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Slicing Your SL Data into Basic Discourse Units (BDUs) Adapting the BDU Model (Syntax + Prosody) to Signed Discourse

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Abstract

This paper aims to propose a model for the segmentation of signed discourse by adapting the Basic Discourse Units (BDU) Model. This model was conceived for spoken data and allows the segmentation of both monologues and dialogues. It consists of three steps: delimiting syntactic units on the basis of the Dependency Grammar (DG), delimiting prosodic units on the basis of a set of acoustic cues, and finding the convergence point between syntactic and prosodic units in order to establish BDUs. A corpus containing data from French Belgian Sign Language (LSFB) will be firstly segmented according to the principles of the DG. After establishing a set of visual cues equivalent to the acoustic ones, a prosodic segmentation will be carried out independently. Finally, the convergence points between syntactic and prosodic units will give rise to BDUs. The ultimate goal of adapting the BDU Model to the signed modality is not only to allow the study of the position of discourse markers (DMs) as in the original model, but also to give an answer to a controversial issue in SL research such as the segmentation of SL corpus data, for which a satisfactory solution has not been found so far.

Keywords: discourse segmentation, Basic Discourse Units (BDU) Model, Dependency Grammar, pauses, sign holds, eye blinks

1. To Start with...

When one cooks, different steps need to be followed to elaborate a dish. Just like when one speaks or signs, different discourse segments are sequenced to produce an oral text. At present, there are still many unresolved theoretical issues concerning the study of orality in both spoken and signed languages, although research on the latter modality is still at its infancy when compared to the first modality. Discourse segmentation is an issue at stake for both modalities because it is at the basis of how discourse in the oral setting is structured. Still, spoken language (SpL) research is slightly in advance as scholars have already developed some consolidated models to segment spoken discourse. The reason why these models emerged is that the concept of sentence works well at the level of syntax, but it has proved to be insufficient to study the structure of oral productions because both monologues and dialogues contain other elements (interjections, discourse markers, etc.) that are not comprised within the traditional syntactic notion of a sentence.

To the best of our knowledge, six different models are used for discourse segmentation of SpLs in the oral setting:¹ the Geneva Model (Roulet et al., 1985), the Val.Es.Co. Model (Briz Gómez and Grupo Val.Es.Co., 2003), the Fribourg Model (Groupe de Fribourg, 2012), the Co-Enunciation Model (Morel and Danon-Boileau, 1998), the Prominence Demarcation Model (Lombardi Vallauri, 2009) and the Basic Discourse Units Model (Degand and Simon, 2005; Degand and Simon, 2009a; Degand and Simon, 2009b). These segmentation models define their discourse units on the ba-

sis of different approaches, namely pragmatic, prosodic or in a combination of syntax and prosody. Despite these three possibilities, prosody is almost always present to a greater or lesser extent because it is one of the main forces that organises spoken discourse (Morel and Danon-Boileau, 1998) and it provides objective and measurable criteria such as pauses, tone units and differences in f_0 .

On the one hand, the Co-Enunciation Model (CEM) and Prominence Demarcation Model (PDM) almost totally base their segmentation methodology on prosody by taking into account long pauses, tone units or a change in f_0 to delimit discourse units. On the other hand, the Geneva Model (GM), the Fribourg Model (FM) and the Val.Es.Co. Model base their segmentation methodology in pragmatics. The GM completely discards prosody and their discourse units are delimited according to illocutive forces, to whether they elicit a response from the addressee or are an answer to the addressor's preceding talk. The FM consists of a micro-syntactic and a macro-syntactic segmentation, the first using relational links (in the sense of *rection* in French, i.e. government) and the second using prosody to delimit discourse units. The Val.Es.Co. Model (VAM) segments according to a hierarchy of units (discourse, dialogue, exchange, turn, intervention, act and subact) where prosody is seen as an accessory that should only be used if needed. Eventually, the Basic Discourse Units Model (BDU) combines both syntax and prosody for the delimitation of their units. This is the model that we took as a basis for our research and that we adapted to the signed modality.

So far, sign languages (SLs) do not have a model for discourse segmentation, although the necessity and importance of having a consistent methodology to segment signed discourses has been widely acknowledged in the literature (Crasborn, 2007; Ormel and Crasborn, 2012; Börstell et al., 2014; Hodge, 2014), to name a few. Some of these authors have undertaken some initiatives to segment signed discourses into sentences (Börstell et al., 2014;

¹There are other well-known methodologies for the segmentation of written productions such as the Basel Model (Ferrari, 2005; Ferrari et al., 2008) and the Rhetorical Structure Theory (Mann and Thompson, 1988). Since SL data is oral, these methodologies for the analysis of written texts are discarded for the purposes of this paper.

Fenlon et al., 2007; Jantunen, 2007; Hansen and Hessman, 2007) by taking into account visual cues. Their claim is that prosody reflects somehow syntactic constituency. To study the structure of discourse, however, the initiatives that aim to a syntactic segmentation into sentences face the same problem that SpLs, i.e. the notion of sentence is not enough to account for the different constituents of oral productions. A different approach is that of Hodge (2014), who proposes to segment into clause-like units (CLUs) defined as "units of analysis smaller than discourse level [...] that correspond with various types of communicative moves in face-to-face interaction" (p. 100). CLUs are identified according to content (semantic relations, image schemas) and perceived form (intonation contours of hand and body rhythms, facial movements and enactment). However, this annotation is largely inductive as the author herself admits.

The creation of a segmentation model that puts aside subjective interpretations and that allows the study of discourse structure is not anodyne as it requires a sound knowledge of the language and a certain amount of data to work on. Unfortunately, SL research is at its beginnings so we are in very preliminary stage of knowledge on how SLs are structured in different linguistic domains (syntax, discourse, etc.), and large amounts of SL data (i.e. corpora) are recently available. The adaptation of one existing SpL segmentation model could palliate these shortcomings. However, this is far from straightforward due to the specificities of SLs: the two hands are the main articulators and they produce simultaneous constructions, and nonmanuals also participate in the construction of meaning. Bearing in mind these specificities, this paper aims to propose a model for the segmentation of signed discourse whose ultimate goal is to allow the study of the structure of discourse, and particularly the position of discourse markers (DMs) through discourse, i.e. large sets of utterances.

After reviewing the different segmentation models for SpLs, the most suitable model for the segmentation of signed discourse seems to be the BDU Model. Its main advantage is that it is not only applicable to conversation, which was the main drawback for other potentially interesting models that have already been used for the study of DMs such as the VAM or the CEM, but it can also be used for monologic data. Due to the delay in SL research, our model needs to be as versatile as possible (i.e. applicable to as many discourse situations as possible) allowing the use of the 'same measures' to segment both monologues and dialogues, and therefore get comparable units in both settings.

This paper is structured as follows. Section 2 describes the data we selected for the adaptation of the BDU Model, i.e. a sample of the LSFb Corpus (Meurant, 2015), and the type of annotations available. Section 3 includes a short presentation of the BDU Model, the different adaptations made to segment signed data and some examples of the usages we have given to the model with our data. Section 4 concludes this work.

2. Method

This research is a crumb of a larger project that aims to describe cross-linguistically DMs in French Belgian

Sign Language (LSFB) and Catalan Sign Language (LSC) across different genres. Our corpus for the adaptation of the BDU Model will exclusively be made up of LSFb data because LSC data are not openly available yet. 6 deaf native signers² were selected from the LSFb referential corpus (Meurant, 2015). This sample is balanced in terms of age (2 signers belonging to each of the following age groups: 18-29, 30-49 and 50-80) and gender (3 men and 3 women). Signers came in couples (both belonging to the same age group) to the studio based at the University of Namur, and their conversations (including argumentative, descriptive, explicative and narrative tasks) were guided by a moderator. For this paper, we chose an argumentation on deaf issues and a narration of a past memory. In total, the corpus lasts for 42'45". Table 1 describes the content of the sample including the genre, the task instruction and the duration of the task per couple of informants.

Our data, containing conversations in LSFb from different genres and different signers, constitutes a sound corpus because language bias are avoided. Indeed, our adaptation of the BDU Model is not constrained by the specificities of a genre or by the idiosyncrasies of a single signer.

All the data were previously annotated by deaf annotators with the multimodal ELAN software³, which allows that tiers can always be added or hidden at any time of the annotation process. The resulting files contain a basic annotation (Johnston, 2015) consisting in ID-glosses for the left and right hands, and free translations. At the time of this research, the selected files had the manual activity fully annotated, but some translations into French were still lacking. The files neither include additional detailed annotation such as non-manual features nor the annotation of units larger than individual signs such as constructed action or constructed dialogue.

For the purposes of this work, we added three extra tiers: one for syntactic units (SyU), one for prosodic units (PrU) and another one for BDUs. Syntactic and prosodic segmentation were carried out independently. First, dialogues were segmented into syntactic units. Afterwards, the SyU tier was hidden in order to delimit prosodic units in the PrU tier. When this was done, both the SyU and the PrU tiers were displayed in order to delimit BDUs in the tier created to this end.

3. Using the BDU Model to Get Sliced SL Discourses

So far, the BDU Model recipe has been used with one type of cuisine: SpL data. As argued above, we would like to give it our touch in order to get sliced SL discourses. In this section, we first describe the BDU Model in a nutshell and afterwards we present the different adaptations made for the signed modality together with some possible usages.

²Researchers take different criteria to refer to the concept of 'deaf native signer'. In our case, we refer to individuals who have been born in deaf families and/or that have followed all their scholarship in a boarding school for the deaf.

³<https://tla.mpi.nl/tools/tla-tools/elan/>

Genre	Task	Duration	Age group
Argumentation	Explain the differences between deaf culture vs. hearing culture	04'53"	18-29
		07'12"	30-49
		08'46"	50-80
Narration	Explain a past memory	04'46"	18-29
		09'05"	30-49
		08'09"	50-80

Table 1: LSFb data

3.1. How Does the BDU Model Work?

The main idea behind the BDU Model (Degand and Simon, 2005; Degand and Simon, 2009a; Degand and Simon, 2009b) is that the only observable linguistic criteria that must be considered for the delimitation of units are syntax and prosody. The resulting basic discourse units (BDUs) are the minimal units the addressee uses when reconstructing what the speaker is saying, and they may be of different nature, i.e. they may regulate discourse, package information, express didactic focus, emphasis (Degand and Simon, 2009a). The segmentation consists of two independent analyses: a syntactic and a prosodic one that are carried out in Praat⁴, a free open source software package to analyse speech.

On the one hand, syntactic mapping is based on the Dependency Grammar (DG) as conceived for spoken French by Blanche-Benveniste et al. (1984) and Blanche-Benveniste et al. (1990). In short, syntactic units are comprised of a 'nucleus' (mostly verbs, but also nouns or adjectives) that governs its 'dependants', i.e. actants (specific dependants belonging to the restricted valency of the verb) or circumstants (dependants of the verb but out of its valency). In addition, there are other elements called adjuncts that can be added to any construction in a less restrictive way. In example 1, borrowed from Degand and Simon (2005, p. 69) together with its translation, the clause contains a verb which is the nucleus, together with three elements: 'le permis' is the actant (ACT) as it belongs to the valency of the verb, i.e. one needs to specify what is possessed. 'Pour le moment' is the circumstant (CIRC) as it depends on the verb but it is out of its valency, i.e. if it is left out, the clause still makes sense. Finally, 'de toute manière' is an adjunct (ADJ) because its role is to connect clauses.

- (1) <de toute manière>_{ADJ} [j'ai pas le permis]_{ACT}
pour le moment]_{CIRC}
'<in any case>_{ADJ} [I do not have
the licence (driver's)]_{ACT} for the moment]_{CIRC}'

The result of this syntactic mapping gives rise to three different types of dependency clauses (Tanguy et al., 2012): verbal dependency clauses (governed by a verb), averbal dependency clauses (governed by an element other than a verb), and elliptical dependency clauses (incomplete clauses that can be interpreted as verbal dependency units when referring to the context as in answers). Moreover, these units can either be interrupted (the clause lacks an obligatory complement and/or it has been started but not

completed) or contain adjuncts such as DMs. The final step for the annotation of syntactic units consists in identifying the 'functional sequences' that integrate each dependency clause. These functional sequences are the "clausal constituents that occupy a main syntactic function like Verb, Subject, Object, etc." (Degand et al., 2014, p. 248).

On the other hand, prosodic mapping is trickier because there is not a consensus on a prosodic model to be used for French. Prosodic segmentation is therefore performed on the basis of a semi-automatic annotation procedure developed by Mertens and Simon (2009) that allows the establishment of major, intermediate and minor prosodic boundaries. Neither minor nor intermediate boundaries are taken into consideration for the BDU Model, only major boundaries are used for segmentation. Major boundaries are marked by a silent pause, a lengthening of the syllable (three times longer than the syllables in context) or a sharp rise of f0 (intra-syllabic f0 superior to ten semi-tones). Four types of segmentation units result from this procedure: "Continuation (rising f0 movement), Finality (falling or low f0), Focus (sharp falling from high to low contour) and Suspense (flat and lengthened contour)" (Degand et al., 2014, p. 249).

Once the syntactic and the prosodic units have been delimited, the frontiers of BDUs are established in the places where syntactic and major prosodic boundaries coincide. As a result, BDUs may be congruent (syntactic and prosodic boundaries coincide), syntax-bound (a syntactic unit contains several prosodic units), intonation-bound (a prosodic unit contains several syntactic units), regulatory (the unit is an adjunct or DM) or mixed (there are several syntactic and prosodic units within the BDU before the boundaries coincide). This segmentation including a syntactic and a prosodic mapping into BDUs allows the study of the position of different discourse elements.⁵ The dependants of a nucleus can be found in initial or in final position with respect to the verb (SV), which means that they are syntactically dependent and prosodically integrated. Example 2 illustrates a clause with a CIRC in initial position.

- (2) [à la première manifestation la première journée de
grève]_{CIRC} c'était]_{SV} le mouvement s'essouffle]
'[at the first demonstration the first day of the
strike]_{CIRC} it was]_{SV} the movement ran out of
steam]'

⁵The following examples of this section together with the translations are borrowed from Degand et al. (2014) and simplified. See note 7 for the symbols used in the examples.

⁴<http://www.praat.org/>

Dependants can also be syntactically dependent but prosodically isolated, i.e. their position is either the prosodic left periphery (LP) or right periphery (RP). This means that, if we take the clause in example 2, there would be a prosodic break between the CIRC and the SV.

As for adjuncts (such as DMs, agents, etc.), they can be syntactically independent but prosodically integrated (syntactic LP or RP). Another possibility for them is to be syntactically independent and prosodically isolated (i.e. syntactico-prosodic LP or RP). In this last case, they constitute a regulatory BDU. Example 3 illustrates these two positions. There are two DMs and two BDUs. The first DM, i.e. 'bon', is situated at the syntactico-prosodic LP and makes up the first BDU which is regulatory. The second DM, i.e. 'mais', is at the syntactic LP as it is out of the dependency of the elliptical clause 'pas nous', but both the clause and the DM are within the second BDU.

- (3) <bon>_{dm} / <mais>_{dm} [pas nous]
'<well>_{dm} / <but>_{dm} [not us]'

All these positions are summarised in table 2.

Position	Syntactically	Prosodically
Initial	Dependent	Integrated
Final	Dependent	Integrated
Syntactic LP	Independent	Integrated
Syntactic RP	Independent	Integrated
Prosodic LP	Dependent	Isolated
Prosodic RP	Dependent	Isolated
Syntactico-prosodic LP	Independent	Isolated
Syntactico-prosodic RP	Independent	Isolated

Table 2: Possible positions in the BDU

3.2. How Do I Use the BDU Model with My Signed Data?

We will answer this question by presenting how we adapted the recipe of the BDU Model to get sliced SL discourses. Afterwards, we also suggest some serving ideas, i.e. some possible applications of the model.

3.2.1. Adapting the Recipe

Take your videos and get prepared to slice them. The first adaptation is that we will use a different segmenting tool from the original BDU Model, i.e. we will be using ELAN instead of Praat. Anyway, our segmentation procedure will consist of three different steps: (i) delimiting syntactic units, (ii) delimiting prosodic units, and (iii) finding the convergence point between syntactic and prosodic units in order to establish BDUs. The first two steps are independent, which means that once the syntactic segmentation is finished, this tier will be hidden in order to carry out the prosodic segmentation independently.

Syntactic segmentation The BDU Model delimits syntactic units (i.e. clauses) using the DG for spoken French as conceived by Blanche-Benveniste et al. (1984) and Blanche-Benveniste et al. (1990), then annotates the type

of clause (i.e. verbal, averbal, elliptical, interrupted or containing a nondependent element) and finally annotates the 'functional sequences' (i.e. verb, subject, object, etc.). For the moment, we will only delimit clauses and we will leave aside the annotation of the type of clause and the functional sequences. Since the ultimate goal of having a segmentation model of signed discourse for us is to study the position of DMs, this first step suffices.⁶

The DG establishes the verb as the nucleus that governs different dependants: actants (inside the valency of the verb) and circumstants (outside the strict valency of the verb). Adjuncts can be added to any construction in a less constrained way. The role of nucleus can also be fulfilled by other elements such as pronouns, nouns or adjectives. In what follows, we will give examples to illustrate these possibilities. We will gather these examples⁷ under the three types of clauses that the BDU Model establishes.

Verbal dependency clauses. As its name reveals, the clause contains a verb that is the nucleus. In SLs, the verb can be either a fully-lexical or a partly-lexical sign. Fully-lexical signs are those tokens that can be dictionary entries of a sign language because they are "highly conventionalised signs in both form and meaning in the sense that both are relatively stable or consistent across contexts" (Johnston, 2015, p. 13). Partly-lexical signs cannot be listed in a dictionary as they are "combinations of conventional and non-conventional (highly contextual) elements" (ibid.). In example 4 (<http://www.corpus-lsfb.be>, session 2, task 4, 03:18-03:20), the verb is a fully-lexical sign with one actant (ACT) and one circumstant (CIRC).

- (4) [PT:PRO1 BUY LAND_{ACT} WITH HEARING_{CIRC}]
'[I bought a land_{ACT} with a hearing person_{CIRC}']

In example 5 (<http://www.corpus-lsfb.be>, session 21, task 4, 02:46-02:50), there is a fully-lexical (START) and a partly-lexical (DS:go-up) sign. The nucleus in this case is DS:go-up and START SCHOOL constitutes a clause that depends on the verb DS:go-up as it is expressing the moment in which the action happens. Therefore, START SCHOOL behaves as a circumstant of the verb DS:go-up. DS:go-up has an actant which is SCHOOL and a circumstant which is UNTIL TEN.

- (5) [START SCHOOL_{CIRC} DS:go-up
SCHOOL_{ACT} UNTIL TIME-TEN_{CIRC}]
'[when it was the time to start school_{CIRC}
we went upstairs (to the classroom)_{ACT}
until ten o'clock_{CIRC}']

⁶We are aware of the interest of looking at the material inside the clause, specially if further research is to be undertaken with a focus on syntax. However, doing so would make the segmentation process too long and therefore not feasible if we want to take several productions (containing different genres and signers) into account.

⁷All the examples in LSFB are annotated using the following conventions: *PT:PRO1* stands for the first person pronoun, *DS:go-up* stands for a depicting sign and its description in context, *-I* stands for an interruption, [] delimit syntactic units (i.e. clauses), < > delimit adjuncts, / separates two different BDUs, and underlined text preceded by \oint marks overlapping between signers.

Averbal dependency clauses. The verb is usually considered the nucleus of the clause. However, there are other elements in oral productions that constitute an averbal dependency clause in itself such as when somebody answers YES to a question (see example 8). On the other hand, SLs allow that another signs working as a pronouns, nouns or adjectives fulfil the role of a nucleus.

In example 6 (<http://www.corpus-lsfb.be>, session 2, task 4, 06:43-06:46), the copulative verb is not manually expressed in the clause, that's why we take the sign DIFFICULT as the nucleus.

- (6) [BANK DIFFICULT MONEY RECEIVE]
'[it was difficult to get money from the bank]'

Elliptical dependency clauses. When a clause is incomplete but it is interpretable as a verbal dependency clause thanks to the context, it is called an elliptical dependency clause (Tanguy et al., 2012). Answers and interventions (among other possibilities) fall within this category. In example 7 (<http://www.corpus-lsfb.be>, session 21, task 3, 04:10-04:16), the signers are discussing about the football matches that used to take place between two boarding schools for the deaf in Brussels called IRSA and Woluwe. S045 says that both schools keep this tradition, but S044 answers that this is not as often as it used to be. The clause that S044 utters (overlapping with his partner) is interpretable as a verbal dependency clause when referring to what S045 says.

- (7) S045: [IRSA WOLUWE TEAM
AGAIN PLAY AGAIN]
ϕ[FOOTBALL PLAY AGAIN] [LESS]
S044: ϕ[PT:DET EVERYDAY] [LESS]
S045: '[the teams at IRSA
and Woluwe still play]
ϕ[they still play football] [less (yes)]'
S044: 'ϕ[not everyday][less often]'

Interrupted dependency clauses. This category encloses all those clauses (verbal, averbal or elliptical) that have been interrupted for a number of reasons such as a new thought that came to the signer's mind, an intervention from the addressee or because of any other contextual factor. In example 8 (<http://www.corpus-lsfb.be>, session 27, task 4, 00:32-00:36), there are two different interruptions. The first time S055 interrupts S056, who is word searching. The second time S055 interrupts herself: she begins a sentence but does not finish it because of the backchannel that S056 provides her.

- (8) S056: [FEEL]^{-I}
S055: [FEEL MORE DEAF] ϕ<PALM-UP>
[BECAUSE PERSON-BLOW]^{-I}
[YES] [THAT-S-IT]
S056: ϕ[YES] <PALM-UP> [GIVE] [YES]
<PALM-UP>
S056: '[I feel]^{-I},
S055: '[you feel more deaf]
ϕ<don't you> [because I realised]^{-I}
[yes] [that's it]'
S056: 'ϕ [yes] <erm> [it makes me feel]
<yeah>'

Clauses containing a nondependent element. This type of clauses include those cases in which adjuncts, i.e. elements that stay out of the dependency structure of the verb such as a DM, constitute a clause alone. Example 9 (<http://www.corpus-lsfb.be>, session 21, task 4, 02:46-02:53) retakes the clause in example 5 and the following one.

- (9) [START SCHOOL_{CIRC} DS:go-up SCHOOL_{ACT}
UNTIL TIME-TEN_{CIRC}] <AFTERWARDS>_{dm}
[PLAY FIFTEEN MINUTES_{CIRC}]
'[when it was the time to start school]_{CIRC}
we went upstairs (to the classroom)_{ACT}
until ten o'clock_{CIRC}] <afterwards>_{dm} [we
played for fifteen minutes_{CIRC}]'

The two clauses express a sequence, i.e. one event happens after the other. This meaning is explicitated by the sign AFTERWARDS that does not take part in the dependency structure of any verb, i.e. it is an adjunct. The nuclei of the two clauses are the depicting sign of movement (Johnston, 2015) DS:go-up and the fully-lexical sign PLAY respectively.

Prosodic segmentation Delimiting discourses into prosodic units is the step that follows syntactic segmentation in the BDU Model. As previously mentioned, both segmentation processes are independent, that's why the tier containing syntactic units has to be hidden before the delimitation of prosodic units starts.

Two types of adaptations are made in order to work with signed data: technical and modality-based adaptations. On the one hand, prosodic segmentation in the BDU Model for spoken data is semi-automatic (Mertens and Simon, 2009). This is far from being a reality with SL data and our prosodic segmentation will be completely manual. On the other hand, the differences between the spoken and the signed modality imply that instead of using a set of acoustic cues to segment spoken productions, we will need to establish a set of equivalent visual cues. The three acoustic cues used in the BDU Model are silent pauses, a lengthening of the syllable (three times longer than the syllables in context) or a sharp rise of f0 (intra-syllabic f0 superior to ten semi-tones). It is known that visual prosodic cues indicate either the duration of phrases (domain markers) or their end (boundary markers) (Wilbur, 2000; Wilbur, 2009). Boundary markers include eye blinks, short head nods, pauses and holds (Herrmann, 2012); and they segment discourse into rhythmic units as they are punctual in nature (i.e. they do not spread) (Pfau and Quer, 2010). Moreover, they coincide with some of the acoustic cues taken into account in the BDU Model for prosodic segmentation.

The first two acoustic cues have a straightforward equivalent in signed discourse as boundary markers: pauses and sign holds (or lengthened signs with respect to the context). *Pauses* are defined as periods of no signing at all in line with Fenlon (2010), and they include stops in which the hands are crossed, are left along the body or are relaxed and placed in the neutral space (Notarrigo and Meurant, 2014). The type of pause is not annotated because it does not seem to provide us with relevant information, and the length is

neither measured.⁸

Sign holds and *lengthened signs* with respect to the context are the equivalents to lengthened syllables. A sign hold appears when the handshape of a sign is held for a longer duration, and a lengthened sign implies that the movement of the sign is repeated, slowed or exaggerated. Although holds can appear at the beginning, in the middle or at the end of the sign (Notarrigo and Meurant, 2014), only holds occurring at the end are taken into account for segmentation. As happened with pauses, neither the type of hold nor the function of the sign hold or lengthened sign are annotated.

For the third acoustic cue used in the BDU Model, i.e. a sharp rise of f_0 , we did not find a straightforward equivalent within the group of visual boundary markers.⁹ We propose to take *eye blinks* as a last visual cue because they are widely acknowledged a prosodic function of marking boundaries in the signed modality (Wilbur, 1994; Sze, 2008; Brentari and Crossley, 2002; Crasborn et al., 2004; Herrmann, 2010) and they segment the discourse into rhythmic units (Pfau and Quer, 2010; Herrmann, 2012) as raises in f_0 do. However, not every eye blink is prosodically relevant as they may serve other linguistic purposes or be physiologically motivated (Wilbur, 1994; Sze, 2008; Herrmann, 2012).

Herrmann (2010) distinguishes between prosodic and non-prosodic blinks by analysing syntactic constituency and sentence structure together with intonational contours and other nonmanual features such as eyebrow movement, eye aperture, eye gaze, head movement, body movement, mouth gestures, and facial expressions (p. 22). We will not follow her syntactic criterion for the identification of prosodic blinks because it would contradict one of principles of the BDU Model, namely that prosodic segmentation has to be done independently from syntax. We will restrict the identification of prosodic blinks to those occurring with another nonmanual prosodic cue. Blinking layered with another prosodic cue was one of the three most common markers of discourse units' boundaries (after pauses and sign holds) in a previous study about the segmentation of LSFb data (Gabarró-López and Meurant, 2014). As with the other cues (i.e. pauses and sign holds or lengthened signs), we will not annotate the visual cues occurring at the prosodic units' boundaries because our purpose is not to do a prosodic analysis but to have a set of cues for prosodic segmentation.¹⁰

⁸The length of a pause is what distinguishes an intermediate and a major boundary in the BDU Model. Not measuring the length of a pause may be seen as a shortcoming in our adaptation, but since we lack of a semi-automatic tool, we should do it manually. Doing so would make the segmentation procedure too long and therefore not feasible.

⁹Spontaneously, one could think of exaggerated signing as a possible equivalent. The main problem is that since there is not a semi-automatic tool that can measure exaggerated signing, this annotation is somehow arbitrary and depends on the annotator's perception.

¹⁰For a study of the most common boundary markers that can be found in LSFb, we refer the reader to Gabarró-López and Meurant (2014).

Delimitation of Basic Discourse Units The final step consists of establishing BDUs where syntactic and prosodic units coincide. Therefore, we will display both the syntactic and prosodic tiers and we will delimit BDUs in a separate tier as shown in Figure 1. The first two tiers in the figure are devoted to the annotation of the manual activity, the third is for syntactic units (SyU), the fourth is for prosodic units (PrU) and the fifth for BDUs. As for SpL data, different kinds of BDU arise after the segmentation of SL data depending on how syntactic and prosodic units align (congruent, syntax-bound, intonation-bound, regulatory and mixed). In Figure 1, there are two different BDUs, the first one is syntax-bound (there are two prosodic units within a syntactic unit) and the second one is intonation-bound (there are two syntactic units within a prosodic unit). So far, the type of BDU has not been annotated although we would like to do so in the future to see if a particular type of BDU is more likely to appear in one genre than in another.

3.2.2. Serving Ideas

Although our adaptation of the BDU Model recipe to get sliced SL discourses is time-consuming, the results have proved to be satisfactory. Undoubtedly, this revisited recipe can be taken as the basis for future research works that require the segmentation of SL discourse. Our serving idea for our sliced SL discourses is to study the position of DMs. As a matter of fact, we have seen that the position of the DM *AUSSI* (here translated as *ALSO*) in LSFb correlates with its function in a particular context. If we take two common functions of *ALSO*, i.e. addition (adding information to the same topic) and specification (introducing an example), we can see that each function displays a particular position with respect to the clause and the BDU. Addition is found at the left periphery (LP) of the clause and at the prosodic LP of the BDU as in example 10 (<http://www.corpus-lsfb.be>, session 21, task 04, 2:37-2:42). There are four clauses, two within each BDU. *ALSO* is out of the dependency structure of the verb *GO* (i.e. clausal LP), but it is prosodically integrated at the beginning of the BDU (i.e. syntactic LP).

- (10) [HEARING PT:PRO1 GO BICYCLE LEARN] [BICYCLE THERE GO] / <ALSO> [GO HORSE] [PT:PRO1 GO HORSE]
'[the Hearing taught me how to cycle] [I went by bicycle] / <and> [I rode horses] [I went to ride horses]'

Specification is found at the LP of the clause and in the medial position of the BDU as in example 11 (<http://www.corpus-lsfb.be>, session 27, task 04, 2:29-2:33). In this case, there are three clauses within the same BDU. *ALSO* is out of the dependency structure of the verb *REMEMBER* (i.e. clausal LP), but it is prosodically integrated in the middle of the BDU (i.e. BDU medial position).

- (11) [YES] <ALSO> [REMEMBER BEFORE LITTLE ALWAYS PT:PRO1] [TODAY SECOND MEMORY CHILD]
'[yes] <for instance> [I remember when I was young] [this is my second child memory today]'

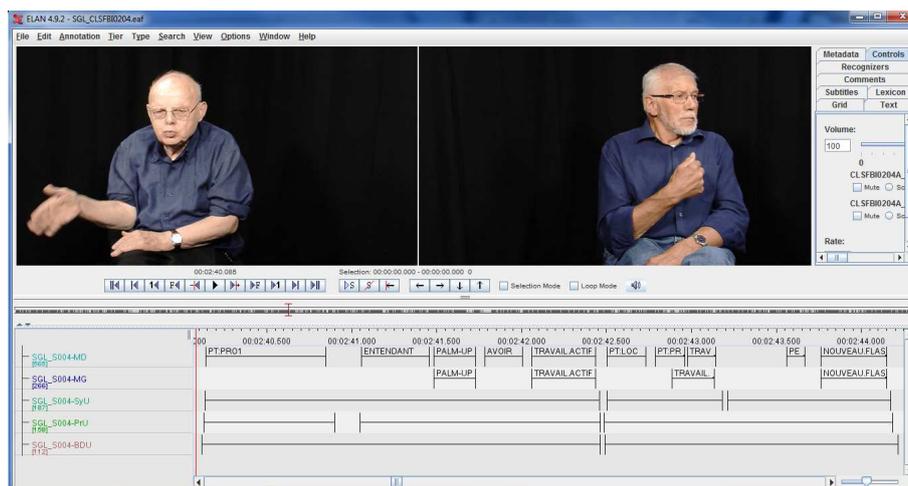


Figure 1: Screenshot of an ELAN file containing syntactic units, prosodic units and BDUs.

This coupling of position and function of ALSO is regular across different examples of our corpus, which includes different signers and different genres. Therefore, the position can be used as a criterion to identify the function of a polysemous DM such as ALSO, whose annotation strongly depends on the annotator's interpretation.

4. To End with...

The recipe to get sliced SL data with the BDU Model is now ready, so make the most of it! At present, our adaptation has proved to be useful for the study of DMs. However, its applications are not restricted to this topic. Our proposal offers a solution for a controversial issue in SL research, i.e. the segmentation of SL corpus data, for which a satisfactory solution has not been found so far. Therefore, this methodology can lead us to explore many unknown issues and answer many questions related to how SLs work.

The segmentation of SL discourses into BDUs could cast light on some of the signers' cognitive processes such as the interpretation of discourses. It is said that a coherent interpretation of a discourse is the result of "integrating the discourse units into a mental representation" (Degand et al., 2014, p. 244). This information packaging takes place at the left periphery (LP) of discourse units as it is the place where the message is started and where it is connected with what was previously said. The study of the LP would give insight on the assumption that SLs prefer constructions of topicalization, or could reveal whether SLs prefer implicit discourse relations over explicit discourse relations.

Another possibility in line with this study of the LP from a broader perspective is to better understand the differences between genres and registers. For instance, we could get to know the discourse features that define a formal speech such as a conference vs. an informal speech such as a joke; or the devices preferred in a monologue over a dialogue. Cross-linguistic SL studies on how discourse is structured would also be feasible because the model proposes a set of common criteria that avoid the annotators' subjective interpretations and therefore assure consistency across data. Just try it and let us know!

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