Utterance fluency in Finnish Sign Language
L1 and L2 signing

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Abstract

This paper explores the fluency of first language (L1) and second language (L2) signers of Finnish Sign Language. The phenomenon was approached by measuring utterance fluency using speed and breakdown parameters. The findings revealed clear differences between L1 and L2 signers regarding the measured fluency parameters. On average, L1 signers produced more signs and had fewer breakdowns per minute than L2 signers. However, the slowest L1 signer and the fastest L2 signer were more similar to each other than the averages of the L1 group's (129.3) and the L2 group's (71.4) signs per minute might suggest. The number of breakdowns per minute differed between the groups, with L2 signers breaking down on average over three times more often than L1 signers. The relative proportion of breakdown types also varied. These findings support the concept of fluency as rather a multidimensional continuum of features than a categorical phenomenon.

Keywords: breakdowns, fluency, L2 learning, Sign Language, speed

1 Introduction

In the most global sense, *fluency* is what Segalowitz (2010) calls *communicative competence*: It includes the requirement of mastering situationally adequate and natural usage of language, portraying it as a rather pragmatic skill. Previous studies on fluency have mainly focused on fluidity in spoken language, and research on fluency in Sign Languages is still limited and in its early stages. In Sign Languages, the parameters of fluency become visible in the visual-gestural modality. However, finding the key parameters of fluency and measuring them in an efficient way is still a work in progress. Knowing the major fluency features of signed languages would benefit L2

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language learners in their pursuit of striving towards fluency. This paper aims to create an opening towards understanding the topic in signed languages.

In the minds of many, the default yardstick in fluency seems to be the idea of an all-embracingly fluent native speaker. However, the tools for assessing skills in foreign languages (including sign languages) may not address native-likeness in their criteria, even at the highest grades, while still mentioning fluency (Council of Europe 2020). The so-called native norm can furthermore be questioned by the findings of Bosker et al. (2014), who showed that there exists variation in fluency ratings given by listeners not only to L2 speakers, but to L1 speakers as well. According to Hulstijn (2011), all language users form a continuum of fluency, in which individual differences in language proficiency and fluency can be remarkable.

In Sign Languages, native standard is even more elusive. Due to the heterogeneity of the signing population, defining a native signer can be a challenging task. The Deaf communities across the world consist of individuals with varying degrees of hearing and differences in the time of acquiring both signed and/or spoken language.[1] The vast majority of Deaf children are born to hearing parents with no prior knowledge of Sign Language, whilst most Deaf parents have hearing children (Allen 2015). Thus, access to both spoken and signed language and the degree of bi- and multilingualism show significant variation in the population. Counting as native only those Deaf people with Deaf parents and access to Sign Language from birth would exclude the vast majority of people using Sign Language as a L1.

Sign Language learners differ from the majority of spoken language learners as well. Instead of being expressed through voice in an oral-aural modality like spoken languages, signed languages utilise a visual-gestural modality by using articulators such as the hands, torso and facial expressions simultaneously (for more, see Puupponen et al. 2015). Therefore, when starting to learn a signed language, hearing language learners with a spoken L1 start learning a new language in an articulatory system different from the one they are accustomed to in the domain of language production. We refer to these people as M2L2 (second modality, second language) learners, to address the second language learning process in the second modality. The challenges of acquiring a new language in a different modality were studied by Hilger et al. (2015). Unlike M2L2 signers, people with a signed language as their L1

[1] To emphasise the sociocultural aspects instead of audiological status, *Deaf* is often spelled with a capital D in sign linguistic literature. For more, see e.g. Chen Pichler et al. (2018).

have the visual-gestural modality internalised for language use and as their first modality (M1), which could mean they show different patterns to those of M2L2 learners when learning a new Sign Language.

Discussion about whether M1L2 learners of a signed language might more resemble spoken language M1L2 learners than M2L2 Sign Language learners is ongoing (Chen Pichler & Koulidobrova 2015). Studying the fluency of M2L2 signers may yield different results than studying unimodal language learners' (M1L2) fluency. This is not to say that hearing Sign Language learners with a spoken L1 are altogether unfamiliar with using a visual-gestural modality. On the contrary, they have been using it for gestures alongside their L1 from the start. Esipova (2019) even suggests co-speech gestures should to be treated as bona fide linguistic objects, as the way they are used and accepted alongside speech is not random. However, when learning a signed language, they are using the modality for the first time systematically for language production. Thus, we argue that it is necessary to be mindful of the fact that M2L2 learners are using not only a foreign language, but also using it in a modality that is distinct from their L1 modality.

When describing the features of fluency in Sign Language, it is important to remember the heterogeneity of language users and learners. In spoken languages, there seems to exist a gap in how temporally similar L1 and L2 speech are perceived (Bosker et al. 2014; Bosker & Reinisch 2015). In order to understand how fluency operates in L1 and L2 signing, it seems therefore necessary to study it in both groups. Juxtaposing L1 and L2 production to study fluency has previously been utilised in spoken languages by Skehan (2009), Bosker et al. (2013) and Hilton (2014). By including both groups and finding what typical fluency behaviour is for each and how they may differ, a fuller picture of the phenomenon in general can be achieved. Hence, language learners and teachers alike can be better supported respectively.

1.1 Operationalising fluency in Sign Languages

In signed languages, fluency becomes observable visually, produced with manual (e.g. handshape, orientation of palm and fingers, place of articulation and movement) and non-manual (e.g. head, mouth, torso and face) elements. In order to operationalise and measure the features of fluency in Sign Language, it is appropriate to review how they have been operationalised in speech in prior studies.

A common solution to the problem of defining fluency in a research-wise

meaningful fashion has been to narrow down the focus of examination to a few designated attributes. Some of these attributes can be seen in Skehan's (2009) segregation of fluency into three categories: *breakdown (dis)fluency*, *repair (dis)fluency*, and *speed fluency*. Of these, breakdown disfluency is indexed with pauses, whereas repair disfluency is identified with instances of repetitions, replacements, false starts and reformulations. Lastly, speed fluency can be calculated using measures such as the number of syllables or words per minute.

In contrast to Skehan's measurement-centred approach, Segalowitz (2010; 2016) argues fluency to be dependent on the point of view: he names the three aspects of fluency as *cognitive*, *perceived* and *utterance fluency*. Of these, cognitive fluency refers to the processes that take place in the speaker's brain, and perceived fluency focuses on the listener's impressions of fluency, based on the qualities of utterances. What Segalowitz calls utterance fluency fits into Skehan's description of fluency, where they both situate the same measurable temporal features, such as utterance speed and breakdowns. The separation of the three aspects is rational according to De Jong et al. (2013), too, as they point out that the crucial features of fluency may not be the same to listeners and utterers.

Even with the theoretical separation of the three aspects of fluency and the possibility of fluency having different key features depending on one's position, the aspects may in practice reflect one another. A rather consistent correlation between two aspects, utterance fluency and perceived fluency, has been found in several studies. Papers by Derwing et al. (2009), Rossiter (2009), De Jong et al. (2013), Pinget et al. (2014) and De Jong et al. (2015) have found that both utterance speed and breakdowns occurring during the production have an influence on the fluency rates given by listeners. At the same time, the pause phenomenon was found to be one of the major disfluency characteristics to diminish the ratings in both Bosker et al. (2013) and Pinget et al. (2014), whereas they had differing findings on the repair phenomenon.

Building on the notion that both speed and breakdowns have an impact on listeners' perception of fluency, Bosker et al. (2014) showed how listeners' ratings of temporally manipulated speech samples of L1 and L2 speakers were affected in a similar fashion by speed and breakdowns. At the same time, the L1 group received more favourable ratings overall. Comparing L2 and L1 users' utterance fluency has been utilised in several other studies as well, such as Skehan (2009), Bosker et al. (2013) and Hilton (2014). Another means to delve into utterance fluency has been to juxtapose the L1 and L2 production of

the same individuals. This was utilised by Duran-Karaoz & Tavakoli (2020) and De Jong et al. (2015), who found that some L2 fluency measures, such as clause-end pauses, could be predicted from L1 behaviour.

The means of counting speed and breakdowns have varied. Whether utterance speed should be measured as words, syllables or pruned syllables per minute or as mean lengths of run between breakdowns has been debated (see Cucchiarini et al. 2002; Derwing et al. 2009; Rossiter 2009; Hilton 2014). Moreover, whether speed should be counted including breakdowns and other disfluencies or without them has been disputed (see Bosker et al. 2013).

In general, the topic of fluency has not yet been investigated thoroughly in signed languages. An overview of the papers assembled by Kanto & Haapanen (2019) showed that the number of papers on fluency in Sign Languages is still minute, although growing. In American Sign Language, perceived fluency was researched by Lupton (1998). Word retrieval tasks have been adopted by Sehyr et al. (2018) in American Sign Language and by Marshall et al. (2013) in British Sign Language in investigations on the semantic fluency of signers.

In Finnish Sign Language, two studies have covered signing speed. Jantunen et al. (2016) compared Finnish and Swedish Sign Language L1 signers in regard to signing speed and head movements. They found that on average, Finnish Sign Language signers' (N=10) narratives included 129 signs per minute, with the time including breakdowns. In Sipronen (2018), the L1 data consisted of signed recollections of past events instead of the elicited narrations that were used in Jantunen et al. (2016) and the current study. The average signing speed of the two L1 signers in Sipronen (2018) was found to be 157.8 signs per minute including breakdowns, but because of the extremely small number of signers in the study mentioned, generalisations regarding these findings cannot be made.

Studying fluency in Sign Languages more thoroughly may introduce a novel angle to the question of whether fluency is a language-specific feature or the result of the individual's own characteristically smooth cognitive processing. Studying fluency in them may therefore shed light on some features of fluency in general.

1.2 The current study

Due to the relatively recent initiation of the field, utterance fluency is one of the domains that have not yet been thoroughly investigated in Sign Language

fluency. Accordingly, even its fundamentals are not established, and there is much we do not know about the topic. As such, this paper makes an important contribution to the field.

As stated, a rather consistent connection between utterance speed and the number of breakdowns produced by speakers, and the grading of fluency by listeners has been found in several papers delving into spoken language fluency (Derwing et al. 2009; De Jong et al. 2013; Pinget et al. 2014; De Jong et al. 2015). Building on this insight, utterance fluency in Finnish Sign Language was measured using two temporal parameters: speed and breakdown fluency. The first of these, here called *signing speed*, is measured as signs per minute. Likewise, breakdown fluency is measured as breakdowns, mainly pauses, per minute. Signing speed was decided to be counted plainly as signs per minute, as the exact nature of the syllable in Sign Languages is still debated (for more, see e.g. Sandler 1993; Brentari 1998; Jantunen & Takkinen 2010). Moreover, this decision enables further, more flexible studies with larger data masses in the future, as the used corpus data have annotations on signs but not syllables.

The research questions are as follows:

1. What is the average number of signs and breakdowns in a minute in L1 and L2 Finnish Sign Language narrative signing?

2. What differences and similarities are there between L1 and L2 signers' signing speed and breakdowns in narrative signing?

We expect to find differences both between the groups and inside the groups. It is likely that L1 signers will produce more signs and fewer breakdowns in their signing. With the two research questions, we hope to illuminate the nature of speed and breakdown fluency in Finnish Sign Language.

2 Methods

2.1 Data

The data was received from the ProGram dataset (University of Jyväskylä 2016), Corpus of Finnish Sign Languages, CFinSL (University of Jyväskylä 2018), and the similar Learner's Corpus. From the seven different options available, task number five with narrations from children's picture books (*The*

Snowman and *Frog, Where Are You?*) were chosen as the research material. The data of CFinSL is taped in pairs sitting opposite each other.

With narratives, the participants recounted the stories in the given picture books to their pairs, after first acquainting themselves with them. According to Skehan (2009), narration tasks can be unrelenting, as there is less room for avoiding the more difficult elements of the language. The reason for choosing a narration rather than a discussion task was that with one-way signing, the impact of interaction on utterance fluency was minimised. During the narrations, the addressee might produce some minor feedback signs, such as KYLLÄ ('yes') or PI ('yes / that's right') might take place from the addressee, but no other interactions were included in the analysed material.

The informants were ten signers aged 22–32, with five Deaf M1L1 and five hearing M2L2 signers. From the L2 group one was male and the rest female, while in the L1 group, two were female and three male. The Deaf participants labelled as L1 signers were all people who had had Finnish Sign Language as their primary language since early childhood in their everyday life. The L2 participants were people with education in Sign Language Interpreting. They all had from five to ten years of experience, including the four-year interpreting education in its entirety, in using Finnish Sign Language as an L2 at the time of the recording. With their uniform, structured background in learning the language, they were considered as a suitable group of L2 users to investigate. Additional proficiency measurements were not used to assess the participants' language skills, as no widely used proficiency tests are available in Finland for Finnish Sign Language.

We opted to call the two groups *L1* and *L2*. Given the heterogeneity of the Deaf community and population in Finland, the word *native* would not have been unproblematic. Defining a native signer is challenging, given that the means and age of acquiring Sign Language vary significantly, and only a minor part of the community acquires it from birth (Allen 2015). Naming the two groups *Deaf* and *hearing* was nevertheless dismissed, as it would have given too much of an emphasis to participants' audiological status at the expense of their linguistic status.

The length of each video was dependent on the signers themselves, as no time restriction was given for either becoming familiar with the given story or narrating it. Thus, the individual duration of the video material varied from 1 minute and 45.6 seconds to 9 minutes and 6 seconds per participant. The L1 group had 20 minutes and 21 seconds combined, while the L2 group's video material was 18 minutes and 43.2 seconds in total. The total length of the

analysed material was 39 minutes and 3.6 seconds, which included the time from the start of uttering the first sign of the narrative to the end of the last sign of the narrative from each participant.

Comparing L1 and L2 signers can prove to be fruitful, as differences between the two groups should be expected. Findings can be utilised for the benefit of language learners and teachers alike if the typical fluency and disfluency patterns in language production are known. One should nevertheless be mindful of the way the results are put forth, so that one does not unwittingly amplify the idea of an ideal standard native, compared to whom the L2 users always lack something. We argue, however, that juxtaposing the groups does not need to mean the same thing as comparing and judging one as "good" and the other as "bad".

2.2 Analysis

The data was processed and annotated using ELAN (2020). Each participant was issued with three tiers: number of signs, breakdowns and notes. In the L1 group's data, two new annotation tiers were a sufficient addition, as the signs in this groups' material were pre-annotated. As in the CFinSL annotation guidelines, the long model of a sign (Jantunen 2015), and the broad notion of the sign (Johnston 2016) were used as a basis for annotating signs. Adhering to the long model of the sign, as outlined by Jantunen (2015), the annotation cells' starting point was when the first articulatory features of a sign could be identified, and the ending point when last such recognisable features ended. In addition, along the lines of Johnston (2016), instead of including only lexicalised and half-lexicalised signs, non-lexical signs such as gestures were also included in the sign annotation tier. They were used to ensure congruence with other CFinSL data to allow possible further analysis. The quantity of signs was concluded to be sufficient, as the content of what was signed was not the focus of this study. The annotation cells that were made in the L2 group's files were therefore left empty.

Signing speed was gauged including breakdowns, instead of deducting their duration from the time signed and then counting speed fluency, as De Jong et al. (2015) and Bosker et al. (2013) suggested. The motive for this decision is that with the annotation conventions and the long model of sign (Jantunen 2015) used here, it is not completely possible to prevent breakdown annotations from overlapping with the annotations for signs. Moreover, as simultaneity is typical of signed languages, pausing while signing or holding

some aspects of the produced signs is seen as a simultaneous phenomenon instead of a consecutive one, and is therefore handled accordingly.

All breakdowns that were deemed as such were annotated accordingly. Thus, whether the breakdowns appeared in a suitable place or manner was not evaluated. Unlike in spoken languages, there is no audiological separation into silent and filled pauses, because of the modality difference. A similar distinction between pauses in which the hands stay in the signing space and pauses where the hands are lowered below the signing space to rest could have been possible, as in Sipronen (2018), but due to the small number of breakdowns with the hands below the signing space, this option was ruled out.

On the breakdown tier, eight distinct types were annotated: *prolong*, *tapping*, *hold*, *false start*, *oscillating*, *empty*, *searching* and *other* (see Table 1). Unlike the other breakdown types listed here, false start is, according to Skehan (2009), not a breakdown but a repair disfluency phenomenon. Nevertheless, we decided to include it in our study. When speaking about our *breakdown* types, we refer to all eight, including false starts. When talking about specific breakdown types excluding false starts, the word *pause* is used as well. Instead of deciding the categories in advance, the eight breakdown types were established in a data-driven process via multiple laps of reviews.

In this paper, *prolong* means situations where the signer had finished uttering a sign, but left the articulating hand or hands in the air, or generally at the sign's finishing point, holding the sign's handshape visible to some extent. The annotation for prolong always started at the first frame in which the sign's micro- or macro-movement had stopped, and ended at the last frame where the signer's hand(s) had not yet started a new movement. At the same time, while the hand(s) was/were stationary, no changes were to occur in the non-manual articulators for the breakdown to be annotated as prolong. A minimum length of five video frames was determined as a threshold for prolongings, along the lines of the CFinSL annotation guidelines (Salonen et al. 2018). The five-frame threshold means a minimum length of 0.2 seconds, as the length of one frame is 0.04 seconds. Occurrences shorter than that were not considered as prolongings and not annotated at all.

Instances where the signer was changing the orientation of their hands and/or the handshape as if seeking the next sign were marked with the annotation *searching*. Searching was manifested by signers altering the handshape and/or orientation of their hands without producing any recognisable signs, usually with their gaze on their hands. Unlike false starts, however, this class of breakdown had no recognisable outcome. Moments in

Table 1. The eight breakdown types

Type	Definition
Prolong	Annotation starts when the movement of a sign ends and the hand(s) stay(s) in the signing space (usually at the end point of the sign), holding the sign's handshape to a recognisable extent. The last frame is the frame that precedes the beginning of a new movement. A minimum length of five video frames (0.2 seconds) was chosen to abide by CFinSL annotation guidelines.
Searching	The signer moves their hands as if searching for the next sign, altering the handshape and/or orientation of their hand(s). Unidentified sign-like productions are also included in this class. The duration of the annotation is the same as the length of the actions mentioned.
False start	The signer starts producing a sign that can be recognised, but discontinues the production before it is finished. The same length as the length of a sign annotation.
Empty	Annotation starts when both hands start lowering downwards under the signing space to rest, and ends at the last frame of stillness before a movement back towards the signing space begins. The hands have to lie still on the lap/stomach for at least one frame (0.04 seconds) to be a pause of this class.
Hold	The next sign can be recognised by the handshape and/or hands' place, but the signer does not start producing the sign until they have held their hand(s) still for a moment. Annotation starts at the first frame where the hand(s) are ready in place and the upcoming sign is recognisable, and ends at the last frame of such a state.
Oscillating	The signer oscillates their fingers without the movement representing a micromovement of a sign. The annotation duration is the same as the fingers' oscillating duration.
Tapping	The signer makes a tapping movement twice or more with their pointed index finger or a pointing sign. With pointing signs, special attention has to be given to non-manual elements to confirm filling a pause. The duration of the annotation is the same as the tapping movement's duration.
Other	The signer holds their hand(s) in the signing space without a clear handshape or movement towards the next sign. Hand lowering, wrists and handshape relaxing, or a minor swaying motion may occur. The length of the annotation is the same as one of the actions listed above.

which the signer's production could not be comprehended or recognised as a meaningful sign, even if it looked as if it was targeted to be a valid one, were also annotated as *searching*.

Episodes where the signer started producing a sign that could be recognised but did not finish it were annotated as *false starts*. The length of the annotation on the breakdown tier with false starts was the same as it was on the sign tier, as, despite their incomplete nature, they were annotated as signs as well (see Salonen et al. 2018). Unlike with false starts, in *holds* the target sign was eventually completed in its entirety. Prolongings and holds occurring inside compound signs were also annotated on the breakdown tier accordingly.

Occasions on which the signer lowered both hands in a resting position below the signing space to rest, usually on their lap or stomach, were classified as *empty*. These breakdowns had a threshold duration of at least one frame (0.04 seconds), during which the hands laid still on the signer's lap/stomach, even though the hands' downward movement was included in the annotation. If the hands did not reach the lap/stomach and did not remain there for least one frame without moving, the breakdown was annotated as *other* (see below).

Those occurrences where the subsequent sign could be recognised by the handshape and/or starting position but the signer did not start to produce it immediately were classified as *holds*. Thus, they were the times when the signer positioned their hand(s) ready, but began to sign only after keeping them still for a moment.

Occasions where the signer waved their fingers without it being a micromovement of a sign were annotated with the *oscillating* tag.

Instances where the signer tapped the air twice or more, usually with their pointed index finger, or with a pointing sign such as KATSOA ('to look at', see Figure 1), were labelled as *tapping* on the breakdown tier. The material only included one instance of a tapping pause with a pointing sign other than pointing with the index finger. Therefore, more consideration will need to be given to discriminating pointing signs that grammatically include the tapping motion from other possible filled pauses indexed with a tapping motion.

The category *other* included episodes in which the signer held their hands in the signing space without a clear handshape or movement towards the next sign. These moments differed from transitions between signs and hold class breakdowns in that the movement was not targeted towards the next sign, although some movement, e.g. hands moving due to relaxing of the wrists, hands lowering towards the lap but not reaching it, or minor swaying motion, may occur.

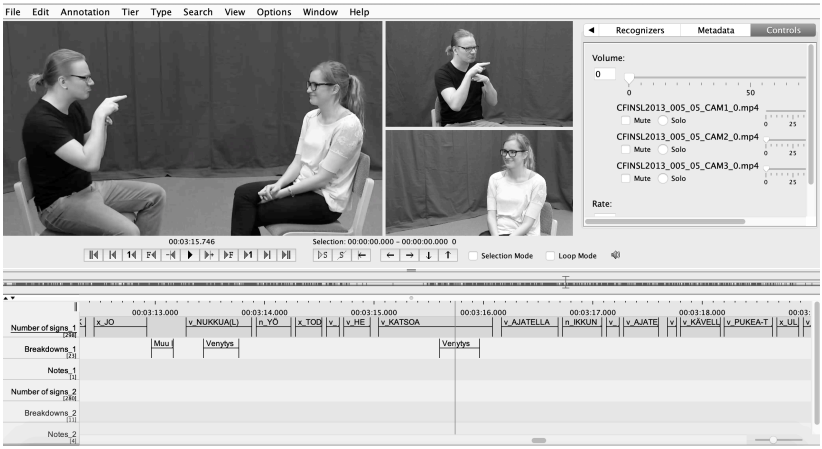

Figure 1. ELAN screenshot showing the signer to the left prolonging the sign KATSOA (‘to look at’)

Notes of signing, breakdowns and non-manual activity were annotated on a separate tier. On this tier were also annotated notes of other phenomena, such as signs that had unnecessarily many repetitions of movement. These were annotated for possible subsequent studies.

One participant’s narrative was randomly selected for the reliability analysis. An L1 user of Finnish Sign Language annotated breakdowns and classified them into the drawn participant’s recording, independently from the main annotator. After this, the two annotators’ works were compared to each other. The inter-rater reliability of breakdown segmentation, as the degree of agreement between the two coders working independently from each other, was 87%. Thus, the coders agreed on the occurrence of breakdowns during the participant’s narration with an interobserver agreement exceeding 80%, which is generally considered sufficient. Cohen’s kappa was used to explore the degree of agreement between the two coders regarding the type of breakdown. Following the guidelines provided by Landis & Koch (1977), the agreement on breakdown types ($k = 0.89$) was very good.

2.3 Statistical analysis

Due to the small size of the data set, only non-parametric statistical tests were used. The Mann-Whitney Test and Monte Carlo analysis were conducted to compare whether there were any statistically significant differences between the L1 and L2 groups regarding the occurrences of different fluency parameters analysed (speed, number and length of breakdowns, and breakdown types). Monte Carlo analysis focuses on exploring whether a correlation is based on coincidence (Van Geert & van Dijk 2002). We decided to run 10,000 iterations to calculate estimated p-values and confidence intervals for p-values.

3 Results

3.1 Speed

With our research questions, we set out to study the signing speed of narratives recounted in Finnish Sign Language, along with breakdown disfluencies during the signing. Moreover, we wanted to find out the differences and similarities between L1 and L2 narrative signing. To answer the research questions, we calculated the number of signs and different types of breakdowns per minute from our L1 participants ($N = 5$, participants F–J) and L2 participants ($N = 5$, participants A–E), and compared these two groups (for the raw numbers, see Table 2).

From the complete material it can be seen that the signing speed presented a considerable amount of variation. The fastest signer produced over 2.5 times more signs per minute than the slowest participant. When counting both the L1 and L2 group signers, the average number of signs per minute was 100.3, with a range of 96.53 and standard deviation (SD) of 34.6.

The signing speed varied both at an individual level and between the two groups. In the L1 group, the average signing speed was 129.3 signs per minute with a range of 47.27 and an SD of 21.5, while in the L2 group the average signing speed was 71.4 signs per minute with a range of 28.56 and an SD of 11.6. Comparing both groups' slowest and fastest participants' signing, we can see that individual variation in both groups was extensive, but the variation in signing speed inside the L1 group was greater than in the L2 group (see Figure 2). With their difference of 20.7 signs per minute, we can also see that the fastest signer in the L2 group and the slowest in the L1 group

Table 2. Findings of speed and breakdown parameters in each participant (* SD 34.6, Range 96.53; ** SD 11.39, Range 35.65; A–E = L2 participants, F–J = L1 participants)

	Total video duration (s)	Signs (*n*)	Signs per minute*	Breakdowns (*n*)	Breakdowns per minute**	Average breakdown annotation duration (s)
A	250.16	296	70.99	111	26.62	0.45
B	158.76	194	73.32	57	21.54	0.47
C	194.2	200	61.79	82	25.33	0.68
D	342.08	511	89.63	81	14.21	0.47
E	177.84	181	61.07	78	39.71	0.55
F	121.48	298	147.18	23	11.36	0.27
G	106.6	280	157.6	11	6.19	0.28
H	232.76	428	110.33	41	10.57	0.36
I	546.16	1043	114.58	37	4.06	0.3
J	214.88	418	116.72	24	6.7	0.3

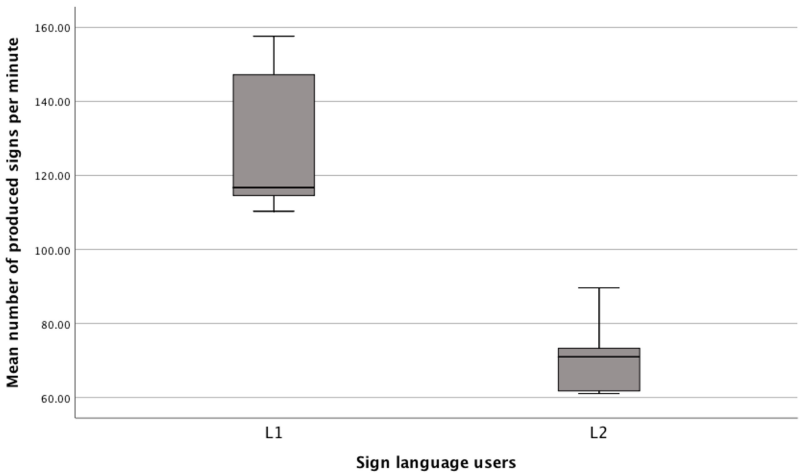

Figure 2. Mean number of signs produced per minute in L1 and L2 groups. Boxplots represent the 95% confidence interval for the means.

were closer to each other than their own group's other extremes. Still, the distinct difference in the two groups' average signing speed was clear. As can be seen in Table 3, the participants in the L1 group produced statistically significantly more signs per minute than those in the L2 group ($U = 0.000$, $z = -2.611$, $p = 0.008$). In addition, Monte Carlo simulations (10,000 iterations) showed significant differences between the groups ($p = 0.007$ with confidence interval $p = 0.005 \ldots 0.009$), suggesting that the signing speed of L1 participants was faster compared to L2 participants.

3.2 Breakdowns

The material contained 545 breakdowns in total. Of these, the L1 group produced 136 in their combined 20.35 minutes and the L2 group 409 in their 18.72 minutes. In total, the L1 group's material contained 41.88 seconds of breakdown annotations, whereas there were 213.4 seconds of breakdown annotations in the L2 group's material. As the lengths of the video materials were not commensurate, the raw numbers are not directly comparable. For this reason, we cover them as instances per minute, as we did with speed fluency.

The difference in average breakdown length and frequency was notable between the groups. The results show that the L2 group broke down more often ($U = 25.000$, $z = 2.611$, $p = 0.008$) and for longer periods of time ($U = 25.000$, $z = 2.611$, $p = 0.008$) than the L1 group did (see Tables 2 and 3, and Figure 3). In addition, Monte Carlo simulations (10,000 iterations) showed p-values of 0.008 (confidence interval $p = 0.005 \ldots 0.009$) for both breakdown length and frequency, suggesting a significant difference between the groups. The average number of breakdowns in the L1 group was 7.8 and in the L2 group 25.5 per minute. On average, signers of the L2 group therefore had breakdowns over three times more often than the participants in the L1 group did. However, as with signing speed, major individual differences existed. In the L1 group, the range in breakdowns per minute was 7.3 and SD 3.09, whereas in L2 the range was 25.5 and SD 9.3. As with signing speed, the individual in the L2 group with the least breakdowns and the individual in the L1 group with the most breakdowns were closer to each other in their breakdown frequency, with their range being only 2.8, than their own group's other extremes.

Comparing the two groups on their average breakdown annotation duration, we found that there existed more variation among the L2 group members than inside the L1 group. In other words, L1 group members were

Table 3. Comparison of different fluency parameters between L1 and L2 signers

Fluency parameters	Sign Language user	Median	SD	Min.	Max.	Mann-Whitney test		
						U	*z*	*p*
Number of signs/min	L1 ($n = 5$)	117	21.6	110	158	0.00	−2.611	0.008
	L2 ($n = 5$)	71	11.7	61	90			
Number of breakdowns/ min	L1 ($n = 5$)	6.7	3.1	4	11	25.00	2.611	0.008
	L2 ($n = 5$)	25.3	5.1	14	26			
Length of breakdowns	L1 ($n = 5$)	6.8	4.6	3.0	14.6	25.00	2.611	0.008
	L2 ($n = 5$)	43	11.3	26.6	55.9			

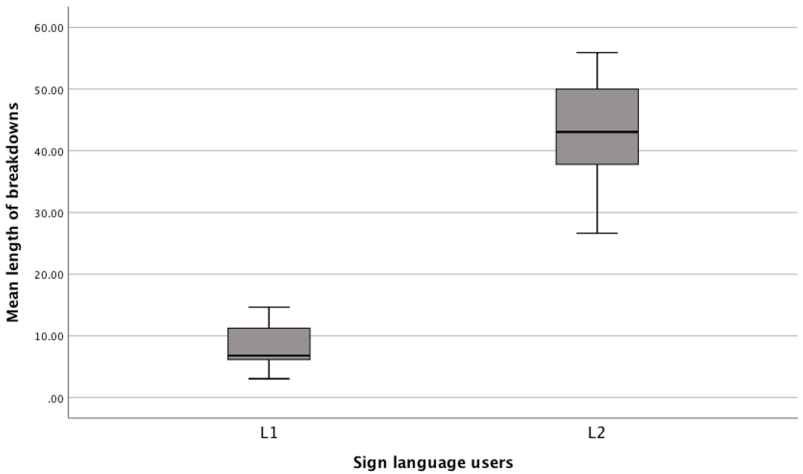

Figure 3. Mean length of breakdowns in the L1 and L2 groups. Boxplots represent the 95% confidence interval for the means.

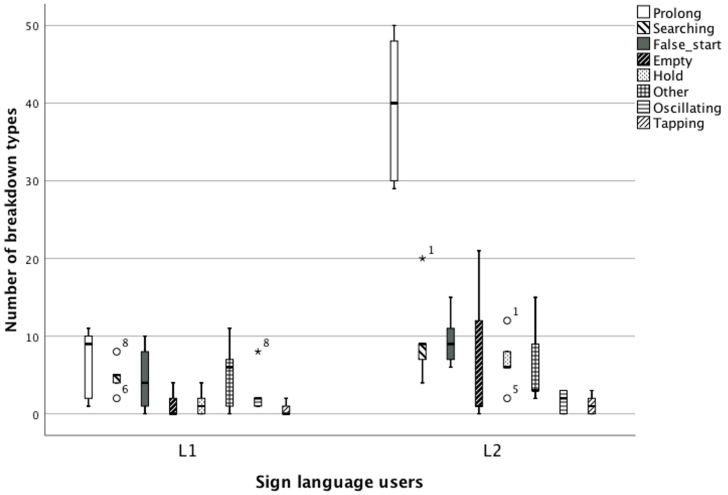

Figure 4. Number of each breakdown type per minute in both groups

more similar to each other on their average breakdown duration than L2 individuals were. On average, the L1 group's breakdown annotation length was 0.3 seconds, with a range of 0.05 seconds and SD of 0.035. In the L2 group, breakdown annotations were 0.52 seconds long on average, with a range of 0.23 seconds and SD of 0.097. The difference in the breakdown length between the L2 signer with the shortest average and the L1 signer with the longest average was greater than the differences inside the L1 group, but nonetheless smaller than among the L2 group members with their range of 0.093.

Notably, the fastest signer G did not have the least amount of breakdowns, nor were they the shortest ones. The least amount of breakdowns per minute were produced by participant I, whose signing speed was on the slower side of the L1 group. Participant F from the L1 group was the second-fastest signer, but produced the most breakdowns of the L1 group. On the other hand, F's breakdowns were on average shorter than anyone else's. The slowest signer in the L2 group (E) had the highest rate of breakdowns per minute, but their average breakdown duration was only the second highest. The longest average breakdown duration was produced by participant C, whose average sign annotation duration was also the longest of all ten participants.

3.3 The eight breakdown categories

Individual variation did occur, and not all breakdown types were equally prominent in each participant's signing. However, some breakdown types had similar total numbers of occurrences (Figure 4). In the L1 group these were other (25), searching (24) and false start (23). Hold (7) and empty (6) were also close to each other in the L1 group. In the L2 group, searching (49) and false start (48) were close, as well as empty (35), hold (34), and other (32).

Searching was one of the two breakdown categories for which every participant had occurrences, with a variation from F's 2 to A's 20. The participants in the L1 group had on average 1.2 searching pauses per minute, while those in the L2 group had 2.6. This finding did not show a significant difference between the groups ($U = 20.500$, $z = 1.687$, $p = 0.095$)

Aside from G's narrative, which had none, false starts appeared in every participant's material. In F's narrative there occurred one false start, while the others had up to 10 in the L1 and 15 in the L2 group. In one minute, the L1 group produced on average 1.1 false starts, whereas among the L2 signers the average number was 2.6 false starts per minute. However, this finding did not show a significant difference between the groups ($U = 20.00$, $z = 4.787$, $p = 0.151$).

Breakdowns categorised as other occurred 57 times in total. Aside from participant J, who had none, everyone had pauses categorised as other from 1 to 15 times in their narratives. On average, L1 signers had 1.2 breakdowns labelled as other in their signing per minute, while for L2 signers the number was 1.7. This finding did not show a significant difference between the groups ($U = 15.00$, $z = 0.524$, $p = 0.690$).

34 out of 41 hold-category breakdowns were found in the L2 group. On average, they occurred 1.8 times per minute in L2 signing. In the L1 group, 0.3 hold pauses were found per minute. The common trend was, however, that L2 signing contained more holds than L1 signing. Thus, L2 signers produced significantly more holds compared to L1 signers ($U = 23.500$, $z = 2.319$, $p = 0.016$). Monte Carlo simulations (10,000 iterations) also showed significant differences between the groups ($p = 0.007$ with confidence interval $p = 0.020 \ldots 0.028$) suggesting that the L2 participants produced more holds than the L1 participants.

Empty was a category in terms of which the participants were distinctly divided into those who lowered their hands down from the signing space often

and those who had only a few or no empty pauses. In the L1 group, this did not occur at all in three participants' narratives, and the other two had 2 to 4 empty pauses. In the L2 group, one participant did not have a single empty pause, and two of them had only one empty pause each. Over half of the total number of empty pauses were therefore produced by two participants in the L2 group. These were D with 12 and E with 21 empty pauses. The average occurrence of empty pauses was 0.3 per minute in the L1 group, and 1.9 times in the L2 group. However, this finding did not show a significant difference between the groups ($U = 17.500$, $z = 1.081$, $p = 0.310$).

The most common breakdown type was prolonging. In total, 230 prolongings were found, of which 33 occurred in the L1 and 197 in the L2 group. As can be seen from the occurrence numbers alone, in the L2 group the category made up almost half of their total breakdowns. Variation between individual signers in both groups existed, but the key to prolong-type pauses' vast number did not lie in any one participant's excessive use of prolonging. In the L1 group, prolonging was the major type of breakdown in two of the participants' signing and occurred 1.6 times per minute on average, whereas in the L2 group it was the largest breakdown category in each participant's narrative and happened 10.5 times per minute on average. Hence, L2 signers produced significantly more prolongings than L1 signers ($U = 25.000$, $z = 2.611$, $p = 0.008$). This finding was found to reach significance also in Monte Carlo analysis ($p = 0.007$ with confidence interval $p = 0.005 \ldots 0.009$).

The least frequent breakdown type in both groups was tapping, with 3 in the L1 and 6 occurrences in the L2 group. On average, L1 signers produced tapping pauses 0.1 and L2 signers 0.3 times per minute. An instance in which the tapping pause happened with a handshape other than a pointed index finger was also found. In signer J's video material, the participant makes a tapping motion while holding the index and the middle finger extended. Consequently, they tap with the sign KATSOA ('to look at') in between two oscillating-type pauses, while the non-manual elements indicate cognitive processing. This finding did not show a significant difference between the groups ($U = 16.000$, $z = 0.785$, $p = 0.548$).

Oscillating was the only breakdown type that at first seemed to occur more in L1 signing than in the L2 group in terms of both raw numbers and frequency. On average, L1 signers had 0.7 oscillating pauses per minute, while L2 signers' narrations contained 0.4 per minute. This is, however, explained by the fact that one L1 signer (H) produced the majority of the oscillating breakdowns alone, elevating the average of the L1 group. This

finding did not show a significant difference between the groups ($U = 11.000$, $z = -0.310$, $p = 0.841$).

4 Discussion

In this study, we examined speed and breakdown phenomena in Finnish Sign Language with a data-driven approach, based on Skehan's (2009) categorisation. The focus was on utterance fluency as described by Segalowitz (2010; 2016). The aim was to study how to operationalise fluency features in Sign Language, and explore these features in L1 and L2 signing. The motivation for focusing on these two phenomena was in the studies by Bosker et al. (2013) and Pinget et al. (2014), who found that the main features that affect listeners' appraisals of fluency were speed and breakdowns. With our approach, we were able to find parameters that were present yet measurably distinct both in L1 and L2 signing. Thus, the same features may be seen as relevant for Sign Language fluency as well. As there is a dearth of research on utterance fluency in Sign Languages, this paper can be seen as an offshoot for a new branch of research.

The L1 group produced more signs per minute, compared to L2 signers. Moreover, L1 signers had breakdowns less often and for shorter periods of time than the L2 group. The average number of signs per minute in the L1 group (129.3) was less than the 157.8 found by Sipronen (2018). However, because of the similar narration data used, our results are better compared to those of Jantunen et al. (2016). The L1 signing speed found here can be rounded to the same as the 129 signs per minute found in Jantunen et al. (2016). The rather notable difference between the current study and Sipronen (2018) can be explained by the number of informants used. With our five informants, the possibility of individual signers' distorting impact on the results is smaller than it would have been by using only two informants, although not negligible. No reasonable parallel to our L2 group's signing speed was available in Finnish Sign Language, as the three informants in Sipronen (2018) did not share equal backgrounds or time frames in acquiring the language as a M2L2.

One of the major findings on the breakdown phenomenon was that L1 signers were more similar to each other than L2 signers were to each other. Two breakdown types correlated significantly with language background. These two were prolong and hold, which were more likely to occur in L2

signing. Prolonging was a common breakdown type in L1 signing as well. Despite being the most frequent breakdown type in our material in general, the number of prolongings was especially conspicuous in the L2 group. The second-largest breakdown category in the L2 group, searching, did not come close to it in numbers or frequency. In contrast to the L2 group, the breakdowns were distributed more evenly between the eight categories in L1 signing.

One reason for the prevalence of prolongings overall might be that it reflects the general function that holding the hands up in the signing space has (see Groeber & Pochon-Berger 2014), even though the task did not include a major interactional aspect.

Hold was another breakdown type that correlated with the L2 background. This is interesting, as hold and prolong could be seen as two manifestations of a similar thing: holding the hands in the signing space with elements of a sign visible. Based on our results, however, there seems to be a distinction between the two in L1 signing.

The least frequent breakdown type in both groups was tapping. This finding was rather surprising, as the expectation based on Sipronen (2018) was that tapping pauses would be found much more frequently. One of the major reasons for the low number of these types of breakdowns compared to the study mentioned above could be found in the difference between definitions, which here included a demand for at least two repetitive tapping motions. Thus, pointing signs with only one tap were not labelled as breakdowns. Likewise, some breakdowns with a pointing element may have been categorised into the prolong and/or hold classes, unlike in Sipronen (2018). Equally unexpected was the finding of a tapping pause uttered with a different handshape than a pointed index finger. The tapping pause with the sign KATSOA (‘to look at’) in between two oscillating-type pauses raises the question as to whether other pointing signs or agreeing verbal signs can function as breakdowns as well. Another question is whether a distinction can be made between pausing in signs that in themselves have a tapping motion and those that do not normally include a tap.

Of the eight categories in our study, oscillating fingers without this belonging to a sign is one of the breakdown types that most signers would most likely deem as an emblematic hiatus in the signing stream. In this material, one L1 signer had a significant impact on the group mean with their well-above-average oscillating, elevating the L1 group’s average in this category above the L2 group. Hence, as participant H produced over half

of the L1 group's oscillating breakdowns, we refrain from stating that the breakdown type was more common in the L1 group on average.

Although the informants formed a certain continuum in their utterance fluency, there were some distinct differences between the two groups. The L1 group signed faster and with fewer breakdowns than the L2 signers. One of the major explanatory factors may lie in the fact that the two groups had very different paths to using Finnish Sign Language. The individuals in the L2 group had started learning Finnish Sign Language formally in a classroom setting as adults, and had been using it more or less frequently as their L2 from five to ten years at the time of the recording. Furthermore, the amount of freely expressed signing, in contrast to signing dictated by the interpreting process, may vary significantly between the five L2 signers. In contrast to this, the L1 group members had had Finnish Sign Language as their primary language since early childhood and as such acquired the language spontaneously during the sensitive period for language acquisition. It is likely our five L2 informants were formally taught how to sign, but not how or where to pause or utilise breakdowns in their signing, whereas the L1 signers acquired this knowledge as spontaneously as the signing.

The other potential explanation for the differences, which may interlace with cognitive fluency, possibly lies in the M2 acquisition process. Although having previous experience of using a visual-gestural modality for co-speech gestures is not alien to spoken L1 speakers, as Esipova (2019) remarked, our five L2 signers had only started to use the modality for language production when starting to learn Finnish Sign Language. As noted in § 1 above, based on Hilger et al. (2015), L2 signers of American Sign Language tend to progress toward more stabilised signing as they gain more experience in using the language. The divergent features of L1 and L2 signing found might suggest that the M2L2 users are still in the learning process of obtaining both cognitive fluency mentioned by Segalowitz (2010; 2016) and kinematically stabilised signs and breakdowns in their M2L2, even if the individual variation never disappears. It should also be noted that L2 behaviour might reflect L1 behaviour, as Duran-Karaoz & Tavakoli (2020) pointed out. Juxtaposing the L2 signers' signing with their spoken L1 production could reveal interesting parallels in their breakdown behaviour.

One major difference between the two groups in breakdown (dis)fluencies was the number of breakdowns per minute. On average, signers of the L2 group had breakdowns over three times more frequently than the participants in the L1 group. This suggests that the location of breakdowns may be at

least to some extent distinct between the two groups. Whether breakdowns are principally located at syntactic boundaries, as nods were found to be in L1 signing (Puupponen et al. 2015), or if there are other patterns or differences in L1 and L2 signing, should be investigated in the future.

Narrative tasks can be ruthless trials of linguistic skills, as they give less opportunity to bypass more complex vocabulary and grammar compared to freely formed speeches, as pointed out by Skehan (2009). With another task type, the results might have been different. Investigating how the patterns found here behave in other types of signed texts, such as more freely formed speeches or dialogues, should expand our knowledge on the topic of fluency.

With a sample of five participants from each group, individual differences affect our results more that they would in larger samples. With careful consideration of participants and their backgrounds, we sought a uniform and coordinated set to examine. All ten signers studied here were young adults, who are less likely to have physical or mental ailments connected to old age. Conducting a study with other age groups might also yield results unlike these. For future research, increasing the sample size could reduce the possibility of the effect of individually exceptional signers on the results. Likewise, to gain comprehensive knowledge about fluency in Finnish Sign Language in different age groups, signers with a broader age range should be examined. The most optimal way to achieve this would be to utilise corpus data. The role that gender may have in signing speed or breakdown behaviour could also be investigated in larger sample sizes in the future.

One possible criticism of this study could be that it included false starts but not other possible instances of repair fluency. While this is true, we think that the topic should be explored with consideration of the lack of previous research and the unique modality that Sign Languages have compared to spoken languages. As the similarities and distinctions between the fluency phenomena in spoken and signed languages are not yet known, we argue that it is possible to approach fluency in Sign Languages from several angles.

As the L2 group signers were all M2L2 signers, our results regarding L2 signing should be compared with caution with the results found in spoken language studies that are unimodal. At the same time, due to the heterogeneity of the community mentioned in Allen (2015), modality differences and the small amount of information we still have on fluency in signed languages, the L1 results should be handled with caution as well. This is not to discourage the usage of these results in future studies, but to remind us that fluency studies in Sign Languages are still in their infancy.

Instead of striving to prove deviances from the native norm in L2 language production, we suggest a continuum-based approach to fluency, as in Hulstijn (2011). Each of our participants, regardless of their language background, had breakdowns in their signing. The L1 and L2 groups did differ from each other on a general level, but at the same time, individual differences within the groups showed great variation as well. Consequently, one should concentrate on defining the typical variation in real-life language users. This paper contributes to this approach by presenting one possible tangent for the study of fluency and its variation in Finnish Sign Language. We think that differences found in the patterns of signing, which can be major, may be used to better understand the typical breakdown or signing speed behaviour of certain language users. With knowledge of the differences, Sign Language teachers can teach their students not only how to sign, but also how to pause aptly.

5 Conclusion

As stated, there exists a persistent myth of a standard native, to which language learners are compared to measure their fluency level. This approach to fluency is problematic in many ways. Not only does such a standard native not exist, but, in addition, native speakers are not tested as routinely on their language in the way language learners are. L1 signers, as well as L2 signers, showed variation in our material, and no participant's production was breakdown-free. We do, however, see comparison between actual L1 and L2 signers as a way to supply valuable information for the benefit of language users, including learners and teachers. Finding differences (and similarities) is seen as a means to further knowledge of the phenomenon of utterance fluency in Finnish Sign Language, not as a tool to prove the superiority of any group.

Exploring the parameters of fluency and measuring them in a meaningful way in Sign Language was one of the factors that needed to be addressed. Hence, utterance fluency was operationalised with the parameters of speed and breakdowns. With the results the study yielded, specifically the continuum that the participants formed in their fluency, we see the chosen parameters as potentially useful in future studies of fluency in Sign Languages. Having a sense of the key features of fluency can be used to refine Sign Language education as well. From this paper, educators and L2 learners can see what breakdown types are common in L1 and L2 signing, and what the variation in both signing speed and breakdown fluency can be.

Another approach to comparing L1 and L2 could have been to juxtapose the same individuals' L1 and L2 production measurements, as De Jong et al. (2015) and Towell (2006) did in their work. According to De Jong et al. (2015), the level of utterance fluency in L1 is the maximum level that an individual can reach in any language. Examining the possible interrelation of M1L1 fluency and M2L2 fluency could be the key to shedding light on the question about whether modality plays a role in fluency development.

To construct a more complete picture of fluency in Sign Languages, more research on various aspects of fluency is needed. The possible links between the other two aspects of fluency, perceived and cognitive fluency, as depicted by Segalowitz (2010; 2016) have not been researched in Sign Languages. For a more precise view of the phenomenon, one should consider utilising motion capture data as a means to examine fluency. In Sign Languages, the visual-gestural modality and the fact that very little is known about fluency make it an abundant topic for research in the future.

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