Testing of subjective perception of complexity of signs of Czech sign language

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Abstract: *The contribution focuses on expanding the theoretical basis for teaching the Czech sign language (hereinafter CSL) and for its particular grammatical description. This knowledge is a necessary condition for efficient teaching both of deaf users (prelingually deaf children) and of hearing users (parents and family members, students of special pedagogy, interpreters etc.).*
More concretely, it reports on the results of research focusing on the subjective assessment of the perception of complexity of signs of CSL from the perspective of potentially hearing students. Another aim of the study was verification of the designed theoretical concept of counting of the number of morphemes in the CSL signs whose number is one of the crucial variables during the process of hierarchical dependences and subsequent verification of the validity of Menzerath-Altmann law in the case of CSL.
In total, 28 signs of CSL were tested while those belong into 7 groups of motion matrices, while 235 respondents subjectively expressed via five-degree Likert scale their opinion on the complexity of a particular sign. From the results, it is concluded that there exists a direct proportional linear dependence between the number of morphemes of individual signs and assessment of their complexity. Based on the discovered results, also an adjustment of the way how to count morphemes was designed for the needs of further qualitatively linguistic analysis.

Keywords: *Czech sign language, teaching sign language, students, quantitative linguistics, Menzerath-Altmann law*

1 Introduction

From January 2017, a multidisciplinary research project funded by the Grantová agentura České republiky (or GAČR, in English the Czech Science Foundation) is solved at Faculty of Education, Palacký University, Olomouc (Czech Republic) in cooperation with Faculty of Arts and Faculty of Science (of the same university) which is called "Theoretical basis for teaching Czech sign language (CSL) tested through

quantitative linguistic methods". A deeper discovering of one of the other linguistic characteristics of CSL (esp. its hierarchical phoneme structure), obtained through quantitative linguistic methods, contribute to the development of special education, especially for theoretical and practical education of CSL. With its concept and used research methods, it is a unique research project while it links the newly created application of qualitative linguistic methods and fractal analysis onto the sign language of deaf people which has (contrarily to the spoken languages) a simultaneous and poly-synthetic nature.

Historically, it was developed based on the analogy with the natural language; equivalents for the concepts used in description of the natural language (like the phoneme, word, sentence etc.) were found for the sign language. This analogy then grounded further focus on the grammar and generally semiotic nature of the sign language. The nature of the sign language, yet, does not reflect the character of a natural language in many aspects as natural languages are usually understood. The biggest difference is seen in simultaneous presence of signs related to phonemes in the text, which does not correspond to natural language speech; whether spoken, written or another. On the other hand, varying individual signs of phonemic analogy in relation to other particular signs corresponds to the allophonic variability and phonotactic rules which are represented more or less in every natural language. There is, however, also a possibility to consider the sign simultaneity in the language of the deaf from the point of view of polysyntheticity; such a perspective, yet, requires the initial grammar model based on the phonemic structure of simultaneously used signs.

Simultaneously composed signs would then be evaluated as sets of semantically independent components, not only phonemes. Such a point of view would mean a significant change in understanding the hierarchy of the CSL. The research project will study the speeches in the CSL of the deaf and will describe them using varying grammar means. It will use for it available transcription methods, possibly it will develop new transcription methods (see further). Such samples will then be analyzed using a wide range of quantitative methods and the results will be compared with quantitative analyses of spoken languages. The used quantitative analyses will enable a safe procedure for evaluating the nature of particular hierarchies through which it sees the analyzed text. This way language types and language unit types will cluster regularly and safely. The same will happen in case of the CSL. This way it will be possible to set up when the grammar description of the CSL is correct and corresponds to the nature of this sign system.

The Menzerath-Altmann law (MAL) is a suitable instrument for text analysis. It is considered as a language universal which reflects so called conservation principles which affect the text production and language structure (cf. the literature at the end of the application). The research project assumes that the identification of the MAL in the CSL manifestations will confirm its correct unit concept, i.e. directly in

comparison with those natural languages with sound-based and with sign writing systems (Chinese). The research will include another range of quantitative metrics through which the manifestations of the CSL will be analyzed. They are e.g. entropy, type-token ratio, word and sentence average length, thematic concentration, the ratio of hapax legomena, token length frequency spectrum, repeat rate etc. Analyses of these metrics will be compared with the manifestations of the MAL.

2 Quantitative linguistics and sign language

In the year of 1928 Paul Menzerath established the following simple hypotheses: "… a sound is the shorter the longer the whole in which it occurs" and "the more sounds in a syllable the smaller their relative length", as stated in (Menzerath, 1928). Later on, in (Menzerath, 1954), when analyzing German words, the author came to a conclusion that the longer the words the shorter the syllables. This way one of the most known, quoted and analyzed laws of quantitative linguistics was born. The hypothesis was put to the test many times employing many samples. Yet, it was popularized and given a mathematical shape by Gabriel Altmann, a German quantitative linguist. Altmann took it under the magnifying glass, tested it and generalized: the longer a language construct the shorter its constituents, cf. (Altmann, 1980), where the language construct is a unit on a higher language level and is composed of units on the immediately lower level, i.e. its constituents. The construct length is measured in the number of its constituents, the constituent length in the number of its subconstituents. The law reflects a universal nature of the language, i.e. to behave in an economical manner. Thus, every natural language is expected to maintain this quality (Köhler, 2008; Hřebíček, 2007; Kelih, 2010).

The research will describe the design of the sign language. The starting point will be elementary semiotic assumptions; it will describe the role of individual CSL instruments based on universal semiotic relationships. The CSL figural level and sign level determinations will become the platform. Following the description of the delimitation of double articulation of CSL levels (i.e. sign means, their components from the point of view of figural means – phonemes/graphemes), the description of the CSL sign structure will be treated and elaborated. It will, at the same time, assist in classifying the combination of distinctive features in figural means. Such analyses will lead to the determination of CSL levels and their quantitative testing based on MAL manifestations. The research will not favor any CSL analogy, yet it backs the design by basic semiotic assumptions.

In a case of linear spoken languages (while it is possible to include Czech, English, German or Chinese languages into this group), the hierarchical dependences and structures are normally researched on the string of the following units:

the text – sentence – clause – word – syllable – phoneme (letter);

in a case of visually motor sign language (with a simultaneous production of phonemes which constitute individual signs and with a possibility of a simultaneous production of more signs), it is possible to research the hierarchical structure on a string of the following units:

the text – sentence – clause – sign – morpheme.

In the case of the first 4 stages (the text – sentence – clause – sign), the spoken languages and sign languages are structurally analogical while it is not possible to identify syllables among the sign languages due to their simultaneousness – the determination of the number of phonemes used is very complicated as well. In the following text, we therefore strive to design a way to calculate phonemes (or meaning-creating morphemes) which are used while articulating individual signs.

The text, apart from the above mentioned, will have to satisfy the criterion of homogeneity to the highest attainable degree. The sentences and clauses are defined in the traditional manner; however, their delimitation will solely be performed by the native speakers of the CSL. The same holds true for the signs (Grzybek, 2015).

Due to a fact that the string of the measurement of the dependence of hierarchical structures (which is mentioned above) has never – in the case of the sign language – been used within the field of quantitative linguistics, it emerged that it is necessary to perform experimental measurement whose aim is a discovery whether there is a similar dependence between the total number of morphemes of individual signs and the subjective perception of their complexity similar to the case of spoken languages (if a word is longer in terms of syllables and speech sounds, it is perceived as more difficult to be learnt and remembered). The educational and didactic aspects of this dependence are also obvious while it may lead to a more effective teaching of the sign language in the practical application from the easier (i.e. easily memorable) signs to signs that are more complex and more difficult.

3 Methodology

Based on the current knowledge, the lowest analyzed level is grounded in the number of morphemes which appear in particularly identified lexical units (signs). Since the signs of CSL (unlike the words of the Czech language) do not consist of linearly produced sounds, with respect to the composition of CSL signs by simultaneously produced parameters, every sign will be presented as the total sum of all morphemes which are produced in its course.

Simultaneously performed manual sign parameters (Macurová, 2008):

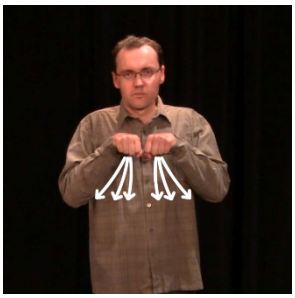
- sign location in the articulation space (TAB)
- the shape of the articulating hand/hands (DEZ)

- the orientation of the palm/palms (ORI1)
- the orientation of fingers (ORI2)
- the movements of the hand/hands (SIG)
- mutual hand arrangement in two-handed signs (HA)

CHOOSE**

	Number of morphemes*	
Parameter	**Right hand**	**Left hand**
TAB	1	0
DEZ	2	0
ORI1	1	0
ORI2	1	0
SIG	1	0
HA	0	
Total	6	

Table 1: The design of the analysis and notation of the total morpheme number in the one-handed sign (CHOOSE)



SPREAD

	Number of morphemes*	
Parameter	**Right hand**	**Left hand**
TAB	2	2
DEZ	2	2
ORI1	1	1
ORI2	1	1
SIG	1	1
HA	1	
Total	15	

Table 2: The design of the analysis and notation of the total morpheme number in the two-handed sign (SPREAD)

* *The number of morphemes on the abovementioned examples states the number of values which are possible to be acquired by a certain parameter in a sign – e.g. the place of articulation of the sign CHOOSE is not changed (TAB = 1) as well as the palm orientation (ORI1 = 1) and orientation of the fingers (ORI2 = 1) while the movement of a hand is not repeated (SIG = 1). However, the original shape of hands is changed (DEZ = 2). At the sign SPREAD, one hand changes the place of articulation (TAB = 2), while the shape of one hand is changed as well (DEZ = 2). Other parameters are not changing (ORI1 = 1, ORI2 = 1, SIG = 1). The mutual position of hands is not changed as well (HA = 1).*

** *In the text, the English equivalents of corresponding signs of CSL are stated in capital letters.*

It is possible to conclude from the stated tables that the total number of morphemes is significantly influenced by the number of hands (which are used to realize a sign) and the number of phonologically important changes in individual parameters (morphemes). However, it remains a question if the abovementioned sign SPREAD (with the total of 15 morphemes) is actually perceived by the students of sign language as significantly more difficult to learn and remember than the sign CHOOSE with the total number of 6 morphemes.

In the professional literature, the signs of sign languages are grouped in several groups according to so-called motion matrices. According to Battison (1978), the following ones are the most common:

- Signs that may be articulated by one hand:
  - signs with zero contacts (e.g. STUDY, DAY, SUN),
  - signs with a contact with the body, however, not with the other hand (e.g. DEAF, FRIEND, OLD).
- Signs articulated by both hands:
  - signs in which both hands are active and both of them are in the same shape (e.g. WEATHER, IMPORTANT, SLOVAKIA);
  - symmetric signs in which one hand is active (the dominant hand – i.e. the right hand among the right-handed people) which articulates above (under, behind, in front of, etc.) the passive hand; both hands are in the same shape (e.g. SOCK, OCTOBER, DANGER);
  - asymmetric signs in which only one hand is active (the dominant hand) which articulates above (under, behind, in front of, etc.) the passive hand; both hands are in a different shape (e.g. GIFT, TECHNOLOGY, TACK).
- Composed signs which include combinations of signs of types mentioned above (e.g. MAY, LIBRARY, DO NOT KNOW).

For the needs of our research and for exploration of the subjective perception of complexity of signs to be learnt, it was necessary to create a classification of motion matrices which respects also the didactic difficulty of individual signs:

- Signs articulated by one hand:
  - signs with zero contacts (= 1H without contact),
  - signs with a contact with the body, however, not with the other hand (= 1H with contact).
- Signs articulated by both hands:
  - symmetric signs in which both hands are active and both of them are in the same shape and perform the same (mirror) motion (= 2H symmetric);

  - semi-symmetric in which the hands are in the same shape and they perform similar or phase-shifted motion (= 2H semisymmetric);
  - non-symmetric signs in which the hands are in the same shape, however, only one hand is active (= 2H non-symmetric);
  - asymmetric signs in which the hands are in different shapes and only one hand is active (= 2H asymmetric).
- Composed signs which include combinations of all above mentioned types of signs (= composed).

All seven motion matrices were accompanied by four corresponding signs of CSL among which the sum of morphemes was analysed. After that, they were anonymized and they were subjected to assessment of respondents of the research in random order (see Table 3). Four signs of each motion matrix seemed optimal number with a regard to the variability of summarized number of morphemes, in order to provide a sufficient number of research data and also with regard to adequate time demands for respondents who had to assess 28 signs in total.

			Number of morphemes											
			Dominant hand					**Non-dominant hand**					**HA**	**Total**
Sign (English equivalent)	**Anonymous code**	**Motion matrix**	**TAB**	**DEZ**	**ORI1**	**ORI2**	**SIG**	**TAB**	**DEZ**	**ORI1**	**ORI2**	**SIG**		
BANANA	SIGN01	2H non-symmetric	3	1	1	1	3	1	1	1	1	0	3	16
YES	SIGN02	1H without contact	1	1	1	2	1	0	0	0	0	0	0	6
TACK	SIGN03	2H asymmetric	1	1	2	1	1	1	1	1	1	0	1	11
DUCK	SIGN04	2H semi-symmetric	1	1	3	1	3	1	1	3	1	3	1	19
100	SIGN05	1H without contact	2	2	2	2	3	0	0	0	0	0	0	11
LIBRARY	SIGN06	composed	3	1	3	1	6	2	1	3	1	2	1	24
MAY	SIGN07	composed	3	3	1	2	2	1	1	1	1	1	2	18
WEATHER	SIGN08	2H symmetric	2	1	1	1	2	2	1	1	1	2	1	15
HIGHWAY	SIGN09	2H semi-symmetric	1	1	1	1	3	1	1	1	1	3	1	15
SUN	SIGN10	1H without contact	3	1	1	1	1	0	0	0	0	0	0	7

SPAIN	SIGN11	1H with contact	1	1	2	1	1	0	0	0	0	0	0	6
OLD	SIGN12	1H with contact	1	1	1	1	4	0	0	0	0	0	0	8
FAT	SIGN13	2H non-symmetric	1	1	1	1	4	1	1	1	1	0	1	13
ART	SIGN14	1H with contact	3	1	2	2	3	0	0	0	0	0	0	11
FEBRUARY	SIGN15	composed	5	2	2	2	5	5	2	1	1	4	2	31
TRUST	SIGN16	2H asymmetric	2	2	2	2	1	1	1	1	1	0	1	14
FAITHFUL	SIGN17	2H non-symmetric	2	1	1	1	1	1	1	1	1	0	1	11
WOLF	SIGN18	1H without contact	2	2	2	2	1	0	0	0	0	0	0	9
BRIGHT	SIGN19	2H asymmetric	3	1	1	2	3	1	1	1	1	0	2	16
DANGER	SIGN20	2H non-symmetric	1	1	1	2	4	1	1	1	1	0	1	14
SHOP	SIGN21	2H semi-symmetric	1	1	2	1	1	1	1	2	1	1	1	13
HELP	SIGN22	2H symmetric	1	1	1	1	1	1	1	1	1	1	1	11
DON'T KNOW	SIGN23	composed	2	2	2	2	2	1	1	1	1	0	1	15
FAMILY	SIGN24	2H symmetric	3	2	1	1	1	3	2	1	1	1	1	17
YEAR	SIGN25	2H asymmetric	3	1	1	1	3	1	1	1	1	1	4	18
EGG	SIGN26	2H symmetric	2	1	1	1	4	2	1	1	1	4	1	19
GREEN	SIGN27	1H with contact	1	1	1	1	3	0	0	0	0	0	0	7
CABBAGE	SIGN28	2H semi-symmetric	1	1	1	2	3	1	1	1	2	3	1	17

Table 3: List of tested signs, their affiliation to motion matrices and numbers of morphemes which are occur in them

The tested signs may be watched (in a form of video recording) at links below:

- 1H without contact – YES (S02), 100 (S05), SUN (S10), WOLF (S18): https://youtu.be/VYzg_bgutxA
- 1H with contact – SPAIN (S11), OLD (S12), ART (S14), GREEN (S27): https://youtu.be/HUdvv7orIHs

- 2H symmetric – WEATHER (S08), HELP (S22), FAMILY (S24), EGG (S26): https://youtu.be/kn5Fc8Lblik
- 2H semisymmetric – DUCK (S04), HIGHWAY (S09), SHOP (S21), CABBAGE (S28): https://youtu.be/7QLuwpoizkE
- 2H non-symmetric – BANANA (S01), FAT (S13), FAITHFUL (S17), DANGER (S20): https://youtu.be/F7Puma2tJVU
- 2H asymmetric – TACK (S03), TRUST (S16), BRIGHT (S19), YEAR (S25): https://youtu.be/5Ec0INzhYoc
- Composed – LIBRARY (S06), MAY (S07), FEBRUARY (S15), DON'T KNOW (S23): https://youtu.be/Znfe8Ikk770

In order to discover the subjective perception of signs' complexity, an online questionnaire was applied (via GoogleDocs) while it employed five-degree Likert's scale to mark the complexity of all 28 signs. Individual signs were introduced to the respondents in anonymized form of isolated video recordings at which a deaf signer interprets the sign. All video recordings of signs were presented in the same light and color conditions and in the same (standard) speed. The respondents might (according to the introductory instruction) play the video recording of each sign any time they wanted and they were asked to mark their subjective perception of each sign on the scale of 1 (very simple) – 5 (very complicated) (see Figure 1 below). It was recommended to watch all the signs at the beginning and to use the whole scale 1–5.

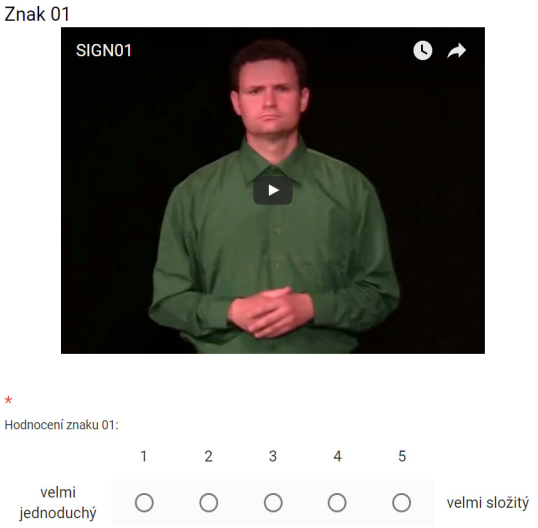


Figure 1: On-line form for the scale-based assessment of signs' complexity

Due to a fact that a vast part of CSL is visually motivated, has an iconic nature and, therefore, the visual course of a sign reminds a typical attribute of an item or a phenomenon which they represent (cf. Langer, 2013), it is possible to think that the knowledge of semantic meaning of these signs may influence the respondent in their subjective perception of sign's complexity. Since the aim of the realized research was to discover the perception of signs' complexity of respondents who were not aware if their meaning, a question to discover respondent's practical experience with CSL (or for how long do they study CSL) was included in the questionnaire as well. At the end of the questionnaire, several additional questions of demographic nature were included to discover the sex, age and economic status (high school student, university student, other respondents) of respondents. The respondents might also add any comments to the researched problematics and the online questionnaire itself.

4 Respondents and research course

The created scale-based online questionnaire was administered for the period of 19 days (13th February – 2nd March 2017), 3 main groups of respondents were addressed while they were typical hearing students of CSL:

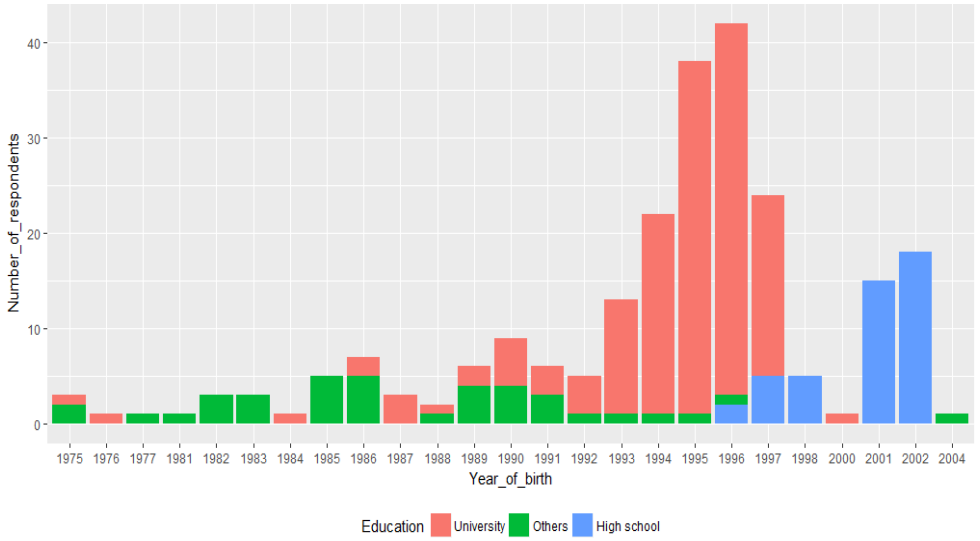
- high-school students who study CSL because of their personal or professional interest,
- university students who study CSL because of their personal or professional interest,
- adults (aged 25–35 years) which is the age in which the hearing parents of a deaf child start to learn CSL.

Contacting of potential respondents was performed in a form of link which was given out together with introductory instructions based on personal visits of researchers in several classes of Slovanské gymnasium Olomouc (in case of high-school students) and personal visits of researchers in classes of university students of 3 faculties of Palacký University Olomouc: Faculty of Education, Faculty of Arts and Faculty of Science. The parents of young deaf children were contacted via personal contacts of researchers, community social networks and the snowball method. The responses of the respondents were anonymous

In total, 236 unique respondents were joined the research while 1 respondent have not managed to fill in the whole online questionnaire correctly. Therefore, this respondent's answers were not included in the further process. Therefore, data by 235 unique respondents were subjected to further analyses (see Table 4 below).

	Sum			Average age		
	Males	**Females**	**Total**	**Males**	**Females**	**Total**
High-school students	19	26	45	16.2	16.9	16.6
University students	15	137	152	24.4	22.6	22.8
Others	16	22	38	30.3	29.7	29.9
Total	50	185	235	23.2	22.7	22.8

Table 4: Demographic characteristics of the respondents



Graph 1: Age structure of the respondents

	Length of CSL study (in years)					
	0	**1**	**2**	**3**	**4**	**5 and more**
High-school students	45	0	0	0	0	0
University students	112	30	6	2	0	2
Others	36	1	0	0	0	1
Total	193	31	6	2	0	3

Table 5: Respondents' experience with CSL study

The possibility to add a comment linked to the researched problematics and to the online scale-based questionnaire itself was used by 36 respondents in total. The vast majority of the respondents positively assessed the form of the questionnaire while it showed a greater interest in CSL and the issue of communication among the deaf. In addition, the impulse to state Czech equivalents of individual signs was frequently mentioned while the anonymization of individual researched signs was the aim of researches (the same information channel was used to send a link to the respondents once the questionnaire was administered while it contained a modified version of the online questionnaire in which the Czech equivalents were stated). Only 2 comments of a technical nature contained an impulse to include a possibility to play the signs slower and to enable the zooming-in to see the signing hands in detail. However, these adjustments were not desirable due to the aims of the research.

5 Results and Discussion

From the responses which were recorded in data file of online questionnaire form, the following results of the scale-based assessment of signs complexity (1 = very easy; 5 = very hard) emerged for the researched signs (see Table 6 below):

				Average rating		
Sign (English equivalent)	**Anonymous code**	**Motion matrix**	**Number of morphemes**	**All**	**Without experience**	**With experience**
YES	S02	1H without contact	6	1.3	1.3	1.3
100	S05	1H without contact	11	3.2	3.1	3.4
SUN	S10	1H without contact	7	1.2	1.3	1.1
WOLF	S18	1H without contact	9	1.5	1.5	1.6
GREEN	S27	1H with contact	7	1.6	1.6	1.7
SPAIN	S11	1H with contact	6	2.2	2.2	2.4
OLD	S12	1H with contact	8	1.4	1.4	1.3
ART	S14	1H with contact	11	2.8	2.9	2.6
WEATHER	S08	2H symmetric	15	1.3	1.3	1.2
HELP	S22	2H symmetric	11	1.3	1.4	1.2
FAMILY	S24	2H symmetric	17	2.0	2.0	1.8
EGG	S26	2H symmetric	19	1.6	1.6	1.4
DUCK	S04	2H semisymmetric	19	3.0	3.0	2.7
HIGHWAY	S09	2H semisymmetric	15	2.0	2.0	1.9
SHOP	S21	2H semisymmetric	13	1.7	1.7	1.6

CABBAGE	S28	2H semisymmetric	17	2.0	2.1	1.9
BANANA	S01	2H non-symmetric	16	2.7	2.9	1.8
FAT	S13	2H non-symmetric	13	1.8	1.7	1.8
FAITHFUL	S17	2H non-symmetric	11	1.4	1.3	1.5
DANGER	S20	2H non-symmetric	14	2.8	2.8	2.6
TACK	S03	2H asymmetric	11	1.6	1.5	2.0
TRUST	S16	2H asymmetric	14	1.8	1.7	2.1
BRIGHT	S19	2H asymmetric	16	3.1	3.1	3.1
YEAR	S25	2H asymmetric	18	2.1	2.2	1.9
LIBRARY	S06	composed	24	3.6	3.7	3.0
MAY	S07	composed	18	3.5	3.4	3.5
FEBRUARY	S15	composed	31	3.1	3.2	2.7
DON'T KNOW	S23	composed	15	3.4	3.4	3.3

Table 6: Average assessment of signs' complexity by the respondents

From the results stated above, it is possible to conclude (see Table 7 below) that the lowest average values at scale from 1 (very simple) to 5 (very complicated) were achieved in all three groups (all/without any experience with sign language/with experience with sign language) by one-handed signs or by two-handed signs in which both hands are in the same shape (the symmetric and non-symmetric). Signs of this type therefore have an extensive didactic potential and they should be (in addition to the contextual and content point of view) included in the vocabulary for students – beginners.

	All			**Without experience**			**With experience**		
Rank	**Sign (English equivalent)**	**Motion matrix**	**Av. rating**	**Sign (English equivalent)**	**Motion matrix**	**Av. rating**	**Sign (English equivalent)**	**Motion matrix**	**Av. rating**
1.	SUN	1H without contact	1.2	SUN	1H without contact	1.3	SUN	1H without contact	1.1
2.	WEATHER	2H symmetric	1.3	FAITHFUL	2H non-symmetric	1.3	WEATHER	2H symmetric	1.2
3.	HELP	2H symmetric	1.3	WEATHER	2H symmetric	1.3	HELP	2H symmetric	1.2
4.	YES	1H without contact	1.3	YES	1H without contact	1.3	OLD	1H with contact	1.3
5.	FAITHFUL	2H non-symmetric	1.4	HELP	2H symmetric	1.4	YES	1H without contact	1.3
6.	OLD	1H with contact	1.4	OLD	1H with contact	1.4	EGG	2H symmetric	1.4

7.	WOLF	1H without contact	1.5	WOLF	1H without contact	1.5	FAITHFUL	2H non-symmetric	1.5

Table 7: The order of seven signs with the lowest average value of complexity.

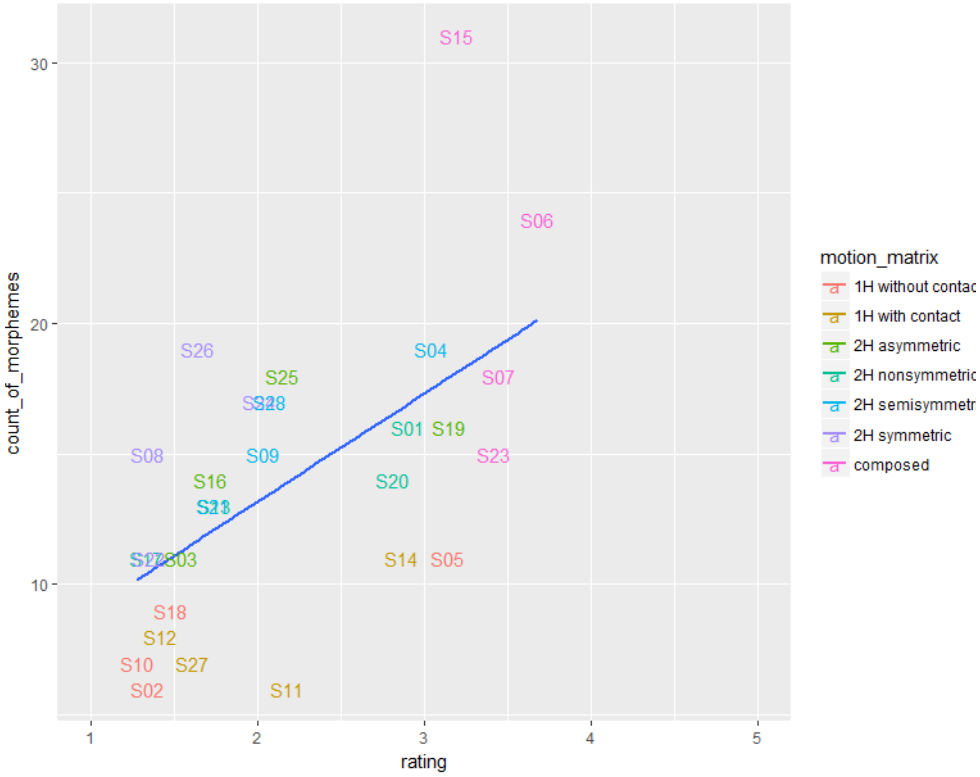
In terms of a group of 7 signs with the highest average value of complexity, the vast majority of respondents (as expected) of all 3 groups mentioned the composed signs – i.e. signs with a combination of more motion matrices in which there is a larger number of morphemes (see Table 8 below). However, the placement of a sign for a numeral 100 with a motion matrix of a one-handed sign without a contact is rather surprising. Nevertheless, it is a sign with rather high number of morphemes which are necessary to capture – therefore, it is obvious that the high number of morphemes is significantly projected in the perception of its complexity even in case of one-handed sign. From the perspective of didactics, they are not appropriate to be taught in the initial training.

	All			**Without experience**			**With experience**		
Rank	**Sign (English equivalent)**	**Motion matrix**	**Av. rating**	**Sign (English equivalent)**	**Motion matrix**	**Av. rating**	**Sign (English equivalent)**	**Motion matrix**	**Av. rating**
22.	DUCK	2H semi-symmetric	3.0	DUCK	2H semi-symmetric	3.0	FEBRUARY	composed	2.7
23.	FEBRUARY	composed	3.1	100	1H without contact	3.1	DUCK	2H semi-symmetric	2.7
24.	BRIGHT	2H asym-metric	3.1	BRIGHT	2H asym-metric	3.1	LIBRARY	composed	3.0
25.	100	1H without contact	3.2	FEBRUARY	composed	3.2	BRIGHT	2H asym-metric	3.1
26.	DON'T KNOW	composed	3.4	DON'T KNOW	composed	3.4	DON'T KNOW	composed	3.3
27.	MAY	composed	3.5	MAY	composed	3.4	100	1H without contact	3.4
28.	LIBRARY	composed	3.6	LIBRARY	composed	3.7	MAY	composed	3.5

Table 8: The order of seven signs with the highest average value of complexity.

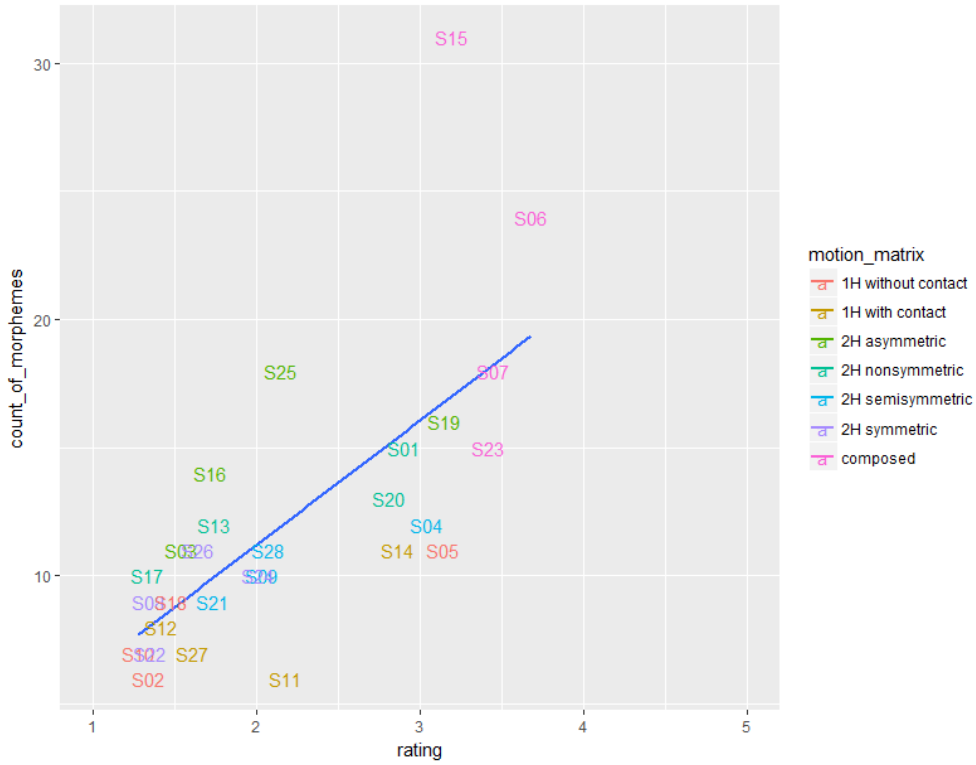
From the distribution of values of average assessment of the signs' complexity, the linear dependency of the complexity of a sign on the number of its morphemes (see Graph 2 below) is obvious, however, not entirely essential (the correlation reaches the value 0.4). At the same time, the non-standard placement of signs S08, S09, S24, S25, S26 and S28 is obvious, while they are, despite a rather high number of morphemes, assessed as relatively simple. Due to a fact that they are two-handed symmetric signs (2H symmetric), there emerge a question of an unwanted overrating of the total

number of morphemes among these signs since it is basically a mirror image and motion of both hands.

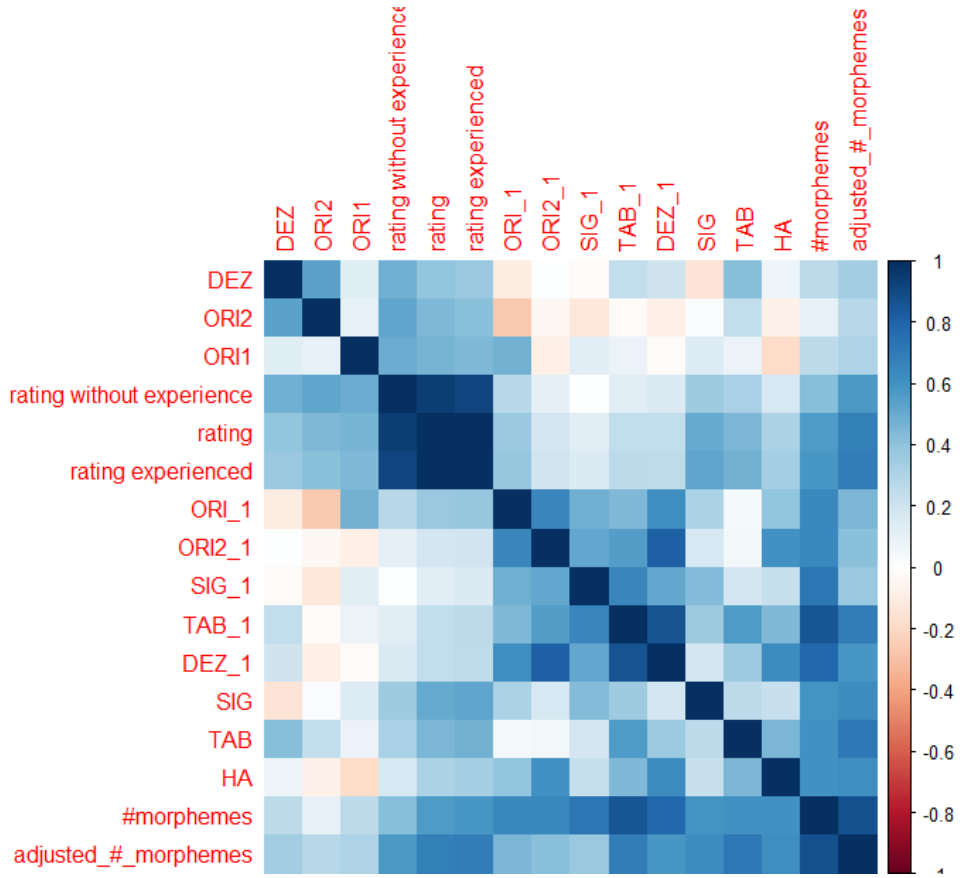


Graph 2: The dependence of the average value of sign's complexity on the number of morphemes

After the supplementary adjustment of number of morphemes of two-handed signs, in which both hands are in the same shape (symmetric, semisymmetric and asymmetric signs), which was based on the reduction of number of morphemes at a non-dominant hand to the value 1 (in case of symmetric signs), reduction to the value 2 (among semisymmetric signs), and reduction to the value 3 (among non-symmetric signs) – the linear dependence is less disrupted (see Graph 3 below).



Graph 3: The dependence of the average value of sign's complexity on the number of morphemes after their supplementary reduction



Graph 5: Correlation of a type of morpheme and its assessment

In the Graph 5 (see above), the correlation matrix for signs and assessments in the questionnaire is plotted. The most interesting discoveries are presented in fourth to sixth rows. The assessment of complexity done by respondents with and without experience with sign language are strongly correlated. Therefore, the signs which are complex for one group are complex for the second group as well. Among both groups, the correlation is growing when the number of morphemes is adjusted (last two columns), therefore, the adjusted assessment is more corresponding to the perception of complexity of signs among the respondents (the correlation raises from 0.42 to 0.57 among respondents without experience, and from 0.57 to 0.68 in total.

6 Conclusion

The realized research confirmed the original theoretical assumption that the number of morphemes (phonemes that carry meaning) in CSL signs is proportionally influencing the subjective perception of complexity of presented signs. The number of morphemes was at the beginning of research stated in a way that it referred to the sum of phonemes occurring during the articulation of a sign in individual parameters of a sign for both dominant and non-dominant hand.

The results also showed the fact that the assessment of complexity of two-handed signs among which both hands are in the same shape (i.e. symmetric, semisymmetric and non-symmetric signs) does not correspond to their placement in a graph of the trends stated by other types of signs. The cause may be the fact that the same shape of hands and more-or-less identical other parameters at both hands cause an impression of relatively simple sign among the respondents. During the modeling and the supplementary adjustment of the sum of total number of morphemes among the three groups of signs (instead of morphemes of the non-dominant hand among symmetric signs +1, among semisymmetric signs +2, and non-symmetric signs +3), their placement within the graph showing the dependence between the number of morphemes and the value of their complexity seems to be adequate and it corresponds the observed linear dependence.

From the didactic perspective, we consider substantial the confirmation of the theoretical assumption of the easier memorability of the signs which contain a lesser number of morphemes. As the simplest ones, the symmetric signs are considered, i.e. those which are performed with hands in the same shape, they are in mirror positions and they perform the identical motion. In addition, both groups of one-handed signs are perceived as relatively simple – e.g. those with no contact and with a contact to a body. The composed signs are unambiguously perceived the most complex and difficult. While designing the methodology of CSL teaching for target groups of hearing people (while the research included respondents from 13 to 42 years of age), it would be appropriate to include signs from groups of motion matrices which were perceived simple mainly in the initial stages of the teaching.

The results stated above are also principal for the execution of planned quantitatively linguistic analysis of CSL for which the numbers of morphemes of individual signs are the lowest level of the observed hierarchic structure. As stated above, the originally proposed calculation of the sum of morphemes proved to be (via research) overvalued (among two-handed symmetric, semisymmetric and non-symmetric signs), therefore, the supplementary adjustment of the calculation was performed.

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