely at the decision process. The most straightforward cases constitute pairs of signs that differ in just one feature or a couple of closely related features. Such differences could be found within each of the three main parameters. The signs PRAGUE#1 and PRAGUE#2 illustrate the variation in *hand configuration*. They differ in the selection of fingers and the position of the thumb: PRAGUE#1 selects the pinky, the thumb is extended (). PRAGUE#2 does not select any finger, and the thumb is flexed (). The difference in *movement* is shown on WHY#1 (single movement) and WHY#2 (repeated movement). The pair of COFFEE#1 and COFFEE#2 exemplifies the difference in *place*. COFFEE#1 performs the first contact at the ipsilateral side of the head and the second contact at the contralateral side. In COFFEE#2, all contact is made at the ipsilateral side.

Apart from the intuitively simple cases mentioned above, we have encountered several more complicated pairs. Consider TUNISIA#1 and TUNISIA#2. At first sight, they use different handshapes and movements. In TUNISIA#1, the selected fingers are extended and move from an open to a closed position; the unselected fingers are closed (from  to ). In TUNISIA#2, the selected fingers are curved and closed, and their position does not change; the unselected fingers are open (). BROTHER-IN-LAW#1 and BROTHER-IN-LAW#2 have different places of articulation that influence the orientation of the dominant hand. In BROTHER-IN-LAW#1, the hand contacts the upper part of the trunk, and it is oriented by the radial side to the addressee. In BROTHER-IN-LAW#2, the hand contacts the non-dominant hand; it is oriented by the fingertips to the addressee. Using the detailed phonological model, we propose clear criteria for classifying data of similar complexity (Section 4).

We have seen a brief preview of the practical application of the One Parameter Criterion to classifying multiple pairs of lexemes with various degrees of differences between them. It is important to note that this criterion is only applicable to

monosyllabic signs at this moment. The discussion of the multisyllabic signs would outscope the current article.

3.2 The *Dictio* Database

The data presented in this paper come from *Dictio*, the largest electronic dictionary database of ČZJ up to date. *Dictio* includes online dictionaries of languages of both modalities, sign and spoken (Czech and ČZJ, English and ASL, and others). The heart of the database is the ČZJ dictionary, currently containing more than 12 000 entries. The teams of editors consist of linguists, interpreters, and native signers.

While working on the content of a particular entry, the Deaf editors often discuss alternative ways of expressing the same meaning. Consider, for example, MONDAY#1 with the  -handshape and a path movement with the first contact of the radial side of the hand on the forehead and the second contact on the chin. Using their introspection, the editors registered two more signs with the same meaning: MONDAY#2 (two-handed symmetrical sign with  -handshape, with a repeated circular movement and continuous contact of the hands) and MONDAY#3 (two-handed asymmetrical sign with the  -handshape, articulated with a repeated forward movement and the initial contact on the non-dominant hand). The relation of synonymy is displayed for all three signs; see, for example, the entry for MONDAY#1. The Deaf editors do not distinguish between synonyms and variants. It is the task of the linguistic team to give the exact criteria for filtering the two groups.

As part of that team, we propose a (partial) phonological model for ČZJ that would help us make a clear cut. Our formal apparatus is based on HTM; however, we already included some modifications resulting from our work with ČZJ. The ČZJ examples in this paper and their analyses should be understood as training data. We keep testing the HTM with our modifications against the real data from *Dictio*. Our goal is to map the strong and weak points of the current version of the model on the way to an adequate phonological representation of ČZJ. However, there is still no comprehensive study of ČZJ phonemes. Descriptions of related issues are given in some BA theses (Silovská [2012] on minimal pairs in ČZJ, or Oberfalzerová [2015] focusing on the handshapes). Unfortunately, we are still a long way from a researchbased list of ČZJ phonemes. The rest of the section briefly describes the elicitation of the examples for this paper. More information about the linguistic methodology of *Dictio* can be found in Vlášková and Strachoňová (2021).

Since *Dictio* is an electronic database, it enables to create a list of unique entries with registered synonyms. After generating the list, we went through it manually and filtered out evident synonyms (the sign-pairs that do not share any parameter, as MONDAY#1 and MONDAY#2). The pairs that share at least one parameter (by intuitive evaluation at this point) were included in the training data set. Consider the semiformal description of the pair of signs translated as ‘brother in law’, in (2). (2a) and (2b) evidently share the handshape. We created a formal representation of them by evaluating their relevant phonological features and concluded that they also share the

same movement, differing only in the parameter of the place. Thus, the pair complies with the requirement of a minimal difference (difference in one parameter), and it is classified as variants. See their full specification in the Appendix (Figures A and B).

(2) (a) BROTHER-IN-LAW#1: -handshape, place of articulation: trunk, movement: path, straight, continuous contact
(b) BROTHER-IN-LAW#2: -handshape, place of articulation: non-dominant hand, movement: path, straight, continuous contact

4. Categories and Features in the Revisited HTM

In this section, we discuss in detail the modified HTM. In each subsection, we focus on one of the main categories (the hand configuration, the place, and the movement). We show the strong and weak aspects of Sandler's HTM and make suggestions that account for more accurate descriptions of the contrasts in ČZJ data. The schematic picture of the fully specified model including our modifications is in the Appendix (Figure C).

4.1 The Hand Configuration

The first category of the model is the most complex, as seen in Figure 2. It reflects the shape of the hand(s). In this section, we proceed from the number of hands involved in the articulation to the configuration of the selected and unselected fingers of the dominant hand (the hand that moves).

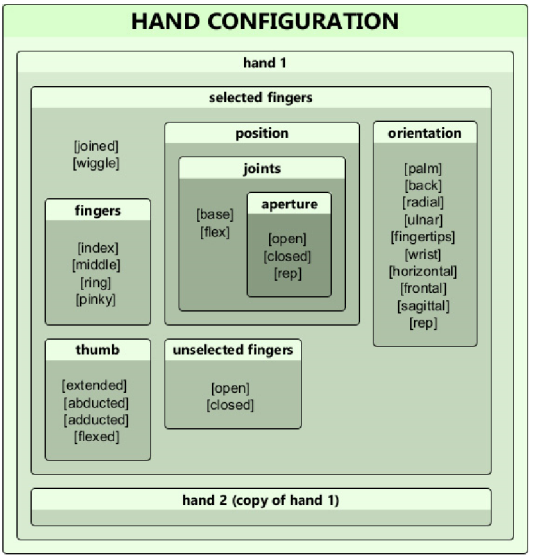

Figure 2. Hand configuration.

4.1.1 The Number of Hands

In ČZJ, as in all known SLs, signs can be articulated with one (dominant) hand or two hands. The two-handed signs are further classified into symmetrical (both hands move) and asymmetrical signs (only the dominant hand moves). For the one-handed signs in HTM, the hand configuration category bears the hand's features (DEAF in the Appendix, Figure D). The phonological form of the two-handed symmetrical signs is described by the Symmetry Condition, in (3).

(3) The Symmetry Condition: (a) if both hands of a sign move independently during its articulation, then (b) both hands must be specified for the same handshape, the same movement (whether performed simultaneously or in alternation), and the specifications for orientation must be either symmetrical or identical.
(Battison 1978 [1973])

Assuming the constraint, the hand configuration node branches and creates a copy of the dominant hand without evaluating the features for the non-dominant hand independently CONSEQUENCE (in the Appendix, Figure E). This architecture reflects the observation that both hands act as equal articulators.The two-handed asymmetrical signs are subject to the Dominance Condition, in (4).

(4) The Dominance Condition: (a) if the hands of a two-handed sign do not share the same specification for handshape (i.e., they are different), then (b) one hand must be passive while the active hand articulates the movement and (c) the specification of the passive handshape is restricted to be one of a small set: A,S,B,G,C,O.
(Battison 1978 [1973])

The HTM parts form the assumption that the non-dominant hand act as a place of articulation. It remains static while the dominant hand performs the movement.[119] Consequently, the complex subcategory of h2 (non-dominant hand) appears under the parameter of *place*. The specification of the dominant hand (h1) remains in the category of hand configuration. See the partial representation of the sign TEST in the Appendix (Figure F).

4.1.2 Selected Fingers

A selected finger is a prominent finger, i.e., extended or otherwise differing from the rest of the fingers (curved index finger in WANT, or the extended index and middle fingers in RESPONSIBILITY). In cases where the handshape is comprised of all fingers in the same position, all fingers are selected (ATOM).

[119] We are aware of borderline cases like SHOW that violate the Symmetry and the Dominance constraint (hands with different shapes moving with continuous contact). However, we must postpone the discussion of such cases on another occasion.

What we intuitively understand as 'fingers' is in HTM divided into two subcategories: *fingers* and *thumb*. The motivation behind asserting an individual feature class to the thumb lies in the higher number of possible positions. Therefore, a special set of features is needed to capture them (Ann 1993; Greftegreff 1993; Sandler 1995).

Let us focus on the first subclass of the selected fingers category: the fingers. In this subclass, there are four features: [index], [middle], [ring] and [pinky]. Specifying a sign for a selected finger (or their combination) means placing the respective feature(s) into the underlying phonological model. Moreover, the feature [joined] is also connected to selected fingers (the contrast between MEANING and IMPORTANT). [joined] is placed outside the fingers class because it can also apply to the thumb.

Various revisions of the HTM employed various features for the thumb position, but we decided to depart from Sandler and consult medical literature (Olson and Pawlina 2008) to describe the anatomical possibilities appropriately. We propose the following set of features, also partly reflected in van der Kooij (2002): [extended]: (EXPLAIN), [abducted]:  (TOGETHER), [adducted]:  (REPEAT), [flexed]:  (KING).

In HTM, there was another thumb feature, [opposed], described as the thumb being in contact with the fingertip of the selected finger(s). We propose to eliminate this feature from the model due to its redundancy. To explain, let us first look more closely at the next class of features called finger position. There are two tiers of contrast: the selected finger(s) can either be [open] (as in OWN) or [closed] (as in FRIEND), and their position can be determined wrt two finger joints. This way we get the minimal pair of FIRST (thumb: [flexed], aperture: [open] + [closed], joints: [flex]) and MINUTE (thumb: [flexed], aperture: [open] + [closed], joints: [flex] + [base]). The feature [closed] involves contact between the thumb and the fingers (Sandler 2006, 154). Thus, every handshape with the thumb touching any finger is sufficiently described with the position feature [closed], making the thumb feature [opposed] redundant.

The last feature subclass of *selected fingers* is *orientation*. The orientation of the hand has long been under discussion. Some researchers treated orientation as a main parameter on a par with handshape, place, and movement (e.g., Battison 1978 [1973]), while others argued for its subordinate position under the handshape parameter (originally in Newkirk et al. 1980). We follow the treatment of HTM and understand orientation as a subclass of the selected fingers category within the handshape parameter. However, we found that the features proposed by Sandler cannot account for the data attested in ČZJ. Sandler uses [palm] when the palm faces the place of articulation and [wrist] in the opposite case. [radial] describes signs with the thumb side of the hand turned towards the place and [ulnar] when the pinky side faces it. [fingertips] is for signs where the hand's fingertips are aimed at the place of articulation,

with no counterpart, although it is anatomically possible (and indeed attested) that such signs can be formed.

Based on the logic that there should be three pairs of features for the six possible ways a hand can be oriented, we propose to add [back] to the model. This feature describes signs where the hand faces the place of articulation with its back, as in YOUR (the counterpart for [palm]). This orientation was formerly analyzed as [wrist], but we have kept the [wrist] feature and redefined it like the hand facing the place of articulation with its wrist (CHILD). For an overview and comparison of Sandler's orientation features and our proposal, see Table 1. To avoid the clash between our and Sandler's understanding of [wrist], we rename the original feature to [back] (the back of a hand).

Sandler's model	[palm]	[wrist]	[radial]	[ulnar]	[fingertips]	∅
Our proposal	[palm]	[back]	[radial]	[ulnar]	[fingertips]	[wrist]
Example from ČZJ	WANT	YOUR	INTERESTING	HALF	TEST	CHILD

Table 1. Comparison of the orientation features

Note that the dominant hand in HALF is not oriented with its ulnar side towards the neutral signing space but the non-dominant hand. We specify the sign by [ulnar] because orientation in HTM is evaluated relative to the place of articulation (the neutral signing space in CHILD, the signer's body in INTERESTING, or h2 in HALF); Sandler (2006, 167).

We propose one important addition to the orientation features: the notion of three spatial planes implemented as features [horizontal], [frontal], and [sagittal] with the mutually disjoint distribution. Such signs would be articulated in alignment with the given plane while also preserving the given orientation. This proposal is motivated by the inability of HTM to properly distinguish the orientation of signs such as TIDY-UP and COMPARE, uniformly described as [wrist]. We avoid this clash by modelling the orientation of TIDY-UP as [wrist] + [sagittal] and the orientation of COMPARE as [wrist] + [horizontal]. Note that not all combinations of orientation and plane features are anatomically possible, i.e., [wrist] + [frontal]. Although the addition of plane features proved useful in distinguishing the orientation of many sign-pairs, some cases still need further attention (e.g., COMPARE and CHILD, both analyzed as [wrist] + [horizontal]).

Finally, two elements bring together the orientation and position subclasses of features: internal and secondary movement. Both the orientation and position features can be branched into two sets, and in that way, multiple (even contradictory) features can be associated with a single hand configuration. Moreover, the branching classes can be temporally linked to a sign's different initial and final locations (Figure G in the Appendix).

The internal movement within a sign with a single location is produced when there are two specifications for orientation (TRANSLATE [palm] and [back]) or finger position (LAMP [closed] and [open]).

The secondary movement, also described as "rapid repetition of handshape or orientation change, or else finger wiggle" (Sandler 2006, 197), is treated by [rep] and [wiggle]. In signs with rapid opening and closing of the fingers (SHOWER), [rep] is added to the subclass of finger position. On the other hand, signs with quick orientation changes (NO) are supplemented with [rep] within the orientation subclass. We follow Sandler (2006), a.o., in understanding the finger wiggle (HOW-MANY) as a type of secondary movement, and model it with a separate [wiggle] feature at the level of selected fingers.

4.1.3 Unselected Fingers

The last subclass of the selected fingers category is the *unselected fingers*. The unselected fingers and their position features ([open], [closed]) are in a subordinate relation wrt to the selected ones. They are dependent on the *selected fingers* and largely predictable. We are following Corina (1993) and her Unselected Fingers Redundancy Rule: "If specified fingers are closed, unspecified fingers are open; otherwise, unspecified fingers are closed." An example of open *unselected fingers* is FRIEND. In KING, the unselected fingers are closed. Both positions are predictable from the Redundancy Rule and therefore are not represented in the underlying model.

Another predictable property of the unselected fingers is the joined vs. spread opposition. We follow Sandler (1995, 121) and her addition to the Redundancy Rule: "When the unselected fingers are open, they must be spread." To the best of our knowledge, this is in accordance with all the ČZJ data attested so far.

However, there are cases where the position of the unselected fingers is not predictable, e.g., in signs with internal or secondary movement. In the absence of Sandler's treatment of such cases, we propose an additional constraint: when the selected finger position is branched, the position of the unselected fingers must be specified in the underlying model. This pertains to signs with internal movement (10-AM vs. WHERE) and with secondary movement (BETTER vs. NOON).

4.2 Place

The category of *place* includes five main areas: the neutral signing space (PRAGUE#1), the trunk (BROTHER-IN-LAW#1), the head (COFFEE#1), the arm (COUNTRY#1), and the non-dominant hand (BROTHER-IN-LAW#2). In HTM, the neutral signing space is considered a default option. Therefore it is not specified with any feature. The rest of the areas is represented by respective values: [trunk], [head], [arm], and a complex subcategory *h2*. Each area is further described with features specifying the exact location (*setting*): [high] for placing the hand higher than the center of the area, [low] for the lower part, [contra] for the part that is on the opposite side

from the dominant hand, [ipsi] for the part that is on the same side, [prox] for the hand in a proximal location, and [dist] for the hand in a distal location; see Figure 3. The category of *place* branches into *locations* in case the sign contains a path movement (NORMAL). Each location is then specified with *setting* features, as in Figure 4.

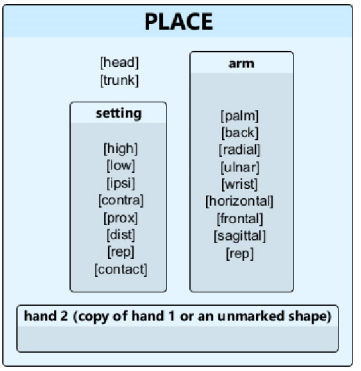

Figure 3. Place of articulation.

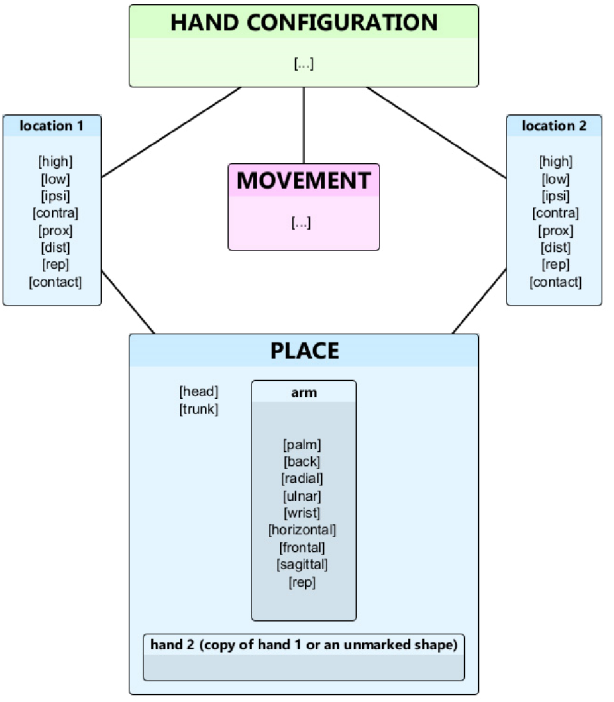

Figure 4. Place of articulation branching into two locations.

Examples from ČZJ illustrating the specific location features are the following: THINK ([head], [high], [ipsi], [prox]), THROW ([head], [high], [ipsi], [dist]), RED ([head], [low]), FRIEND ([trunk], [high], [contra]). The signs articulated in the middle of the neutral space (AREA) do not have any *place* features since this configuration is considered the default. FATHER contains two locations (L1, L2): the movement begins at the forehead (L1: [head], [high]), and it ends at the chin (L2: [head], [low]). The same features transfer to the non-dominant hand, which serves as a place of articulation in two-handed asymmetrical signs. Consider BEGINNING: The movement of the dominant hand starts with the contact on the fingertips of the non-dominant hand. The dominant hand moves with continuous contact toward the wrist of the non-dominant hand. The specification for place contains two locations (L1: h2 and [high]; L2: h2 and [low]).

Sandler (2006, 171) pointed out that in signs that contain both the internal movement and the path movement, the first position of the fingers temporally coincides with the first location; and analogically for the second position and location. Consider an example HOME. The hand starts from the proximal location to the *head*. All selected fingers and thumb are extended and open (). While moving to the distal location from the head, the hand keeps closing. At the final location, the fingers are closed (). The correspondence between the two finger positions and the two locations of the hand is captured by the link between the branching nodes of the *hand configuration* category and the category of *place*. See Figures G–J in the Appendix for AREA, FATHER, BEGINNING, and HOME.

The non-dominant hand (h2) is a complex subcategory within the *place*. Besides the features employed for the rest of the areas, *h2* inherits the specifications for hand configuration. The shape of h2 in two-handed asymmetrical signs is defined by the Dominance Condition (in (4) above) and revisited by Sandler, who pointed out that h2 either has one of the unmarked shapes or as a copy, it mimics the shape of h1 (Sandler 2006, 184). The HTM implements the Dominance Condition by allowing the handshape specification of *h2* to be as complex as the specification of *h1* (in case h2 is a copy). ČZJ can provide examples of variant pairs that exploit both strategies. Consider the pair of COUNTRY#1 (unmarked shape on h2) and COUNTRY#2 (h2 copies h1).

The boundary between the area of the non-dominant hand and the arm is defined by the wrist (belonging to h2).[120] In our modifications of HTM, we suggest the extension of the orientation features to the *arm* (as an area that shares certain physiological properties of h2).[5] In HTM, the *arm* is a simple feature within the category of *place*. By adding the set of orientation features, we redefine *arm* as a

[120] A similar transitive area is between the *head* and the *trunk* (the neck forms part of the *head*).

5 Only the orientation features that are physiologically possible are inherited (that excludes, e.g., [fingertips]).

complex subcategory. This update allows us to adequately describe the difference, e.g., between signs that employ contact on the opposite sides of the forearm (COUNTRY#1 vs. BLOOD).

The last two features are [contact] and [rep] (repetition). [contact] can be placed on the main area of articulation (MASK: [head] and [contact]), on one of the two locations (APARTMENT: [contact] on L2), or at both locations (COFFEE#1). COFFEE#2 shows the application of [rep] with [contact] on *head*, specified by location features [low] and [ipsi]; See Figure K in the Appendix for the full specification.

4.3 Movement

The movement category is the simplest among the three; see Figure 5. It covers only the primary (path) movement. As we have explained in Section 4.1.2, the secondary and internal movements are accounted for in the hand configuration category.

Figure 5. Movement.

It is common (Sandler 2006, a.o.) to account for signs with a straight movement between L1 and L2 as having no movement features (FATHER). When two locations are determined between which the hand(s) must move, a straight path is a phonetic necessity.

When [contact] is defined on movement, two situations are possible: (i) the sign exhibits a *brushing* movement (the hand only touches the place during the movement and not on the locations; NUDE); or (ii) the sign exhibits a *continuous* contact (the hand touches the place throughout the whole articulation; TEA); Sandler (2006, 202).

The circular movement is more complex. We follow Sandler (1989, 1990, 2006) and Corina (1990) in modeling circular movements as a series of arcs with opposite concavity. The default arc movement defined with [arc] (WORLD) is concave, meaning that both L1 and L2 are closer to the body or the middle of the signing space than the midpoint of the movement. The opposite effect is derived by [convex] (DRESS). When combined, these features describe a circular movement (HOUR).

However, HTM could not account for distinctions between a near-minimal pair of signs such as HOUR and WE. The two signs would have to be defined in the same way wrt to their place, and movement (L1 in the middle of the neutral space, L2 on the ipsilateral side of the neutral space; and the movement between them as a series of arcs defined for [arc] and [convex]). Such a model does not reveal the difference between the two movements without the additional features for the planes. The features can

distinguish the movements in the horizontal (WE), frontal (HOUR), and sagittal (YEAR) plane. Therefore, we propose adding the corresponding features to the movement segment as well.

Another feature that has already been mentioned is [rep]. When applied individually, it gives rise to signs with a repeated straight path movement between two locations (TOURISM). In combination with [contact], we get signs such as BATHROOM, where the hand(s) contact the place of articulation or each other during the repeated movement. The most complex case is represented by signs such as TORNADO#1 and TORNADO#2 (combination of [arc], [convex], and [rep]). We part from the HTM here. Sandler regards every arc as an individual temporal segment, but this prevents her from combining circular and path movements (TORNADO#2). In our solution, the circular movement fills a regular timing slot for movements, which accounts for TORNADO#1, and is also compatible with defined initial ([high], [ipsi]) and final ([low], [ipsi]) locations (TORNADO#2). In this way, we account for the simultaneous articulation of the path and the circular movement.

There are other types of path movements attested in the literature and also in ČZJ (FAMOUS or THREE), a so-called α-movement (FACTORY; Pfau and Quer 2007), or the ASL movement '7' (Sandler 2006, 197). Some of these could be considered iconic movements, together with the movement in classifier constructions, and therefore are not part of the underlying phonological representation. In any case, more research in this area is needed to determine what is the correct way of analyzing these types of complex movements.

5. Conclusion

The HTM outlined above has proven to be useful in describing ASL and ČZJ data. However, in applying the HTM descriptions to ČZJ, we encountered some theoretical problems of the model, to which we proposed solutions based on certain refinements. The main adjustments are: (i) addition of features [horizontal], [frontal], and [sagittal] into the categories of handshape (namely orientation) and movement in order to propose a solution to the problems of phonologically distinguishing certain types of hand orientation or movement direction; (ii) explicitly characterizing the position and conditions of use of the [rep] within all three main parameters; (iii) addition of the orientation feature [back] and the redefinition of [wrist], according to the anatomical possibilities of the hand orientation; (iv) removal of the thumb feature [opposed] due to its redundancy; and (v) redefinition of the *arm* as a subcategory of the place parameter with its orientation features, rather than keeping it as an individual feature [arm].

6. References

Anderson, John, and Colin Ewen. 1987. *Principles of Dependency Phonology*. Cambridge: Cambridge University Press.

Ann, Jean. 1993. "A Linguistic Investigation into the Relation Between Physiology and Handshape." PhD diss., University of Arizona.

Aronoff, Mark, Irit Meir, Carol Padden, and Wendy Sandler. 2004. "Morphological Universals and the Sign Language Type." In *Yearbook of Morphology 2004*, edited by Geert Booij and Jaap van Marle, 19–39. Dordrecht: Kluwer.

Battison, Robbin. 1978 [1973]. *Lexical Borrowing in American Sign Language*. Silver Spring: Linstok Press.

Brentari, Diane. 1998. *A Prosodic Model of Sign Language Phonology*. Cambridge, MA: MIT Press.

Clements, George N. 1985. "The Geometry of Phonological Features." *Phonology* 2 (1): 225–252.

Corina, David. 1990. "Reassessing the Role of Sonority in Syllable Structure: Evidence from Visual-Gestural Language." *Papers from the Chicago Linguistic Society* 26 (2): 33–44.

Corina, David. 1993. "To Branch or Not to Branch: Underspecification in ASL Handshape Contours." In *Current Issues in ASL Phonology*, edited by Geoffrey R. Coulter, 63–95. New York: Academic Press.

Dictio: Multilingual Online Dictionary. 2020. Brno: Masaryk University. Accessed October 31, 2021. www.dictio.info.

Durand, Jacques. 1986. *Dependency and Non-Linear Phonology*. London: Croom Helm.

Channon, Rachel. 2002a. "Beads on a String? Representations of Repetition in Spoken and Signed Languages." In *Modality and Structure in Signed and Spoken Language*, edited by Richard P. Meier, Kearsy Cormier, and David Quinto-Pozos, 65–87. Cambridge: Cambridge University Press.

Channon, Rachel. 2002b. "Signs Are Single Segments: Phonological Representations and Temporal Sequencing in ASL and Other Sign Languages." PhD diss., University of Maryland.

Čermák, František. 1995. "Paradigmatika a syntagmatika slovníku: možnosti a výhledy." In *Manuál lexikografie*, edited by František Čermák and Renata Blatná, 90–115. Jinočany: H&H.

Fenlon, Jordan, Kearsy Cormier, and Adam Schembri. 2015. "Building BSL SignBank: The Lemma Dilemma Revisited." *International Journal of Lexicography* 28 (2): 169–206.

Filipec, Josef. 1995. "Teorie a praxe jednojazyčného slovníku výkladového." In *Manuál lexikografie*, edited by František Čermák and Renata Blatná, 14–49. Jinočany: H&H.

Greftegreff, Irene. 1993. "Anatomy and Features in Sign Language Handshapes." Ms., University of Trondheim.

Liddell, Scott K. 1984. "THINK and BELIEVE: Sequentiality in American Sign Language." *Language* 60: 372–392.

Liddell, Scott K. 1990. "Structures for Representing Handshape and Local Movement at the Phonemic Level." In *Theoretical Issues in Sign Language Research*, edited by Susan Fischer and Patricia Siple, 37–65. Chicago: Chicago University Press.

Liddell, Scott K., and Robert E. Johnson. 1989 [1985]. "American Sign Language: The Phonological Base." *Sign Language Studies* 64 (1): 195–277.

Newkirk, Don, Ed Klima, Carlene Canady Pedersen, and Ursula Bellugi. 1980. "Linguistic Evidence from Slips of the Hand". In *Errors in Linguistic Performance: Slips of the Tongue and Hand*, edited by Victoria Fromkin, 165–197. New York: Academic Press.

Oberfalzerová, Anna. 2015. "Tvary ruky českého znakového jazyka a typy jeho znaků (frekvenční analýza komunikace českých neslyšících)." Bachelor's thesis. Charles University in Prague.

Olson, Todd R. and Wojciech Pawlina. 2008. "Upper Limb." In *A.D.A.M. Student Atlas of Anatomy*, edited by Todd R. Olson and Wojciech Pawlina, 277–346. Cambridge: Cambridge University Press.

Perlmutter, David. 1992 [1993]. "Sonority and Syllable Structure in American Sign Language." *Linguistic Inquiry* 23: 407–442.

Pfau, Roland and Josep Quer. 2007. "On the Syntax of Negation and Modals in German Sign Language (DGS) and Catalan Sign Language (LSC)." In *Visible Variation: Cross-linguistic Studies on* Sign Language Structure, edited by Pamela Perniss, Roland Pfau, and Markus Steinbach, 129–161. Berlin: Mouton de Gruyter.

Sagey, Elizabeth. 1986. "The Representation of Features and Relations in Non-linear Phonology." PhD diss., MIT.

Sandler, Wendy. 1986. "The Spreading Hand Autosegment of American Sign Language". *Sign Language Studies* 50: 1–28.

Sandler, Wendy. 1987a. "Assimilation and Feature Hierarchy in American Sign Language." *Papers from the Chicago Linguistic Society, Parasession on Autosegmental and Metrical Phonology*: 266–278. Chicago: Chicago Linguistic Society.

Sandler, Wendy. 1987b. "Sequentiality and Simultaneity in American Sign Language." PhD diss., University of Texas.

Sandler, Wendy. 1989. *Phonological Representation of the Sign: Linearity and Nonlinearity in American Sign Language*. Berlin: Walter de Gruyter.

Sandler, Wendy. 1990. "Temporal Aspect and American Sign Language." In *Theoretical Issues in Sign Language Research*, edited by Susan Fischer and Patricia Siple, 103–129. Chicago: University of Chicago Press.

Sandler, Wendy. 1995. "Markedness in the Handshapes of Signs: A Componential Analysis." In *Leiden in Last: Holland Institute of Linguistics Phonology Papers*, edited by Jeroen van der Weijer and Harry van der Hulst, 369–399. The Hague: Holland Academie Graphics.

Sandler, Wendy. 2006. "Phonology." In *Sign Language and Linguistic Universals*, edited by Wendy Sandler and Diane Lillo-Martin, 111–278. New York: Cambridge University Press.

Silovská, Zuzana. 2012. "Minimální páry v českém znakovém jazyce." Bachelor's thesis. Charles University in Prague.

Stokoe, William C. 1960. "Sign Language Structure: An Outline of the Visual Communication Systems of the American Deaf." *Studies in Linguistics: Occasional Papers*. Buffalo: University of Buffalo. van der Hulst, Harry. 1989. "Atoms of Segmental Structure: Components, Gestures and Dependency." *Phonology* 6: 253–284.

van der Hulst, Harry. 1993. "Units in the Analysis of Signs." *Phonology* 10: 209–242.

van der Kooij, Els. 1998. "The Position of Unselected Fingers." In *Linguistics in the Netherlands 1998*, edited by Renée van Bezooijen and René Kager, 149–162. Amsterdam: John Benjamins.

van der Kooij, Els. 2002. "Phonological Categories in Sign Language of the Netherlands: The Role of Phonetic Implementation and Iconicity." PhD diss., Netherlands Graduate School of Linguistics.

Vlášková, Lucia, and Hana Strachoňová. 2021. "Sign Language Lexicography: A Case Study of an Online Dictionary." *Slovenščina 2.0: Empirical, Applied and Interdisciplinary Research* 9 (1): 90–122. Accessed October 31, 2021. https://revije.ff.uni-lj.si/slovenscina2/article/view/9860.

Zeshan, Ulrike. 2003. "Towards a Notion of 'Word' in Sign Languages." In *Word: A Cross-linguistic Typology*, edited by Robert M. W. Dixon and Alexandra Y. Aikhenvald, 153–179. Cambridge: Cambridge University Press.

7. Appendix

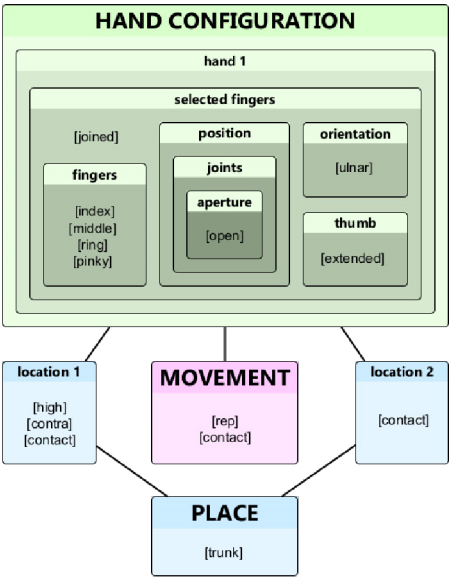

Figure A. BROTHERTON-LOW#1.

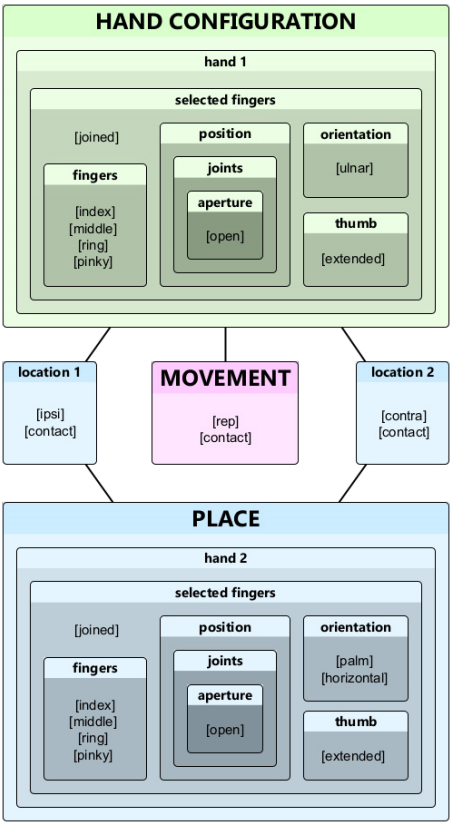

Figure B. BROTHERTON-LOW#2.

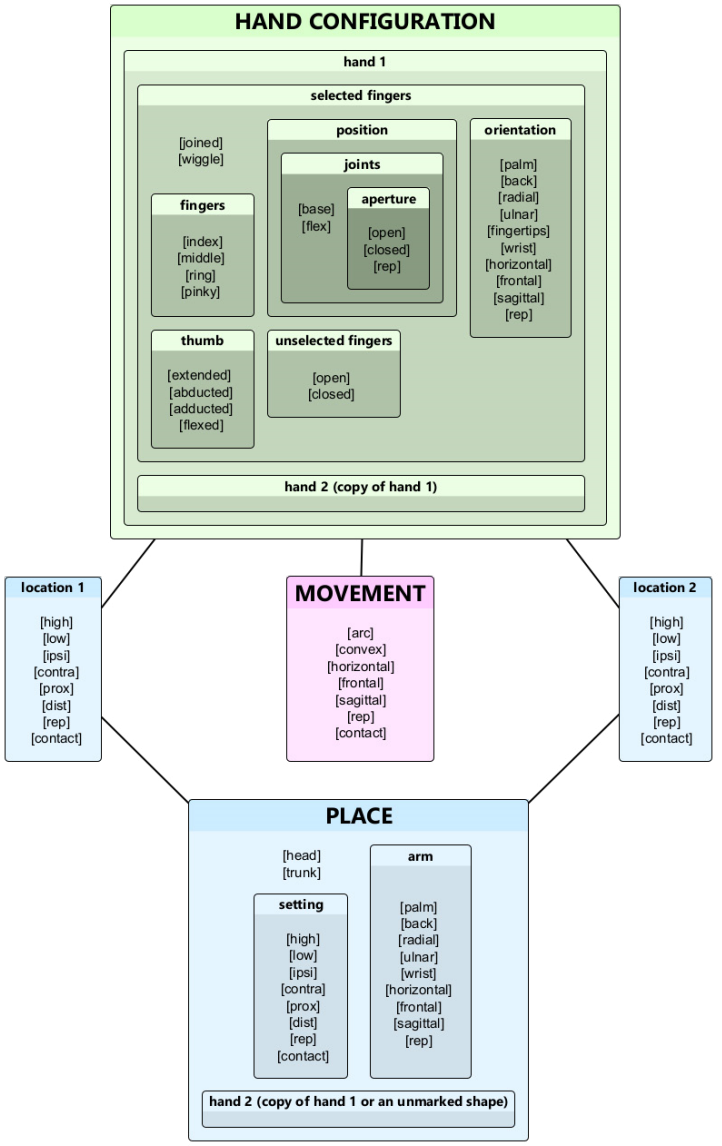

Figure C. HTM with terminal features.

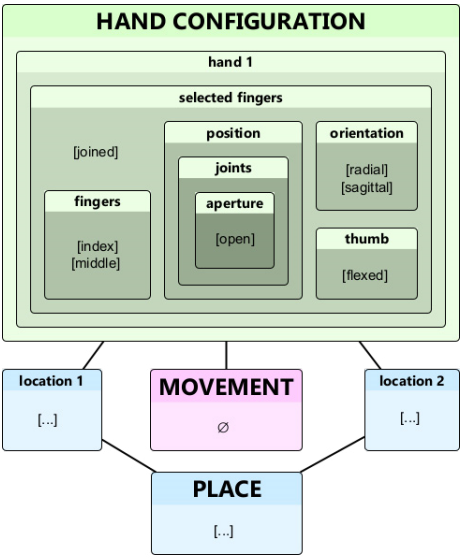

Figure D. DE F.

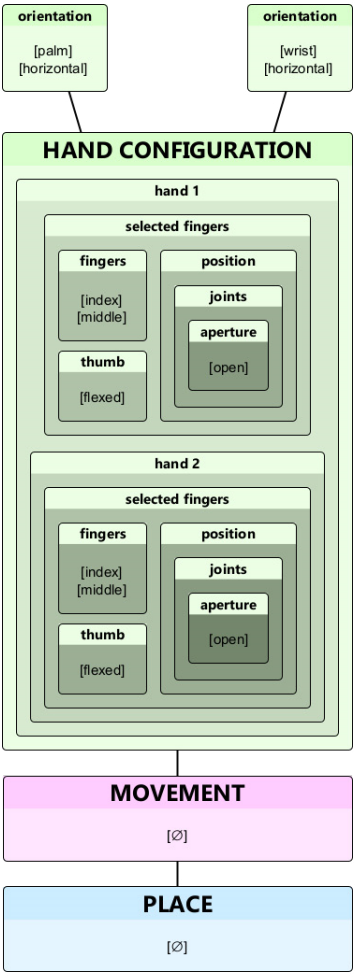

Figure E. CONSEQUENC

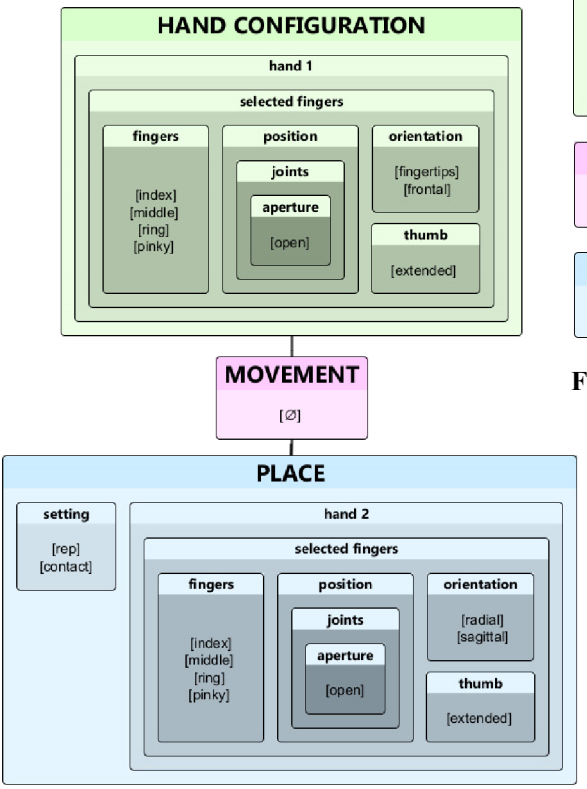

Figure F. TET.

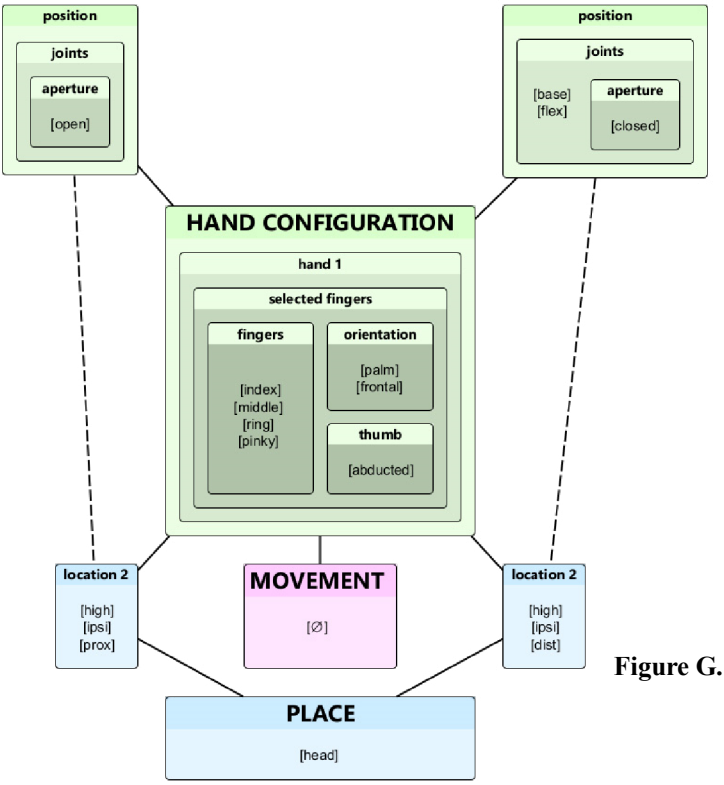

Figure G. HOME

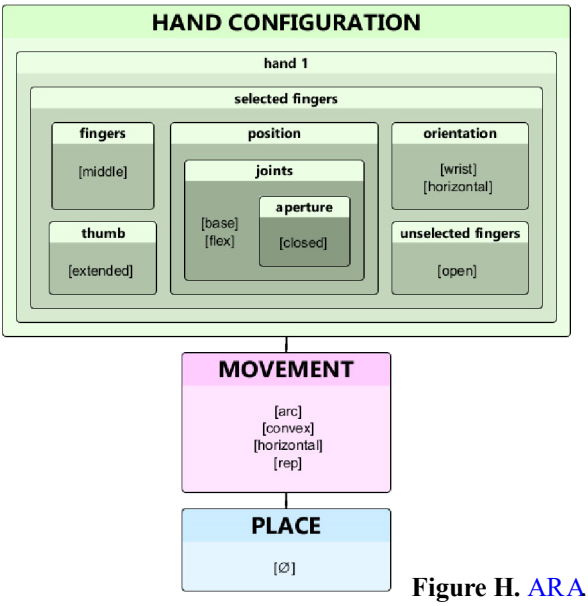

Figure H. ARA

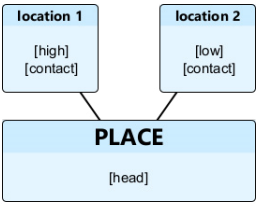

Figure I. FATHER.

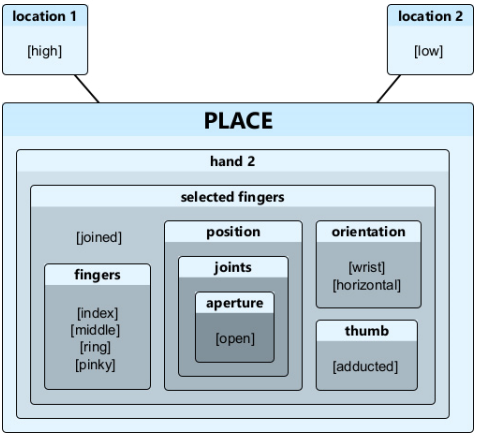

Figure J. BEGINNING.

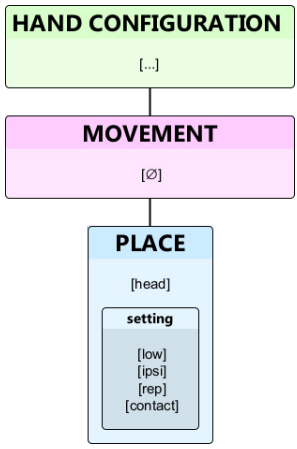

Figure K. COFFEE#2.

Language Use and Linguistic Structure
Proceedings of the Olomouc Linguistics Colloquium 2021

June 10–12, 2021
Faculty of Arts, Palacký University Olomouc, Czech Republic http://olinco.upol.cz e-mail: olinco@upol.cz

Edited by Markéta Janebová, Joseph Emonds, and Ludmila Veselovská
Series: Olomouc Modern Language Series In-house editor: Otakar Loutocký
Typesetting and cover design: Gobak DTP

Published by Palacký University Olomouc
Křížkovského 8, 771 47 Olomouc, Czech Republic
vydavatelstvi.upol.cz Olomouc 2022

First edition

ISBN 978-80-244-6148-9
(online: iPDF; available at https://anglistika.upol.cz/olinco2021proceedings/)

DOI: 10.5507/ff.22.24461489

Not for sale