

The Nature of Verbs in Sign Languages: A Role and Reference Grammar account of Irish Sign Language Verbs

Irene Murtagh

Technological University Dublin

irene.murtagh@tudublin.ie

Abstract

This paper is concerned with the special nature of sign language verbs, in particular to this research, Irish Sign Language verbs. We use Role and Reference Grammar to provide a definition of the structure of lexical entries that are sufficiently rich and robust in nature to represent Irish Sign Language verbs. Role and Reference Grammar takes language to be a system of communicative social action, and accordingly, analysing the communicative functions of grammatical structures plays a vital role in grammatical description and theory from this perspective. This work is part of research on the development of a linguistically motivated computational framework for Irish Sign Language. In providing a definition of a linguistically motivated computational model for Irish Sign Language we must be able to refer to the various articulators (hands, fingers, eyes, eyebrows etc.), as these are what we use to articulate the various phonemes, morphemes and lexemes of an utterance. Irish Sign Language is a visual gestural language. The fact that Irish Sign Language has no written or oral form means that, for us to represent an Irish Sign Language utterance in computational terms we must implement the use of a humanoid avatar capable of movement within three-dimensional space. Here, we provide an account of the grammatical information that can be found within Irish Sign Language verbs. We use the Signs of Ireland corpus to access the relevant linguistic data pertinent to Irish Sign Language. Further to this we use ELAN software as an application tool, which allows us to view the corpus and collate relevant linguistic phenomena pertinent to Irish Sign Language. We utilise the Event Visibility Hypothesis in the development of our proposed lexicon architecture. The computational phonological parameters for Irish Sign Language manual features and non manual features are defined within a framework, which we refer to as *the Sign_A framework*, where the “A” within this

title refers to *Articulatory Structure Level*. We leverage the Sign_A framework, and in particular, Articulatory Structure Level, in the development of a linguistically motivated computational definition of lexicon entries that are sufficiently robust in nature to represent ISL verbs within the Role and Reference Grammar lexicon.

Keywords: *Role and Reference Grammar; Generative Lexicon Theory; Sign_A framework Articulatory Structure Level; Event Visibility Hypothesis; Irish Sign language; Irish Sign Language Verbs*

1. Introduction

This paper is concerned with the investigation of the nature of sign language verbs and the architecture of Role and Reference Grammar (RRG) lexicon entries for SL verbs, in particular Irish Sign Language (ISL) verbs. We investigate the nature of ISL verbs and the challenges involved in the development of a lexicon entry that is capable of representing lexical information pertinent to ISL verbs. Sign Languages (SLs) are visual gestural languages articulated within gestural space (Rathmann & Mathur, 2002). SLs have no written form. ISL (O Baoill & Matthews, 2000; Leeson & Saeed, 2012) is a linguistically complete and very complex language. Communication occurs using a visual-gestural modality, encompassing manual and non-manual gestures. Manual gestures make use of hand forms, hand locations, hand movements and orientations of the palm. Non-manual gestures include the use of eye gaze, facial expression, head and upper body movements. Within the field of spoken language linguistics, a wealth of research has been carried out in relation to verb categorisation and classification. Levin (1993) provides a comprehensive taxonomy of over 3000 verbs from spoken English based on the properties of shared meaning and behaviour. He takes the view that the meaning of a verb affects its syntactic behaviour and he provides us with numerous verb classes by distinguishing verbs with similar syntactic behaviour. In relation to SLs, verb classification is traditionally described according to Padden's (1998) classical tripartite classification of verbs based on American Sign Language (ASL), which has more recently been revisited (Meir et al. 2007). However, the tri-partite verb theory has been, in most cases, universally accepted.

In this paper we provide an account of the grammatical information that can be found within ISL verbs. We provide an analysis of the Signs of Ireland (SOI) corpus (Leeson et al., 2006) and of the literature within the field in relation to the linguistic phenomena associated with ISL. Johnston and Schembri (2007, pp. 163–169) outline the difficulties involved in the analysis of SLs. With regard to our analysis of ISL verbs and data used, we look initially to the SOI corpus for data examples which allows us to provide still images of the phenomena together with a glossed example and the English translation. Where we use data from the SOI corpus we also provide a reference to the participant, the data source number and also location information. All of this information is provided by the SOI corpus.

With regard to glossing, Pizzutto and Pietrandres (2011) identify the difficulties that can occur when glossing SL data with English tags. Taking this into account, we provide as many images from the original SOI data source as is possible due to illustrate the signed examples directly. Like Leeson and Saeed (2012), we follow Johnston (2001) in our approach to glossing. In an attempt to limit imposing variable lexical and grammatical information on the data, sentences were glossed using an ID-gloss for all variations of a single form. Where certain examples are particularly relevant, we also use literature from the field in the development of this framework, referencing them appropriately.

We utilise the Event Visibility Hypothesis (EVH) (Wilbur 2008) in the development of our proposed lexicon architecture. We leverage Articulatory Structure Level (Murtagh, 2018) in the development of a linguistically motivated computational definition of lexicon entries that are sufficiently robust in nature to represent ISL verbs within the RRG lexicon. We utilise this newly proposed level of lexical representation, which describes the essential (computational) phonological parameters of an object as defined by the lexical item to cater specifically for the computational linguistic phenomena consistent with signed languages. These parameters will be used to account for various linguistic phenomena pertaining to ISL manual features (MFs) non manual features (NMFs), which are necessary to adequately represent ISL within our computational framework. We refer to our newly developed framework as the Sign_A framework, with the “A” within this term representing Articulatory Structure Level. We leverage our proposed Articulatory Structure Level for lexical meaning to accommodate the linguistic phenomena consistent with ISL and to develop a lexicon architecture capable of accommodating ISL in computational linguistic terms.

2. Irish Sign Language

ISL is a linguistically complete, rich and complex language. Communication within a sign language community occurs using the visual-gestural modality, encompassing MFs and NMFs. MFs include hand shapes, hand locations, hand movements and orientation of the palm of the hands. NMFs include the use of eye gaze, facial expression, mouthing, head and upper body movements. The visual gestural realisation of a word in SL involves the simultaneous and parallel expression of a varied number of MFs and NMFs, each with their own duration, orientation and relative configuration and movement.

As discussed previously, verb classification within SL is traditionally described according to Padden's classical tripartite classification of American Sign Language (ASL) verbs (Padden, 1988). The original theory has subsequently been re-visited, but Padden's observation, which was in most cases universally accepted, is that SL verbs fall into one of three categories: *plain* verbs, *spatial* verbs and *agreeing* verbs. Padden initially named agreeing verbs as inflecting verbs but subsequently changed the term to agreeing verb.

SL verb classes can be differentiated between depending upon the arguments that they encode. Not all SL verbs use a phonological shift in orientation or direction of movement to reflect a change semantically. According to Padden (1988) *plain verbs* are verbs that constitute the default semantic class. Plain verbs do not encode any grammatical features of their arguments. They do not encode morphological information for person and number by movement and do not show agreement with either subject or object. Plain verbs are uninflected and do not take agreement affixes. *Agreeing verbs*, which agree with the subject and/or object, are a class of verbs that denote transfer and are said to encode the syntactic role of the arguments, as well as their person and number features, via the direction of the movement of the hands and the orientation of the palms. Agreeing verb affixes show agreement with person or location. *Spatial verbs* are verbs that denote motion and location in space. Spatial verbs encode the locations of locative arguments (the source and the goal), based on the direction of movement of the hands. The shape of the path movement the hands are tracing often depicts the shape of the path that an object traverses in space. Figure 1 illustrates the three verb categories proposed by Padden (1988) in the tripartite theory of verbs.

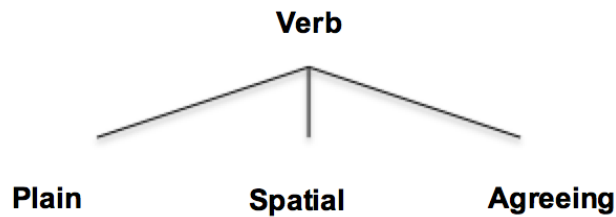


Figure 1: Tripartite verb classes (Padden 1988)

Verbs in ISL, similar to other SLs, are identified as belonging to one of three morphological classes: plain, agreement, (or, in Padden's (1988) words, 'agreeing' verbs) or classifier verbs (McDonnell 1996). In more recent literature, classifier verbs and classifier predicates are more commonly referred to as depicting verbs (Liddell, 2003). Figure 2 taken from McDonnell (1996, p. 109, Figure 3.14), provides an illustration of ISL verb classes and their respective sub-classes. McDonnell (*ibid.*) reports that plain verbs in ISL do not take affixes, whereas agreement verbs take affixes, which mark for person or location, altering the form of the verb in different contexts. McDonnell (*ibid.*) identifies that in relation to locative agreement verbs a separate distinction is made between locative verbs and classifier predicates of motion and location. Here, classifier predicates present a hand configuration that provides both a morphological and a phonological function, whereas in agreement and plain verbs, hand configuration provides a phonological function only. This study will focus in particular on ISL plain and ISL agreement verbs. Depicting verbs will not be considered within the scope of this study.

McDonnell (1996) distinguishes between ISL between plain verbs, which are uninflected and do not take agreement affixes, and agreement verbs, which show agreement with both person and location. He also suggests that ISL agreement verbs may be further sub-divided into those that show *person agreement* with subject/actor or object/undergoer and those whose affixes are controlled by locations (*locative agreement*).

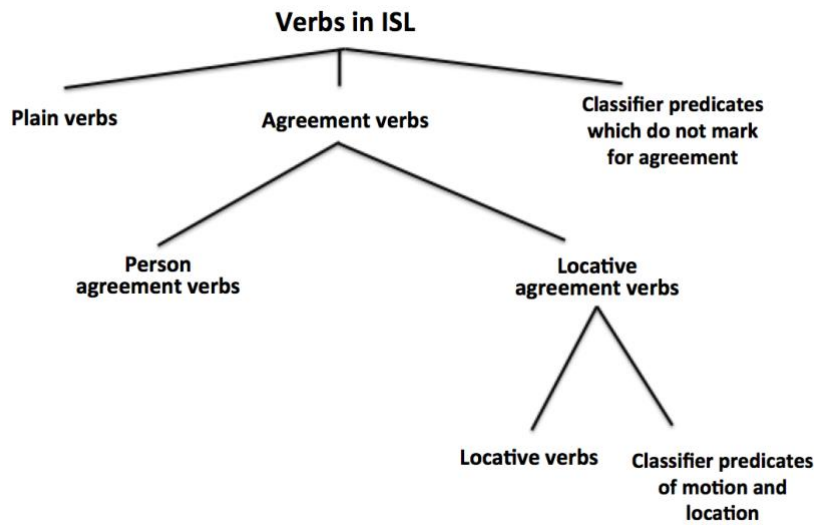


Figure 2: Categories of Verbs in Irish Sign Language, (McDonnell 2006: 109, Figure 3.14)

2.1. Plain verbs

Plain or unmarked verbs are seen as the default semantic verb class in SL and they do not move through space to show grammatical information. Any information regarding person or number needs to be provided separately. Many plain verbs are body-anchored (that is, they are articulated on the body) (Leeson & Saeed, 2012), however, this is not always the case (Sutton-Spence & Woll, 1999). Indeed, Sutton-Spence & Woll (ibid.) provide the following list of body-anchored plain verbs in British Sign Language (BSL): LIKE, LOVE, THINK, KNOW, SMOKE, UNDERSTAND, FEEL, SWEAR, WANT. Other BSL verbs, which are also plain but not body-anchored include: SWIM, RIDE-A-BICYCLE, RUN and RESEARCH. Manner and aspect can be marked on plain verbs in BSL via speed of repetition and also by the use of NMFs.

McDonnell (2006, p. 116) provides evidence that ISL plain verbs do not take affixes which mark for person or locative agreement. McDonnell (ibid.) also points out that ISL plain verbs are typically contact or body anchored signs. He notes that ISL plain verbs typically occur within semantically related fields, “and there is often a motivated relationship between the forms which these verbs take and their meanings”. Examples provided for verbs of emotion, which occur in the chest/sternum area include LIKE, FEEL, BE-ANGRY, HATE, HAPPY and BE-FRUSTRATED. Figure 3, taken from the SOI corpus, provides an example of the ISL plain verb LOVE, articulated on the signer’s torso.



Figure 3: ISL Plain Verb Love: (I) like (it), Signs Of Ireland Corpus Noeleen (03) Personal Stories (Dublin)

2.2. Agreement verbs

Agreement verbs allow the signer to indicate the subject and the object by changing the direction of the movement and the orientation of the sign (Mathur & Rathmann, 2012). Mathur and Rathmann (ibid.) identify the occurrence of verb agreement in many SLs including but not limited to ASL (Padden, 1983), Argentine Sign Language (Massone & Curiel, 2004), Australian Sign Language (Johnston & Schembri, 2007), Brazilian Sign Language (Quadros, 1999), British Sign Language (Sutton-Spence & Woll, 1999), German Sign Language (Rathmann, 2000), Greek Sign Language (Sapountzaki, 2005), Indo-Pakistani Sign Language (Zeshan, 2000), Israeli Sign Language (Meir, 1998b), Japanese Sign Language (Fischer, 1996), Korean Sign Language (Hong, 2008), Sign Language of the Netherlands (Bos, 1994; Zwitserlood & Van Gijn, 2006), and Taiwanese Sign Language (Smith, 1990). Contrary to this view, Liddell (2003, p. 52) argues that directing verbs in space has nothing to do with an agreement process and is not inflectional in nature.

McDonnell (1996) argues for the existence of agreement verbs in ISL, sub-dividing these into sub-categories that show *person agreement* with subject/actor or object/undergoer and those whose affixes are controlled by locations (*locative agreement*).

Person agreement in ISL may be described with respect to the following subcategories: single, double, backwards and reciprocal agreement. Locative agreement verbs on the other hand, are verbs that are morphologically linked to locations rather than participants. Leeson and Saeed (2012) describe how, in semantic terms, locative agreement agrees with the source, goal or location, rather than actor or undergoer. They note that that locative agreement

provides the location of an entity or the path of its movement. McDonnell (1996) identifies a subclass of locative agreement within ISL where agreement is marked at specific locations on the body as opposed to specific locations in space. An example of this is: SLAP, where the verb SLAP can be associated with a location on the body, for example on the face.

3. Articulatory Structure Level

Prior to preparing a linguistically motivated computational definition of verb lexicon entries that are sufficient to represent ISL verbs within the RRG lexicon, we must first define ISL phonological parameters in computational terms. A prerequisite in the provision of a definition of a linguistically motivated computational model for ISL is the capacity to refer to the various articulators (hands, fingers, eyes, eyebrows etc.), as these are what we use to articulate various phonemes, morphemes and lexemes of an utterance (Murtagh, 2019b). We leverage the use of a humanoid avatar capable of movement within three-dimensional (3D) space in order to communicate an ISL utterance in computational terms. This provides us with tangible computational parameters for implementation within our lexicon architecture.

Our proposed new level of lexical representation: *Articulatory Structure Level*, caters specifically for the computational linguistic phenomena consistent with signed languages. For the purposes of this research, *Articulatory Structure Level* enables us to adequately represent ISL within the RRG lexicon (Murtagh, 2019a). We leverage our proposed new level of lexical representation, which describes the essential (computational) phonological parameters of an object as defined by the lexical item.

3.1. Generative lexicon theory

Pustejovsky (1995) defines the Generative Lexicon (GL) as a theory of linguistic semantics, which focuses on the distributed nature of compositionality in natural language. Aristotle proposed that there are four basic factors or causes by which an object can be described (Kronlid, 2003). Pustejovsky (1991a) applied these basic Aristotelean principles (Lloyd, 1968) in the development of the generative lexicon (GL) framework. Table 1 illustrates Pustejovsky's proposal that lexical meaning could best be captured by assuming four levels of lexical representation.

Lexical Representation Level	Description
<i>Argument Structure</i>	The behaviour of a word as a function, with its arity (number of arguments) specified. This is the predicate argument structure for a word, which indicates how it maps to syntactic expressions.
<i>Event Structure</i>	Identification of the particular event type (in the sense of Vendler (1967)) for a word or phrase: e.g. as state, process, or transition.
<i>Qualia Structure</i>	The essential attributes of an object as defined by the lexical item.
<i>Inheritance Structure</i>	How the word is globally related to other concepts in the lexicon.

Table 1: Lexical meaning representation levels (Pustejovsky 1991a)

The representation levels for lexical meaning, illustrated in Table 1, and as defined by Pustejovsky (1995), are the modes of explanation associated with a word or phrase. Qualia provide a description of the meaning of lexical items in terms of four roles. An example to illustrate the roles provided by Pustejovsky (1991a) and re-interpreted by Van Valin (2005) is provided in (1).

(1) **Minimal semantic description for the noun “novel” (Van Valin 2005).**

Novel (y)_{SEP}^[L]

Const: **narrative**(y)_{SEP}^[L]

Form: **book**(y), **disk**(y)_{SEP}^[L]

Telic: **do** (x, [**read** x,y])_{SEP}^[L]

Agentive: **artifact**(y), do (x, [**write** (x,y)] & INGR **exist** (y))

3.2. Lexical meaning for Irish Sign Language

Bearing in mind the computational phonological parameters necessary to represent an ISL utterance and taking into account Pustejovsky’s proposal (Pustejovsky, 1991a) that lexical meaning could best be captured by assuming four levels of representation, We propose that in order to create a lexicon architecture which is sufficiently rich in nature to capture the

linguistic phenomena consistent with ISL, the number of levels of lexical representation available within the GL framework should be extended from 4 levels to 5. It is proposed an entirely new level of representation for lexical meaning be developed to capture the linguistic phenomena consistent with ISL. The computational phonological parameters of ISL (Murtagh, 2018), account for various linguistic phenomena pertaining to ISL Manual Features (MFs) and Non-Manual Features (NMFs). We refer to this new level of information structure as *Articulatory Structure Level*. Figure 4 provides the five levels of lexical representation for SL. We illustrate the four levels of lexical meaning proposed by Pustejovsky (1991a) and add an additional level: Articulatory Structure Level, which is necessary to cater for the linguistic phenomena consistent with a sign language, and in this case, ISL.

Lexical Representation Level	Description
<i>Argument Structure</i>	The behaviour of a word as a function, with its arity specified. This is the predicate argument structure for a word, which indicates how it maps to syntactic expressions.
<i>Event Structure</i>	Identification of the particular event type (in the sense of Vendler (1967)) for a word or phrase: e.g. as state, process, or transition.
<i>Qualia Structure</i>	The essential attributes of an object as defined by the lexical item.
<i>Inheritance Structure</i>	How the word is globally related to other concepts in the lexicon.
<i>Articulatory Structure</i>	The essential (computational) phonological parameters of an object as defined by the lexical item.

Figure 4: Five Levels of Lexical Representation for Sign Languages

Figure 5 provides an overview of the Articulatory Structure Level computational phonological parameters representing handshape <HS> in ISL. Articulatory Structure Level represents the essential (computational) phonological parameters of an object as defined by the lexical item. These parameters will be used to account for various linguistic phenomena

pertaining to the handshape <HS> in ISL, which are necessary to adequately represent ISL within a computational framework.

Parameter	Computational Parameter Subcategories
Handshape <HS>	f1Shape(xi,yi,zi).... f1Shape(xn,yn,zn) f2Shape(xi,yi,zi).... f2Shape(xn,yn,zn) f3Shape(xi,yi,zi).... f3Shape(xn,yn,zn) f4Shape(xi,yi,zi).... f4Shape(xn,yn,zn) tShape(xi,yi,zi).... tShape(xn,yn,zn) tOverLap(xi,yi,zi).... tOverLap(xn,yn,zn) tPalm(xi,yi,zi).... tPalm(xn,yn,zn) eventDuration(EDti, EDtn) timeline(TLti, TLtn) hsDef((f1Shape_i, f1Shape_n, eventDuration(EDti, EDtn)), (f2Shape_i, f2Shape_n, eventDuration(EDti, EDtn)), (f3Shape_i, f3Shape_n, eventDuration(EDti, EDtn)), (f4Shape_i, f4Shape_n, eventDuration(EDti, EDtn)), (tShape_i, tShape_n, eventDuration(EDti, EDtn)), timeLine(TLti, TLtn))

Figure 5: ISL Handshape <HS> Computational Phonological Parameters and their Corresponding Subcategories

With regard to Figure 5, f1Shape, f2Shape, f3Shape and f4Shape refer the shape of finger one, finger two, finger three and finger four respectively with f1 representing the index finger and f4 representing the little finger. The coordinates of each finger within 3D space (x,y,z) have an initial position (xi,yi,zi) and a final position (xn,yn,zn) depending on the handshape being represented. The thumb shape (tShape) also has an initial and final position and the thumb may also wrap around the fingers when they are in a closed fist shape (tOverLap) or overlap the palm of the hand (tPalm). Finally, each of the various articulators on the hand will have timing information associated with it to allow for the synchronisation of the simultaneous articulation of the various articulators associated with an utterance. Each articulator will have an *eventDuration* associated with it, which represents the amount of time it will take to move from the initial coordinate (xi,yi,zi) to the final coordinate (xn,yn,zn). The eventDuration of each of the articulators will map to an overall *timeline* parameter, which is responsible for the overall synchronisation of an utterance across a period of time.

Figure 6 provides an overview of Articulatory Structure Level body anchored location categories. Due to the fact that the location at which a sign is realised within 3D space is

significant with regard to syntax and semantics in ISL, Articulatory Structure Level must also provide various parameters for location including body anchored locations. Figure 6 provides the body anchored locations catered for within Articulatory Structure Level as body anchored head <BHEAD>, body anchored arm <BARM>, body anchored hand <BHAND> and body anchored trunk <BTRUNK>. It also lists the subcategories catered for within these categories, with Lf1 to Lf4 representing the fingers of the left hand and Rf1 to Rf4 representing the fingers of the right hand. We also include Lt and Rt, which represent the left thumb and the right thumb respectively.

Location	Subcategory
<BHEAD>head	hair, topHead, backHead, leftTemple, rightTemple, leftEar, rightEar, leftCheek, rightCheek, nose, chin, forehead, mouth, frontneck, backNeck, rightNeck, leftNeck
<BARM>arm	rightShoulder, leftShoulder, rightUpper, leftUpper, rightElbow, leftElbow, rightLower, leftLower, rightWristTop, leftWristTop, rightWristPalm, leftWristPalm, rightWristRightSide, RightWristLeftSide, LeftWristRightSide, LeftWristLeftSide
<BHAND>hand	rightBack, leftBack, rightPalm, leftPalm, rightIndexup, leftIndexUp, Lf1(x,y,z), Lf2(x,y,z), Lf3(x,y,z), Lf4(x,y,z), Lt(x,y,z), Rf1(x,y,z), Rf2(x,y,z), Rf3(x,y,z), Rf4(x,y,z), Rt(x,y,z)
<BTRUNK>trunk	chestCentre, chestHeart, tummy

Figure 6: Body Anchored Location Categories with Subcategories

Articulatory Structure Level also provides various parameters for locations within the 3D gestural space.

Figure 7 provides an overview of these within the gestural space allocation map for ISL. L1 represents the signer and the upper, mid and lower layers allow us to divide the gestural space into three layers with mid representing the level of neutral space in front of the signer and upper and lower representing the upper and lower gestural space in relation to this.

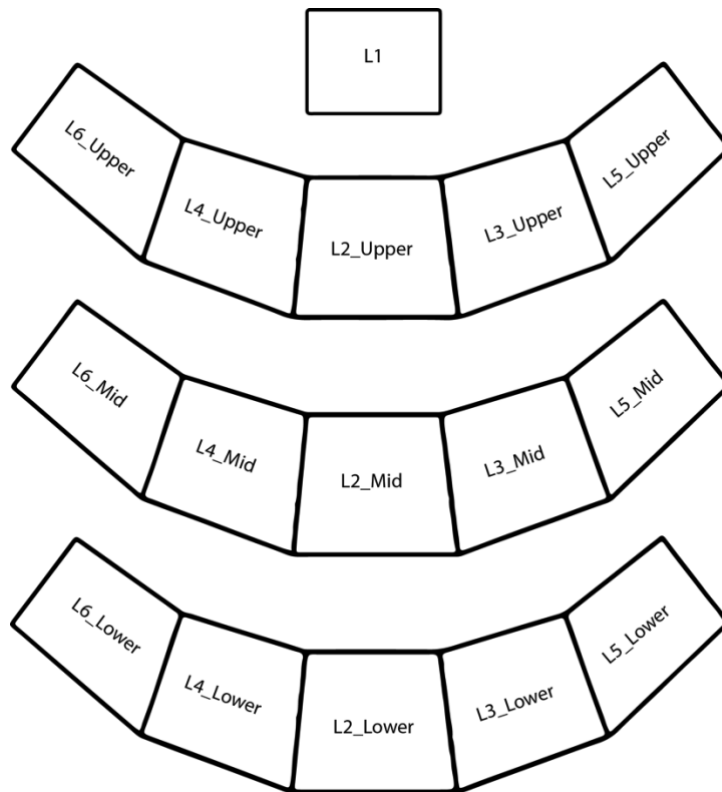


Figure 7: ISL Computational Gestural Space Allocation Map

4. Role and Reference Grammar

Role and Reference Grammar (RRG) is a theory of grammar that is concerned with the interaction of syntax, semantics and pragmatics across grammatical systems. RRG can be characterised as a descriptive framework for the analysis of languages and also an explanatory framework for the analysis of language acquisition. It is a monostratal theory positing only one level of syntactic representation, the actual form of the sentence. RRG does not allow any phonologically null elements in the syntax; if there's nothing there, there's nothing there (Van Valin, 2005). Figure 8 illustrates the organisation of RRG.

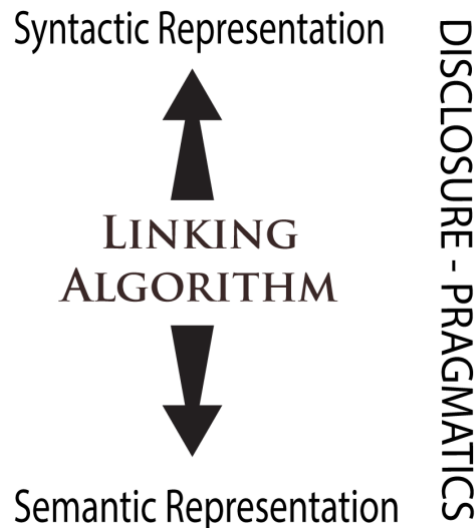


Figure 8: Organisation of Role and Reference Grammar (after Van Valin 2005)

With respect to cognitive issues, RRG adopts the criterion of psychological adequacy formulated in Dik (1991), which states that a theory should be compatible with the results of psycholinguistic research on the acquisition, processing, production, interpretation and memorisation of linguistic expressions. The RRG approach to language acquisition rejects the theory that grammar is radically arbitrary and therefore unlearnable. RRG is a monostratal theory, positing a single syntactic representation for a sentence, linked directly to a semantic representation by means of a bi-directional linking algorithm. RRG has a rich theory of the lexicon. The syntactic representation of clause structure in RRG is referred to as the layered structure of the clause (LSC). RRG also posits a layered structure of the noun phrase (LSNP), which is similar but not identical to the LSC. The RRG lexicon, the LSC, LSNP together with the bi-directional linking system and semantics to syntax interface provide us with a theory of grammar that will allow us to cater for the various linguistic phenomena associated with ISL verbs in this research study.

4.1. RRG verb classes

The semantic representation is based on a system of lexical representation and semantic roles. RRG employs the system of lexical decomposition proposed by Vendler (1967). Verbs are represented in the lexicon according to their Aktionsart classification and can be divided into four distinct classes: states, activities, achievements and accomplishments. These four classes can be further defined by three features: $[\pm\text{static}]$, $[\pm\text{punctual}]$, and $[\pm\text{telic}]$ (Binns-Dray,

2004). *Static* indicates if a verb represents something happening. If one can answer the question, “What happened?” or “What is happening?” then the verb is seen to be static. *Telic* represents whether a verb describes a state of affairs that has a terminal end point. Achievements and accomplishments are telic, or bounded, as in ‘*The clothes are drying on the line*’, while states and activities are atelic, or unbounded, as in ‘*John is running in the park*’. *Punctual* represents whether a telic verb (achievements and accomplishments) has internal duration or not (Binns-Dray, 2004).

The lexical representation of a verb or other predicate is termed its logical structure [LS] (Van Valin & La Polla 1997, p. 102). State predicates are represented simply as **predicate'**, while all activity predicates contain **do'**. Accomplishments, which are durative, are distinguished from achievements, which are punctual. Accomplishment LSs contain BECOME, while achievement LSs contain INGR, ‘ingressive’. Semelfactive LSs contain SEML. In addition, causation is treated as an independent parameter that crosscuts the six *Aktionsart* classes. It is represented by CAUSE in LSs. The lexical representations for each type of verb are provided in Table 2.

Verb Class	Logical Structure
State	predicate' (x) or (x, y)
Activity	do' (x, [predicate' (x) or (x, y)])
Achievement	INGR predicate' (x) or (x, y), or INGR do' (x, [predicate' (x) or (x, y)])
Accomplishment	BECOME predicate' (x) or (x, y), or BECOME do' (x, [predicate' (x) or (x, y)])
Active accomplishment	do' (x, [predicate ₁ ' (x, (y))]) & BECOME predicate ₂ ; (z, x) or (y)
Causative	α CAUSE β where α , β are representations of any type

Table 2: Lexical Representation for Aktionsart Classes (Van Valin & LaPolla, 1997)

5. Event Visibility Hypothesis

Wilbur (2008) proposed the Event Visibility Hypothesis (EVH), which states that in the predicate system, the semantics of the event structure is visible in the phonological form of the predicate sign. This suggests that predicate signs contain morphemes that reflect the event structure that they represent. Wilbur (ibid.) proposes that with the exception of classifier predicates (CLP) and spatial tracing movements, within the predicate domain in SL, the path movement of predicate signs indicates the temporal extent of an event (e), and that the path movement between sign repetitions reflects time between events (e). Wilbur (ibid.) also proposes that the phonological end-marking of the movement reflects the final state of telic events (e_n) and that movement that stops at points (p) in space also indicates individual argument semantic variables (x). Wilbur (2008, p. 218) proposes that: “This mapping of semantic components and phonological forms represents a systematic recruitment of characteristics of the physical world for conceptual, hence morphological, semantic and syntactic purposes”. Event structures are analysed as conceptual structures that correspond to morphemes in the lexicon. The EVH uses a model of event structure, which was developed from the sub-event analysis of Pustejovsky (1991b, 1992, 1995, 2000), where events are composed of sub-events of two types: static (S) and dynamic process (P). The EVH deals with temporal component events, and not with causation, agentivity, or linking. Wilbur (ibid.) proposes that there is a morphological mapping of sign formation and event structure in SL. In the predicate system, the semantics of the event structure is visible in the phonological form of the predicate sign. Table 3 taken from Wilbur (2008, 220) provides the proposed EVH morphemes and their description.

Morpheme Class	Function	Sub-event type	Phonological Form
EndState	Marker of telic events	State	Rapid deceleration to a stop
InitialState	Marker of initial state	State	Rapid acceleration from a stop
Extent	Duration of events	Process	Path, [tracing]
Path	Distance of spatial events	Process	Path, [tracing]
Extra	Adverbial Modifier		[Arc]
USET	Adverbial Temporal Modifier		Trilled Movement [TM]

Table 3: Event Visibility Hypothesis (Wilbur 2008, 220)

Telic and atelic events are separated based on Wilbur (2003, p. 355), who argues that “Transition predicates, which are telic, have a phonologically overt ‘EndState’ in their form, whereas states and processes, which are atelic, do not”. Telic events are defined within the context of event structure as the property of events containing a natural conceptual/semantic endpoint. In contrast, atelic events do not contain such an endpoint and have the potential to continue indefinitely, without any change in their internal structure. Telic events having a heterogeneous internal structure, while atelic events have a homogenous internal structure.

Rathmann (2005) provides an overview of Wilbur’s (2004) study where linguistic correlates for situation types that were found on the phonological level. Wilbur found that ASL signs denoting Transitions (following the terminology of Pustejovsky, 1995, roughly the set of telic predicates, i.e. achievements and accomplishments) share the phonological property that there is a change in some *phonological parameter of the sign*. On the other hand, ASL signs for Processes (i.e. the set of atelic predicates, or activities and semelfactives) share a different phonological property. They all have path movement or “movement over a line”. They do not involve a change in *handshape* or *orientation*. Table 4 provides a summary of this overview.

Phonological Feature	Achievement (telic)	Accomplishment (telic)	Activities (atelic)	Semelfactives (atelic)
<i>Movement</i>	May change	May change	Change	Change
<i>Orientation</i>	May change	May change	No change	No change

<i>Handshape</i>	May change	May change	No change	No change
<i>Location</i>	May change	May change	Change	Change

Table 4: Summary of Phonological Feature Change Patterns in Relation to Situation Types (Wilbur 2008, pp. 220–222)

Wilbur (ibid.) draws on Brentari (1998)’s prosodic model for ASL in the development of the EVH. The prosodic model provides a comprehensive theory of ASL phonology and the phonological organisation of signs (ibid.). Feature geometry is applied in the hierarchical organisation of a sign’s parameters based on phonological behaviour and articulatory properties. A root lexeme branches into both Inherent Features (IF) and Prosodic Features (PF). IFs define those features that persist throughout the sign. IFs branch into the parameters of handshape and location/place of articulation (POA). The PF branch defines dynamic features that can change during the formation of a sign. PFs represent movement in ASL signs and require specification of at least two phonological timing slots (x-slots).

6. Analysing ISL verbs and associated situation types

We provide an analysis of the SOI corpus and of the literature within the field in relation to the linguistic phenomena associated with ISL verbs. With regard to our approach to analysis, we select approximately twenty examples of verbs from the SOI corpus and from the literature based on their appropriateness of coverage of the phenomena under investigation to serve as a dataset for this study. Table 5 provides examples of ISL glossed sentences taken from the SOI corpus. The ISL verb in each sentence is categorised according to the tripartite verb class, transitivity and situation type. These verbs were then categorised according to their ISL morphological verb classes (McDonnell, 1996). Bearing in mind that RRG semantic representation is based on a system of lexical representation and semantic roles, and that RRG employs the system of lexical decomposition proposed by Vendler (1967), the next step in our investigation was to analyse the verbs further and determine each verb’s Aktionsart classification or situation type (Vendler, 1967). The relevant situation type was determined depending on the features displayed by the verb. Possible features of the verb include [\pm static], [\pm punctual], and [\pm telic]. Based on the features applied, the verbs were then categorised into distinct classes of states, activities, achievements and accomplishments, active accomplishments and semelfactives.

Sentence	ISL Verb	ISL Verb Class	Transitivity	Aktionsart Class	Reference
REAL LIKE MY JOB 'I really love my job'	LIKE	plain	trans.	state	SOI Corpus Noeleen (03) Personal Stories (Dublin)
OPEN HANDS PALM UP-CL DRIVE-ME-MAD 'They drive me mad'	DRIVE-ME-MAD	plain	trans.	activity	SOI Corpus Noeleen (03) Personal Stories (Dublin)
- n NEVER LIKE LEAVE '(I would) never like to leave'	LIKE	plain	intrans	state	SOI Corpus Noeleen (03) Personal Stories (Dublin)
SOME BOY THINK 'Some boys think'	THINK	plain	intrans	activity	SOI Corpus Noeleen (03) Personal Stories (Dublin)
ARRIVE HOTEL '(I) arrived at the hotel'	ARRIVE	plain	intrans	achievement	SOI Corpus Mary (30) Personal Stories (Cork)
INDEX+c MAKE DINNER FOR SIGN NAME (Pat OShea) 'I made dinner for Pat O'Shea'	MAKE	plain	trans	accomp.	SOI Corpus Alice (29) Personal Stories (Cork)
DAUGHTER RUN+sl TO HOTEL 'My daughter ran to the hotel'	RUN	locative agreement (spatial)	intrans	active accomp.	SOI Corpus Mary (30) Personal Stories (Cork)
c+ASK+f 'I ask you'	ASK	double agreement	trans	activity atelic durative	McDonnell (1996: 160, Example 5.58)
c+ACCUSE+f 'I blame you'	ACCUSE	double agreement	trans	activity	McDonnell (1996: 160, Example(5.62)
DISAPPEAR '(The dog) disappeared'	DISAPPEAR	plain	intrans	semelfactive	SOI Corpus Rebecca (38) Personal Stories (Waterford)
BOY SLAP-FACE+c 'The boy slapped me on the face'	SLAP	locative agreement (body	trans	achievement	McDonnell (1996: 179, Example 5.132)

		anchored)			
c+CHOOSE+fl 'I chose (something)'	CHOOSE	backward agreement	trans	achievement telic punctual	SOI Corpus Kevin (17) Personal Stories (Dublin)
GUIDE TELL-ME 'The tour guide told me'	TELL-ME	single agreement	trans	activity atelic durative	SOI Corpus Mary (33) Personal Stories (Galway)
c+DISCUSS+f f+DISCUSS+c 'We discussed the issue'	DISCUSS	reciprocal agreement	trans	accomp. Telic durative	SOI Corpus Annie (26) Personal Stories (Wexford)
DRIVE+f HOME 'I drove home'	DRIVE	locative agreement (spatial)	intrans	active accomp.	SOI Corpus Fergus D. (06) Personal Stories (Dublin)
c+GIVE+f '(I) gave (the dog) (food)'	GIVE	double agreement	ditrans.	achievement telic punctual	SOI Corpus Rebecca (38) Personal Stories (Waterford)

Table 5: Analysing ISL event types

Our investigation of ISL verbs and the associated Aktionsart classes found that ISL shows linguistic correlates for five situation types: states, activities, achievements, accomplishments and semelfactives. From the investigation carried out here, there are no apparent patterns or correlations between the traditional tripartite verb classes in ISL and the situation types associated with ISL verbs or indeed the transitivity of the verb.

Wilbur (2008) adopted Pustejovsky's terminology for event structure and argues that transition events, which are atelic, have a phonologically overt 'EndState' in their form, whereas States and Processes, which are atelic, do not. Wilbur (ibid.) proposes that states, activities and semelfactives (homogenous atelic events) all have path movement or "movement over a line". They do not involve a change in handshape or orientation.

Drawing on Wilbur (2008) and correlations found in relation to event types and SL verbs, we provide the following proposal in relation to the lexical representation for Aktionsart classes for ISL. Leveraging the computational phonological parameters defined within Articulatory Structure Level (Murtagh, 2019b), we propose that in relation to lexical entries for atelic situation types: states, activities and semelfactives, the initial specification for handshape <HS> and orientation <ORI> will remain for the duration of the event. All other features

including wrist <WRIST>, forearm <F_ARM>, upper arm <U_ARM> and location <LOC> may change from the initial specification or point in 3D space across the duration of the event to a different specification or point in 3D space. Leveraging Wilbur (2008), in the case of *handshape* and *orientation*, we propose that the initial state for handshape and also for orientation will hold for the duration of the event. Therefore, <HS> and <ORI> will be initialised and the final positioning specification for these two parameters will be set to the same values as the initial parameter settings. Figure 9 illustrates the computational phonological parameters that will be available at the beginning of an ISL articulation. The parameters for ISL NMF parameters are initially empty therefore we use the notation <...>. The Handshape <HS> will be accounted for in relation to location <LOC>, which may be body anchored somewhere on the head, arm, hand or trunk or located within the 3D gestural space anywhere within upper, mid or lower gestural space. The finger and thumbs will be catered for by f1 to f4 and TShape, passing in an initial parameter (xi,yi,zi) and a final parameter (xn,yn,zn). We also account for palm orientation <PO>, arm movement <AM>, forearm <FA>, upper arm <UA>, head <HEAD>, eyebrow <EB>, eyelid <EL>, eyegaze <eg>, cheek <CHK>, mouth <MTH>, tongue <TNG> and shoulder <SHL>.

```
<HS><LOC>[(<body_initial>(head), (arm), (hand), (trunk)) || (<spatial>(upper),
(mid), (lower))..... (<body_end>(head), (arm), (hand), (trunk)) ||
(<spatial>(upper), (mid), (lower))]] timeline[eventDuration(f1IShape( xi,yi,zi),
(f2IShape( xi,yi,zi ), f3IShape( xi,yi,zi ), f4IShape( xi,yi,zi ), TShapeI(xi,yi,zi).....
(F1EShape (xn, yn, zn), (f2EShape (xn, yn, zn), f3EShape (xn, yn, zn), f4EShape
(xn, yn, zn), TShapeE (xn, yn, zn))]
<PO> timeline [eventDuration (p_initial (xi, yi, zi)..... p_end (xi,yi,zi))]
<AM> timeline [eventDuration (w_initial ( xi,yi,zi).....w_end(xi,yi,zi))]
<FA> timeline [eventDuration (f_initial ( xi,yi,zi).....f_end(xi,yi,zi))]
<UA> timeline [eventDuration (u_initial ( xi,yi,zi).....u_end(xi,yi,zi))]
<HEAD> timeline [eventDuration (<.....>)]
<EB> timeline [eventDuration (<.....>)]
<EL> timeline [eventDuration (<.....>)]
<EG> timeline [eventDuration (<.....>)]
<CHK> timeline [eventDuration (<.....>)]
<MTH> timeline [eventDuration (<.....>)]
<TNG> timeline [eventDuration (<.....>)]
<SHL> timeline [eventDuration (<.....>)]
```

Figure 9: Computational phonological parameters for ISL realisation of atelic events

NMF computational phonological parameters may be used simultaneously along with the MF parameters. Table 6 provides a sample of ISL NMF phonological parameters relating to the eye, and their associated phonemes.

ISL NMF Phonological Parameter	ISL NMF Phoneme
EyeBrow (left and right simultaneous)	neutral, frown, arch
EyeLids (left and right simultaneous)	neutral, wide, squint, blink, closed
EyeGaze(left and right simultaneous)	neutral, left, right, up, down, left_up, left_down, right_up, right_down, locus

Table 6: ISL NMF phonological parameters with associated phonemes

With reference to Wilbur (2012) and with regard to the situation types of *achievements* and *accomplishments*, the initial specification for handshape <HS> and orientation <ORI> does not remain for the duration of the event, similar to all of the other MF computational phonological parameters, including wrist <WRIST>, forearm <F_ARM>, upper arm <U_ARM> and location <LOC>.

It is proposed that a template similar to Figure 9 is available in terms of the lexical representation of ISL verbs. This template will represent the Articulatory Structure Level parameters (Murtagh, 2019a) and will be initialised once an ISL articulation begins. The template chosen will be based on the Aktionsart class associated with the ISL verb in the sentence. States, Activities and Semelfactives (atelic events) will have access to a template where the <HS> and <ORI> parameters have an initial and final specification that is the same for the duration of the articulation based on the EVH. Achievements and Accomplishments will have access to a template where the <HS> and <ORI> parameters have an initial and final specification that varies depending on the event and the sentence being articulated. It is important to note that parameters relating to the timeline (overall time taken to communicate the entire ISL lexeme, utterance or sentence) and the duration required to realise each computational phonological parameter must be recorded. Further, in relation to the handshape, the location in 3D (gestural space or body-anchored) in which the handshape is realised must also be initialised and tracked for the duration of the event and with regard to the overall timeline or duration of the articulation.

7. RRG + Sign_A logical structures for ISL plain verbs

In defining the RRG Logical Structure for ISL verbs we begin by looking to our analysis of ISL verbs. Both ISL plain verbs and agreement verbs show linguistic correlates to all five situation types for ISL. Mapping the new Articulatory Structure Level (Murtagh, 2019a) to RRG logical structures based on event/situation type, we provide a proposal for RRG logical structures for ISL plain verbs. In Examples (2) and (3) we illustrate that we have reduced the parameters displayed for ease of illustration by using a <MF> parameter, which represents MF computational phonological parameters and <NMF>, which represents NMF computational phonological parameters. The parameter for timeline <Tline>, which is essential for representing the overall timeline for all <MF> and <NMF> parameters for the entire ISL articulation is included at this level. (4) provides us with an illustration of this.

(2)

<MF>(<HS><ORI><WRIST><F_ARM><U_ARM>)

(3)

<NMF>(<HEAD><EB><EL><EG><CHEEK><MOUTH><TONGUE><LSHOUL><RSHOUL>)

Example (4) provides our proposed logical structures for ISL plain verbs based on their associated situation types. Plain verbs are not marked for person or location.

(4)

a. State

REAL LIKE MY JOB

‘I really love my job’

LIKE’ <TLine><MF><NMF> (1sg, JOB)

Based on Example 5.2, SOI Corpus Noeleen (03) Personal Stories (Dublin)

b. Activity

SOME BOY THINK

‘Some boys think’

do’(BOY.pl, [**THINK**’<TLine><MF><NMF> (BOY.pl)])

Based on Example 5.5, SOI Corpus Noeleen (03) Personal Stories (Dublin)

c. Semelfactive

DISAPPEAR

‘(The dog) disappeared’

SEML **do’** (DOG, [**DISAPPEAR’**<TLine><MF><NMF> (DOG)])

Based on Example 5.9, SOI Corpus Rebecca (38) Personal Stories (Waterford)

d. Achievement

ARRIVE HOTEL

‘(I) arrived at the hotel’

INGR **ARRIVE’**<TLine><MF><NMF> (HOTEL)

Based on Example 5.6, SOI Corpus Mary (30) Personal Stories (Cork)

e. Accomplishment

INDEX_{+c} MAKE DINNER FOR SIGN-NAME (Pat OShea)

‘I made dinner for Pat O’Shea’

BECOME **COOK’**<TLine><MF><NMF> (1sg, DINNER) + be_{_at} (DINNER, SIGNNAME)

Based on Example 5.7, SOI Corpus Alice (29) Personal Stories (Cork)

8. RRG + Sign_A logical structures for ISL agreement verbs

Interpreting the linguistic phenomena associated with ISL agreement and introducing this into the logical structures of RRG is not a simple process. Brentari (1988) produced a syntactic account of agreement verbs and observed that within SL communication and with reference to SL verbs, the orientation of the palm of the hand is representative of the marking of spatial agreement. Meir (1998ab, 2002) produced a thematic analysis of verb agreement that includes a semantic and syntactic account. She notes that in Israeli Sign Language, path movement within 3D space and the facing of the hands are used to denote motion and transfer respectively for agreement and spatial verbs. The lexical structure for these type of verbs denotes transfer from source to goal. Person agreement verbs are morphologically linked to participants. They agree with actor and undergoer, which can be mapped to grammatical roles of subject and object. Locative agreement verbs are morphologically linked to locations and their arguments are derived from source/goal and theme (moving item) or location. The goal

and theme can be mapped to grammatical roles of object and subject respectively. Both person and locative agreement verbs in Israeli SL see semantic roles inflected by direction of path movement while the syntactic role is represented by the facing of the verb. Spatial verbs represent locations in space and denote motion and location in space. The locations of locative arguments, (the source and the goal) are based on the direction of movement of the hands. The shape of the path movement that the hands trace often depicts the shape of the path that an object traverses in space. As such, the movement parameter can capture information on *interaction*, *contact*, *direction* and *manner*. The semantics of this parameter is central to this study.

Agreement verbs are inflected by the *direction* of the *path movement*. Agreement verbs mark subject and object by the *location in space* or *on the body* at the start and end of the verb articulation respectively, reversing this for backward agreement verbs. Also, in terms of spatial locative verbs and in terms of encoding the locations of locative arguments, the semantic roles of source and goal are marked based on the *direction* of movement of the hands. With spatial locative verbs, the shape of the path traversed by an entity is depicted by the *path movement* of the hands.

Taking this into account, we look again to RRG logical structures for ISL agreement verbs and propose that accounting for the event types associated with ISL verbs is not sufficient in terms of representing the semantics of these verbs. These highly complex structures encode information in terms of their visual gestural modality and therefore it proves very challenging to account for certain linguistic phenomena using only association to Aktionsart classes as a representation mechanism.

There is no doubt that spoken language linguistics has influenced our approach in the development of sign language linguistics. However, when developing logical structures for a sign language it is not sufficient to use structures that are satisfactory in the representation of spoken language due the difference in modality. ISL is a visual gestural language and therefore logical structure entries for ISL verbs must account for this. While Aktionsart classes may be used to capture a certain amount of information pertinent to sign language verbs in terms of the four levels of lexical representation (argument, event, qualia and inheritance) within the GL framework (Pustejovsky, 1991), the Articulatory Structure Level

has not been accounted for in terms of RRG and so a proposal to allow for this within RRG logical structures for ISL follows.

Example (5) provides our proposed logical structures for ISL agreement verbs based on their associated situation types. Example (5a) provides an ISL double person agreement verb, ACCUSE, which has a situation type of activity. The signer (the locus, c. refers to the canonical locus) is situated within the *alocus* in this example, which has a location in front of the signers chest or L1 on the Sign_A framework gestural space allocation map in Figure 7. The movement is towards the *blocus* (in this case ‘f’ or forward locus representing YOU), which has a location in at L2_mid on the Sign_A framework gestural space allocation map in Figure 7. Movement occurs from *alocus* to *blocus*.

Example (5b) provides an ISL spatial locative verb KNOCK++++ displaying iterative aspect, knocking repeatedly, and with urgency. The door that the participant is knocking on was established previously in the discourse and therefore it is salient. The participant in this case provides an aspectually modified variant of the verb KNOCK++++ representing four repetitions (typically there are two). This aspectual variation will be marked under aspect within our framework. The event duration parameter will allow us to increase the speed of knocking and also allow for the repeated knocking. NMFs will also be catered for based on instantiating the appropriate parameters within the Sign_A framework Articulatory Structure Level (Murtagh, 2019a).

Example (5c) provides the proposed logical structure for the ISL body-anchored locative agreement verb SLAP. Similar to the spoken language RRG logical structure for English, *slap* occurs *on* the location of *the face*. The PP expresses the location of the event of slapping and therefore, *on* is identified as the highest predicate in the logical structure and it takes *the face* and the logical structure for *slap* as its two arguments. The *clocus* is a body anchored location (the face) and it is associated with the *blocus* (the signer in this case) as the slap occurs on the signer’s face. We provide a list of ISL NMF body anchored locations within the Sign_A framework Articulatory Structure level (Murtagh, 2018). The NMF location allocation will be used to situate the slap on either the right or the left cheek of the signer in this example.

Finally Example (5d) provides an ISL reciprocal agreement verb DISCUSS, which has a situation type of accomplishment. The signer uses both hands (c referring to canonical locus) which has a location in front of the signers chest or L1 on the Sign_A framework gestural space allocation map in Figure 7 and ‘f’ locus, which has a location of ‘f’, forward in front of the signer’s chest or at L2_mid on the Sign_A framework gestural space allocation map. _{ab}locus represents ‘c’ (canonical locus) and ‘f’(forward locus) respectively. “the issue” is situated in this case within the _clocus.

Movement occurs from _a locus to _b locus alternating the hands in a circular motion representing ‘we’ and also representing the iterative nature of the verb. The verb DISCUSS is also mouthed using NMFs.

(5) a. Activity (double person agreement)

c+ACCUSE+f

‘I blame you’

McDonnell (1996, p. 160, Example 5.62)

do'(1sg , [**aACCUSE'**_b <TLine><MF> <LOC> <NMF> (a1sg , b2sg)])

<HS> both hands in handshape [24]

<LOC> (a c locus or body chest, converts to L1 on Sign_A allocation map) (b pronominal reference (you), converts to L2_mid on Sign_A framework map) // marks for source and goal or subject and object

<MOV> from point a to point b //shows direction

<ORI> palm down, fingertips forward

b. Semelfactive (spatial location)

KNOCK++++

‘I was banging down the door’

SOI Corpus Catherine (31) Personal Stories (Cork)

SEML _a elided **KNOCK'** _b elided <Tline><MF><NMF> ((_a elided 1sg, _b elided door)

<HS> one handed, handshape [4]

<LOC> (a elided referring to signer not overtly realised in the syntax) (b elided the door located at L2_upper on the Sign_A allocation map is also salient in discourse common ground, and elided in the syntax) // marks for source and goal or subject and object

<MOV> from point a to point b //shows direction

<ORI> palm moving upwards and then downwards

c. Achievement (body anchored location)

BOY SLAP+face c

‘The boy slapped me on the face’

McDonnell (1996: 179, Example 5.132)

on(cface,[a**SLAP**'b<Tline><MF><NMF> (aBOY, b1sg)])

<HS> one handed, handshape [1]

<LOC> (alocus pronominal reference/source or subject (the boy)) (b locus person being slapped.) (c locus is the body anchored location or goal (the face))

<MOV> from alocus to c locus //shows direction

<ORI> palm towards signers face

d. Accomplishment (reciprocal agreement)

c+DISCUSS+f

f+DISCUSS+c

‘We discussed the issue’

SOI Corpus Annie (26) Personal Stories (Wexford)

do'(1sg and 2sg , [a**DISCUSS**'b <Tline><MF> <LOC> <NMF> (a1sg and 2sg, b2sg)])

<HS> two hands same shape

<LOC> (alocus: refers to the signer L1) (b locus: refers to L2_mid locus where one or more participants have been established.

<MOV> plural form ‘we’ represented on Sign_A framework gestural space allocation map (Figure 4) by movement from L2_mid toward signer L1 using two hands alternately iterating around //shows direction and iterative nature

<ORI> palm upwards and tilted towards signers face

In the case of verbs and RRG logical structures, it proposed that ISL verbs are categorised according to Aktionsart classes and also by plain or agreement categories. Agreement verbs inflect for person agreement and locative agreement. The logical structure entries for ISL verbs includes specifications for the computational phonological parameters which are defined at the Articulatory Structure Level within our Sign_A framework. These parameters are represented in the extended GL theory (Pustejovsky, 1991), where we propose a fifth level of lexical representation be added to account for the essential (computational) phonological parameters of an object as defined by the lexical item. It should be noted that the theory of EVH holds in relation to initial and end states for <HS> and <ORI> parameters, where there was no change in either of these for the activity agreement verb ACCUSE in Example 5a).

9. Conclusion

In this paper we have provided lexical entries for a sample of ISL verbs within the RRG lexicon. We have provided an account of the literature in relation to sign language verbs, and paid specific attention to how ISL verbs have been described. We analysed various verb types from the SOI corpus and subsequently categorised these according to traditional tripartite verb class, transitivity and situation type. On investigation of ISL verbs and the associated Aktionsart classes we identified that ISL shows linguistic correlates for five situation types: states, activities, achievements, accomplishments and semelfactives. We also noted that ISL verb behaviour is in line with Wilbur's (2008) EVH hypothesis. Finally, we provided a template for the computational phonological parameters necessary for ISL realisation. Based on these parameters, we leverage the Sign_A framework. Referring specifically to Articulatory Structure Level in terms of lexical meaning for ISL and the essential (computational) phonological parameters of an object as defined by the lexical item, we provided the RRG logical structure for the ISL plain verbs and ISL agreement verbs based on their respective event/situation type.

Acknowledgements

I wish to acknowledge the very kind support of Dr. Brian Nolan and Professor John Saeed. I also wish to acknowledge the Centre for Deaf Studies, Trinity College Dublin for providing me with access to the Signs of Ireland (SOI) Corpus for analysis and investigation in this research study. All data from the SOI corpus are used with permission of the Centre for Deaf Studies, Trinity College Dublin. Finally, a very sincere thank you to the reviewers for your comments and observations, which were so helpful in shaping this paper.

References

- Bos, H. (1994) An Auxiliary Verb in Sign Language of the Netherlands. In I. Ahlgren, B. Bergman & M. Brennan (Eds.) *Perspectives on Sign Language Structure: Papers from the Fifth International Symposium on Sign Language Research, Vol. 1*. Durham: International Sign Linguistic Association, pp. 37–53.
- Binns-Dray, K. R. (2004) *Content Questions in American Sign Language: An RRG Analysis*. Unpublished PhD dissertation. State University of New York at Buffalo.
- Brentari, D. (1988) *A Prosodic Model of Sign Language Phonology*. Cambridge: MIT Press.
- Dik, S. (1991) Functional Grammar. In F. Droste & J. Joseph (Eds.) *Linguistic theory and grammatical description*. Amsterdam and Philadelphia: John Benjamins, pp. 247–274.
- Fischer, S. (1996) The Role of Agreement and Auxiliaries in Sign Languages. *Lingua* 98, 103–120.
- Hong, S. E. (2008) *Eine Empirische Untersuchung zu Kongruenzverben in der Koreanischen Gebärdensprache*. Hamburg: Signum.
- Johnston T. (2001). The Lexical Database of Auslan (Australian Sign Language). *Sign Language Linguistics* 4 (1/2), pp. 145–169.
- Johnston, T. & Schembri, A. (2007) *Australian Sign Language: An Introduction to Sign Language Linguistics*. Cambridge: Cambridge University Press.
- Kronlid, F. (2003) *Modes of explanation - Aristotelian Philosophy and Pustejovskyan Linguistics*. Unpublished PhD Dissertation. University of Goteborg, Sweden.
- Leeson, L., Saeed, J., Byrne-Dunne, D., Macduff, A. & Leonard C. (2006) *Developing a Digital Corpus of Irish Sign Language. The 'Signs of Ireland' Corpus Development Project. Information Technology and Telecommunications Conference*. Carlow: Carlow Institute of Technology, Ireland.
- Leeson, L. & Saeed J. (2012) *Irish Sign Language*. Edinburgh: Edinburgh University Press.
- Levin, B. (1993) *English Verb Classes and Alternations*. Cambridge: Cambridge University Press.
- Lloyd, G. E. R. (1968) *Aristotle: The Growth and Structure of his Thought*. Cambridge: Cambridge University Press.
- McDonnell, P. (1996) *Verb Categories in Irish Sign Language*. Unpublished doctoral dissertation. Centre for Language and Communication Studies (CLCS), University of Dublin, Trinity College, Dublin, Ireland.
- Massone, M. I. & Curiel, M. (2004) Sign Order in Argentine Sign Language. *Sign Language Studies*, 5, 63–93.
- Mathur G. and Rathmann C. (2012) *Verb Agreement*. In: R. Pfau, M. Steinbach, B. Woll (Eds.) *Sign Language: An International Handbook*. Berlin: Mouton de Gruyter, pp. 136–157.
- Meir, I., Padden, C., Aronoff, M., Sandler, W. (2007) Re-Thinking Sign Language Verb Classes: The Body as Subject. *Journal of Linguistics*, 43, 531–563.

- Meir, I. (1998a) *Thematic Structure and Verb Agreement in Israeli Sign Language*. Unpublished Doctoral Dissertation. The Hebrew University of Jerusalem, Jerusalem.
- Meir, I. (1998b) Syntactic-semantic interaction in Israeli Sign Language verbs: The case of backwards verbs. *Sign Language and Linguistics* 1(1), 3–37.
- Meir, I. (2002) A cross-modality perspective on verb agreement. *Natural Language and Linguistic Theory*, 20, 413–450.
- Meir, I., Padden, C., Arnoff, M., Sandler, W. (2007) Re-Thinking Sign Language Verb Classes: The Body As Subject. *Journal of Linguistics*, 43, 531–563.
- Murtagh I. (2019a) A Linguistically Motivated Computational Framework for Irish Sign Language. Dublin: Trinity College Dublin, Ireland.
- Murtagh I. (2019b) Motivating the Computational Phonological Parameters of an Irish Sign Language Avatar. In B. Nolan and E. Diedrichsen (Eds.) *Linguistic Perspectives on the Construction of Meaning and Knowledge Representation*. Cambridge: Cambridge Scholars Publishing, pp. 323–339.
- O’Baill, D. & Matthews, P. A. (2000) *The Irish Deaf Community (Volume 2): The Structure of Irish Sign Language*. Dublin: The Linguistics Institute of Ireland.
- Padden, C. (1983) *Interaction of Morphology and Syntax in American Sign Language*. PhD Dissertation, University of California, San Diego [Published 1988 by Garland Outstanding Dissertations in Linguistics, New York].
- Padden, C. (1988) *Interaction of Morphology and Syntax in American Sign Language: Outstanding Dissertations in Linguistics, Series IV*. New York: Garland Press.
- Pizzutto, E. & P. Pietandrea (2001) The Notation of Signed Texts. *Sign Language and Linguistics* 4, (1/2). pp.29–45.
- Pustejovsky, J. (1991a) The Generative Lexicon. *Computational Linguistics*, 17(4), 209–441.
- Pustejovsky, J. (1991b) The syntax of event structure. *Cognition*, 41, 47–81.
- Pustejovsky, J. (1992) The syntax of event structure. In B. Levin and S. Pinker (Eds.) *Lexical and conceptual semantics*. Cambridge, MA: Blackwell Publishers, pp.47–81.
- Pustejovsky, J. (1995) *The Generative Lexicon*. Cambridge: MIT Press.
- Pustejovsky, J. (2000) Events and the semantics of opposition. In C. Tenny & J. Pustejovsky (Eds.) *Events as Grammatical Objects*. Stanford, CA: CSLI, pp. 445–482.
- Quadros, R. (1999) *Phrase Structure of Brazilian Sign Language*. Unpublished PhD dissertation. Pontifícia Universidade Católica do Rio Grande do Sul, Porto Alegre.
- Rathmann, C. (2000) *The Optionality of Agreement Phrase: Evidence from Signed Languages*. MA Thesis. The University of Texas at Austin.
- Rathmann, C. & Mathur, G. (2002) Is Verb Agreement the Same Cross-modally. In R. Meier, K. Cormier & D. Quinto-Pozos (Eds.), *Modality and Structure in Signed and Spoken Languages*. Cambridge: Cambridge University Press, pp. 370–404.
- Rathmann, C. (2005) *Event structure in American Sign Language*. Unpublished doctoral

- dissertation. Austin: University of Texas.
- Sapountzaki, G. (2005) *Free Functional Elements of Tense, Aspect, Modality and Agreement as Possible Auxiliaries in Greek Sign Language*. Unpublished doctoral dissertation. Bristol: University of Bristol.
- Smith, W. (1990) Evidence for Auxiliaries in Taiwan Sign Language. In S. Fischer & P. Siple (Eds.) *Theoretical Issues in Sign Language Research, Vol. 1: Linguistics*. Chicago: University of Chicago Press, pp. 211–228.
- Sutton-Spence R & Woll, B. (1999) *The Linguistics of British Sign Language; An Introduction*. Cambridge: Cambridge University Press.
- Van Valin, R. (2005) *Exploring the Syntax-Semantics Interface*. Cambridge: Cambridge University Press.
- Van Valin, R. & La Polla, R. (1997) *Syntax: Structure, Meaning and Function*. Cambridge: Cambridge University Press.
- Vendler Z. (1967) *Linguistics in Philosophy*. New York: Cornell University Press.
- Wilbur, R. B. (2003) Representations of telicity in ASL. *Chicago Linguistic Society*, 39, 354–368.
- Wilbur, R. B. (2008) Complex Predicates involving Events, Time and Aspect: Is this why sign languages look so similar? In J. Quer (Ed.), *Signs of the time: Selected papers from TISLR 2004*. Hamburg: Signum Press, pp 217–250.
- Zeshan, U. (2000) *Sign Language in Indopakistan: A Description of a Signed Language*. Amsterdam: Benjamins.^{[L]_{SEP}}
- Zwitserlood, I. & Van Gijn, I. (2006) Agreement Phenomena in Sign Language of the Netherlands. In: P. Ackema, P. Brandt, M. Schoorlemmer & F. Weerman (Eds.) *Arguments and Agreement*. Oxford: Oxford University Press, pp. 195–229.