

Numeral Incorporation in Russian Sign Language:
 Phonological Constraints on Simultaneous Morphology
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Abstract

This paper looks at numeral incorporation in Russian Sign Language (RSL). Numeral incorporation is the simultaneous combination of a numeral and a base sign into one sign. Incorporating forms typically use the numerical handshape combined simultaneously with the movement, location, and orientation of the base lexical sign; for example, “three months” will be expressed through an incorporating form 3_MONTH. RSL is a language with a two-handed numeral system. Investigating two-handed numeral incorporation in RSL provides important insights into the constraints on numeral incorporation across languages as well as into the phonological structure of RSL.

Numeral incorporation is a general preference in RSL that is highly constrained: not all calendric terms can incorporate, and not all numbers can be incorporated. For example, the sign MONTH incorporates numbers one through nine (one through five are one-handed, and six through nine are two-handed). The incorporating one-handed form 5_MINUTE exists, while the two-handed *6_MINUTE form does not occur (that is, its meaning is expressed sequentially), and the sign DAY does not incorporate numbers at all. These limits are conditioned for semantic (lexical frequency, pragmatics) and phonological reasons. Because the numeral system of RSL is two-handed, the results show, first, that numeral incorporation is not limited to one-handed numerals. In addition, the results indicate that limits on numeral incorporation are not universal across sign languages. In RSL, each paradigm shows specific numeral incorporation limits that are phonologically conditioned. These limits are explained by the interaction of phonological rules at all levels of sign sublexical features for both the numeral and lexical sign: location, orientation, handshape, and movement.

The location and orientation parameters of sign, however, have not been previously noted as being factors that limit numeral incorporation and sign complexity in a sign language. Our analyses, from both the numeral incorporation data and from elicitation and RSL corpus data, show that location and orientation function as phonological constraints in the composition of two-handed signs. Specifically, location and orientation operate in handshape symmetry restrictions. Our analyses also show that signs located on the head do not allow two-handed numeral incorporation. The corpus analyses corroborated this finding: all two-handed signs on the head that we found in our RSL corpus were symmetrical and frequently included weak drop, such that we found no asymmetrical two-handed signs on the head. Another symmetry restriction relates to orientation. Analyses of the RSL numeral incorporation data and the RSL corpus data and dictionaries show that RSL disfavors asymmetrical handshapes in two-handed signs having lateral orientation (palm facing the central line) (Fenlon et al. 2013).

One of the particularities of sign languages (in comparison to the spoken ones) is the presence of two independent articulators. Although in principle the simultaneous articulation of two signs is possible, in reality it occurs only in highly constrained conditions, such as in the case of week freeze, or passive hand hold that may be phonetically, syntactically, or semantically motivated (Kimmelman, Safar, and Crasborn 2016), in classifier constructions (Eccarius and Brentari 2007), or in poetic discourse (Crasborn 2006). Independent of simultaneous articulation, there exist two-handed signs that require both hands to be involved in the expression of a single sign. Anatomically, the signer’s two hands are identical, yet even in two-handed signs not all combinations of handshapes, locations, and movements are allowed on both hands. Several constraints limiting sign complexity have been described for sign language phonology. Some constraints are claimed to be applicable to all signs (for a review, see Sandler 2012), while other constraints have been described specifically for two-handed signs (Crasborn and Van der Kooij 2013; Eccarius and Brentari 2007; Kimmelman, Safar, and Crasborn 2016; Morgan and Mayberry 2012). Although initially observed in different sign languages, such as American Sign Language (Battison 1978), Sign Language of the Netherlands (van der Kooij and Crasborn 2008) or Kenyan

Sign Language (Morgan and Mayberry 2012), many of these constraints are relevant to other sign languages as well (Sandler 2012). The goal of the present study is to describe complexity constraints on one- and two-handed signs in Russian Sign Language (RSL), looking specifically at numeral incorporation. Numeral incorporation is a morphophonological phenomenon attested in most sign languages of *large Deaf communities* (a term used by Nyst, 2012); specifically, it is a combination of a numeral and a base sign into one sign. Typically, incorporating forms insert the numerical handshape into the movement, location, and orientation of the base lexical sign. Numeral incorporation shows typological similarities across different sign languages: it mainly occurs in calendric or measurement terms (Sagara and Zeshan 2013), such as year, month, or hour, which all incorporate numbers in RSL. Being a moderately productive and highly constrained process, it can yield unique insights into the morphophonology of sign languages, especially when compared cross-linguistically.

The present study describes numeral incorporation in contemporary RSL by focusing on sign complexity constraints that restrict numeral incorporation both in terms of lexical roots and numbers. RSL uses a two-handed numeral system, while calendric terms are usually one-handed. Little is known about the morphophonological structure of RSL (Grenoble 1992; Kimmelman 2017; Zaitseva 2000), so the present study represents a first step towards a phonological analysis of RSL. The paper is structured as follows. First, we briefly describe numeral incorporation in sign languages and constraints on sign phonological complexity. Next, we present the RSL numeral system, calendric terms and their variation. Third, we describe and explain the RSL paradigms that allow (or disallow) numeral incorporation, along with the phonological constraints they reveal. By paradigms, we mean a set of linguistic items that form mutually exclusive choices, formed through numeral incorporation, such as WEEK, 2_WEEK, 3_WEEK, 4_WEEK, 5_WEEK).¹ Finally, we consider alternative explanations of the observed phenomena.

1. Background

1.1. Numeral incorporation

Aronoff, Meir, and Sandler (2005) point out a peculiarity of sign language morphology: these languages have both sequential (where the morphemes are organized in a linear way) and simultaneous (where morphemes are simultaneously superimposed) morphology. Comparing ASL and Israeli Sign Language, they argue that simultaneous morphological processes seem to be similar across these two languages, while sequential morphological processes differ significantly.

One simultaneous morphological processes attested to in most developed sign languages is numeral incorporation. First described for ASL by Stokoe (1965), it is generally defined as the inclusion of a numeral marker within another single sign (Liddell 1996). Numeral incorporation has been described to occur in Japanese Sign Language (Ktejik 2013), Kenyan Sign Language (Morgan 2013), Catalan and Spanish Sign Languages (Fuentes et al. 2010), Taiwan Sign Language (Fisher, Hung, and Liu 2010), and Argentine Sign Language (Johnson and Massone 1992), among others. After examining data from 21 sign languages, Sagara and Zeshan (2016) observed typological similarities in numeral incorporation cross-linguistically. The most frequent paradigms of numeral incorporation are signs for time units and calendric terms, money or currency, and school grade. Calendric terms are lexemes that define different parts of the calendric cycle, both man-made and natural (Petruck and Boas 2003). Although Sagara and Zeshan (2013) propose that numeral incorporation may be restricted to sign languages, similar phenomena have also been attested in the spoken languages of Kabardino-Cherkessian, Adygean (Moroz 2015), and Nootka (Stonham 1998). In these languages, numeral incorporation is

sequential and is not restricted to calendric terms (unlike in sign languages), but nouns and incorporated numerals also become one phonological unit. Despite evidences that shared (or village) sign languages—which emerge in areas of a high incidence of deafness and are used by both the deaf and hearing members of the local community—often lack simultaneous constructions (Nyst 2012), simultaneous morphology in the derivation of numerals, multiplication strategies, and restrictive numerals (such as “only two”) have been observed in Alipur Sign Language (APSL) and Mardin Sign Languages (MarSL) (Zeshan et al. 2013). Data on numeral incorporation in calendric terms in village sign languages are scarcer. Le Guen (2012) mentions that Yucatec Maya Sign Language (YMSL) productively uses numeral incorporation for the sign DAY (not observed in the spoken language of this community) and has lexicalized items for IN ONE DAY, IN TWO DAYS, or IN THREE DAYS, but not *IN FIVE DAYS. However, the examples given are sequential, rather than simultaneous, in nature where a number sign precedes a lexical one.

A distinguishing characteristic of numeral incorporation is that it is highly phonologically constrained in all sign languages. Not all time signs can incorporate numerals (for example, in RSL MINUTE allows numeral incorporation, while SECOND does not), and not all numerals can be incorporated. For example, the number two is incorporated by most time signs in RSL, the number twelve is only incorporated by one sign, and the number twenty is never incorporated. Being partially lexically restricted, numeral incorporation is regularized by the general phonological constraints of a given language.

Although several RSL studies mention numeral incorporation (Korolkova 2013; Moroz 2015; Zaitseva 2000), formal analyses of numeral incorporation in RSL have not been conducted to date. When a numeral limit has been mentioned in the literature, it has been assumed to be five for all paradigms (Korolkova 2013). The numbers one through five are one-handed in RSL, while the numbers six through ten are articulated with two hands. This assumption would predict that two-handed numerals are not incorporated. That is, the form 5_HOUR (five hours) or 5_MINUTE (five minutes) would be possible, while 6_HOUR (six hours) or 6_MINUTE (six minutes) would not be. However, as we find in the present analyses, this is not always the case. Rather, paradigms vary significantly in RSL in relation to phonological constraints on numeral incorporation. Some signs allow incorporation of two-handed numerals (for example, HOUR). Some signs only allow incorporation of one-handed numerals (for example, MINUTE). Other signs never incorporate (for example, DAY). The question we address here is what specific phonological constraints explain the limits on these paradigms.

Our fieldwork on numeral incorporation in RSL revealed thirteen measurement signs typologically expected to incorporate numbers: eleven incorporate numerals, and two do not (see Table 1 for a summary). We compared and contrasted the numeral incorporation paradigms as a function of their incorporation limits. The hypothesis we tested here is that limits on numeral incorporation are conditioned by the interaction of phonological constraints at all featural levels of sign: orientation, location, handshape, and movement. Discovering numeral incorporation constraints as a function of featural level can open the door to future phonological analyses of RSL. This approach also allows us to determine the degree to which featural complexity constrains simultaneous morphological processes across sign languages.

Previous research (Kubuş 2008; Mathur and Rathmann 2010) has proposed that the level of phonological complexity allowed in a sign language explains numeral incorporation limits. Constraints on movement and handshape complexity have been described as a major limiting factor for numeral incorporation in ASL and German Sign Language (DGS; Mathur and Rathmann

2010), as well as Turkish Sign Language (TID; Kubuş 2008). Here we investigate the impact that each feature of sign has on numeral incorporation in RSL, not only movement and handshape, but also location, orientation, and contact preservation.

While location is considered one of the most salient features in sign language phonology (Rozelle 2003), orientation (Battison 1978) and contact (Friedman 1975; Mandel 1982) are now traditionally regarded as secondary parameters (Sandler 2012). However, they also may play a major role in phonotactic constraints. Contact is one of the subordinate categories of location (Sandler 2012). According to Battison (1978) and Rozelle (2003), contact may serve as a “diagnostic test” for markedness: signs with marked handshapes are more restricted in where and how they can contact the place of articulation.

Orientation is considered an inherent feature of hand configuration and location (Brentari 1998; van der Hulst 1996). As our work shows, when interacting with other features, orientation limits the handshapes that can occur in two-handed forms of numeral incorporation. We now examine the constraints on two-handed signs in more detail before turning to our data and analyses.

1.2. Complexity Constraints in Sign Languages: One- and Two-Handed Signs

Not all combinations of the articulators’ movements and positions are allowed in the world’s sign languages. As Sandler (2012) points out, following Hockett (1960), these constraints reflect duality of patterning (meaningful units are composed from meaningless elements), which is a design feature of all human languages and not found in any animal communication systems. Several constraints have been described for the world’s sign languages that limit the overall complexity of any sign: for example, symmetry and dominance conditions for two-handed signs (Battison 1978), selected and unselected finger constraints (Mandel 1981) and internal movement constraints (Mandel 1981; see Sandler 2012, 2017 for a review). Although initially proposed for particular sign languages, these constraints were later argued to be applicable to sign languages of large Deaf communities (Sandler 2012), although cross-linguistic violations have been found for initialized signs (Sandler 2017). Constraints may operate at the level of a free morpheme or a syllable (which in sign language is understood as a movement segment or simultaneous movements), which constitutes the visual equivalent of sonority (Brentari 1998; Perlmutter 1992; Sandler 2010). Constraints also operate on all featural levels. We turn now to the constraints relevant for two-handed signs.

While investigating the phonological structure of ASL, Battison (1978) noted that not all handshapes and movements can occur in two-handed signs. The restrictions mainly apply to the non-dominant hand and the way it interacts with the dominant hand in sign production. Based on these observations in ASL, Battison formulated the Symmetry and Dominance conditions for monomorphemic signs that were later argued to be relevant for the structure of many sign languages (Sandler 2012):

Symmetry condition: If both hands move independently during sign articulation, then both hands have to be specified for the same location, same handshape, the same movement (performed simultaneously or in alternation), and the specification for orientation must be either symmetrical or identical.

Dominance condition: If the two hands do not share the specification for handshape, then one hand must be passive, while the active one articulates movement. The handshape specification of the passive hand is restricted to a set of unmarked handshapes: A, S, B, 5, G, C, and O.

The so-called unmarked handshapes have common properties. First, they are the most frequent in ASL (and in other sign languages too), geometrically distinct, and perceptually salient. Second,

these handshapes are among those first acquired by children (Boyes-Braem 1990; Henner, Geer, and Lillo-Martin 2013; Marentette and Mayberry 2000). Based on the symmetry and dominance condition for movement and handshape, Battison proposed a classification of ASL two-handed signs: type 1 signs are balanced for both handshape and movement; type 2 signs have the same handshape but are unbalanced for movement (only the dominant hand moves); and type 3 signs have different movement but the same handshape. According to Battison (1978), signs in which both hands move but have different handshapes are very rare and unnatural. For example, TOTAL-COMMUNICATION has different handshapes (T and C) performing alternating movement near the chin. This sign came to ASL through the influence of signed English. Frishberg (1975) notes, however, that these signs were more common in nineteenth-century ASL and later evolved in a way that satisfies the symmetry and dominance conditions. Further research on ASL and other sign languages has revealed sign types that do not follow the symmetry and dominance conditions and yet are part of natural sign language. These new data prompted a revision of the originally proposed symmetry and dominance conditions (Channon 2004; Eccarius and Brentari 2007; Napoli and Wu 2003). For example, Napoli and Wu (2003) investigated ASL vocabulary and found nineteen two-handed signs with different handshapes in which both hands move as a unit. From the point of view of the original dominance condition proposal, these signs are impossible. Signs of this type have also been described in Sign Language of Netherlands (NGT) by van der Hulst (1996). After investigating the handshape distribution of these signs, Napoli and Wu (2003) proposed a reformulated version of the dominance condition:

Expanded dominance condition: in a two-handed sign in which the two hands have different handshapes, the non-dominant hand must have an unmarked handshape.

Investigating signs of this type cross-linguistically, Rozelle (2003) introduced a contact condition:

Contact Condition: if one hand moves and the other remains still, there must be contact (or proximity) between the two hands at some time during the articulation of the sign.

Rozelle proposes this constraint to be phonotactic and not anatomical. Signs that violate this constraint are possible to produce but do not occur in the lexicons of ASL, Korean Sign Language, New Zealand Sign Language, and Finnish Sign Language (Rozelle 2003).

In the sign language literature, the behavior of classifiers under symmetry and dominance conditions has been analyzed differently. Aronoff et al. (2003) claimed that classifiers often violate both conditions. Eccarius and Brentari (2007) analyzed two-handed classifiers across Hong Kong, American, and Swiss German sign languages (including the large proportion of signs that violate the original symmetry and dominance conditions). Based on their analysis, they proposed another revision to the symmetry and dominance conditions that accounts for classifiers:

Maximize symmetry and restrict complexity in the handshape features of the two hands.

Modified dominance condition: Handshape on the non-dominant hand must be a simple structure morphosyntactically and phonologically in order to achieve word-like prosody.

Modified symmetry condition: To achieve word-like prosody, a form must have symmetrical timing (i.e., be articulated simultaneously).

All of the numeral-incorporating, two-handed forms in our data follow these revised conditions as well as the modified dominance condition proposed by Napoli and Wu (2003),

while some two-handed incorporating forms contradict the original symmetry condition. Although the present study does not allow us to draw conclusions about the possible classifier nature of calendric terms, our analyses provide support for the above described revisions to the symmetry and dominance conditions proposed to account for classifiers, cross-linguistic data, and various kinds of symmetry that are possible in sign languages.

It is important to note here that incorporating forms are by definition polymorphemic (i.e., a number sign is combined with a calendric or measurement sign). At the same time, as we will show, all the RSL forms we analyze here are predicted by the expanded dominance condition and contact conditions. This finding underscores the proposal that these constraints not only govern complexity within a morpheme, but also their simultaneous combination.

2. Numeral Incorporation in RSL: What Combines?

2.1. Russian Sign Language (RSL)

Russian Sign Language (RSL) is a sign language of a very large Deaf community, used in the territory of Russia, in many—but not all (Kibrik 2008)—countries of the former Soviet Union (Grenoble 1992). Wittmann (1991) and Zeshan (2006) categorize RSL as a member of the Old French Sign Language Family. The first Deaf school in St. Petersburg was founded in 1806 and used the French method of teaching, promoting signing. The process was led by French instructor who was a student of Roch-Ambroise Sicard, the successor of Jean-Michel de l'Epée in Paris (Basova and Yegorov 1984). According to the Russian National Census in 2010, 120,500 Russians mentioned RSL among the languages they use daily. However, the census data need to be interpreted with caution because the questionnaire did not have a separate option for RSL in the list of languages available to check. According to other sociolinguistic analysis, RSL is used by two million signers in the territory of Russia (Voskresensky 2002).

2.2. Data Collection

Data were gathered from eight language consultants (two of whom were males) from Moscow, St. Petersburg, Novosibirsk, and Kirov in Russia from 2015 through 2016 via face-to-face, video-recorded interviews and Skype. All the language consultants were native signers (one hearing signer with deaf parents), and all indicated that they interact daily in RSL with their families, friends, and at work. The data were collected through translation elicitation (from Russian to RSL), a picture description task, and metalinguistic questions.² The interviews were conducted by the first author using RSL and Russian; RSL interpreters assisted with three interviews. Two signers recorded themselves during translation elicitation and shared these recordings with the first author. The language consultants were first asked to show their signs for calendric or measurement terms and time units. They were then given a list of sentences in Russian to translate into RSL. The sentences contained time, measurement, and calendric units in different contexts. Next, the language consultants were asked to describe a series of pictures. (For example, one picture displayed an enthusiastic young man with a bouquet of flowers standing under a street clock showing noon. In a second picture, the same man stands under the same clock, now showing 3 o'clock, with faded flowers and a sad face). Finally, the language consultants were interviewed about their intuitions and metalinguistic judgments of numeral incorporation, limits of incorporation (what numbers can be incorporated, what signs can incorporate), any regional variations they were aware of, and any situations of RSL use in which numeral incorporation could or could not be used. The RSL interpreters were familiar to the language consultants and contributed to the discussions (i.e., suggesting more contexts).

The interviews were then transcribed by the first author using ELAN 4.9.3 with separate tiers

for transcription, Russian and English translation, and comments. In most cases, the decision as to whether a certain form is incorporated was straightforward. In three cases in which it was unclear, the same RSL language consultants were asked to clarify. All their metalinguistic judgments were consistent. All the consultants had strong intuitions about numeral incorporation.

Once the transcriptions were complete, each informant's consistency in use of numeral incorporation was checked for each particular sentence and for every construction (across sentences). Before we describe the detailed analyses of the gathered data, we describe the numeral system of Russian Sign Language.

2.3. RSL Numeral System

The numeral symbols of sign languages are constrained by the physical properties of the manual articulators: we only have two hands with ten digits, the signing space has limits, and not all hand configurations are anatomically possible. This differentiates sign language numeral signs from the extended body part numeral systems that use the body with pointing. A certain degree of iconicity is present in all the numeral systems of natural sign languages described to date (Zeshan et al. 2013). The numeral systems of sign languages may use one hand (as does ASL) or two hands (as does DGS)(Pfau, Steinbach, and Woll 2012). Taub (2001) describes sign language numeral systems as being a special case of iconicity, that is, *number-to-number iconicity*: the number of fingers is in one-to-one correspondence with the number of referents for some numerals. This kind of iconicity is limited by the number of available articulators and can be observed in pluralized classifiers, grammatical dual number, and numeral incorporation (Taub 2001). The degree of number-to-number iconicity in the number systems of sign languages varies. In RSL, as in most sign languages, numbers from one through five are represented iconically by extending the corresponding number of fingers on the dominant hand. Another type of iconicity found in sign languages is orthographic iconicity: signs for numbers represent the written forms of these numbers in the spoken language, such as Kanji for Japanese Sign Language (JSL) numbers (Zeshan and Palfreyman 2017). This kind of iconicity also can be found in RSL in the signs THOUSAND and MILLION.



Figure 1.
Gesture for 9, commonly used in Russia.

Although the natural sign languages of Deaf people around the world typically have existed in the situation of diglossia (with spoken languages), their numeral systems do not always reflect the type of numeral systems of the spoken languages within which they are embedded despite their close proximity (Pfau, Steinbach, and Woll 2012)—although there is some dependency in many sign languages (Safar et al. 2018; Zeshan et al. 2013). Nor do the numeral signs of RSL seem to depend on the common gestural representations of numbers. The common Russian gesture for nine would be an iconic extension of five digits on one hand and four on the other (figure 1), but RSL has a different sign for the number that is less transparently iconic. The sign NINE, for instance, is

two-handed; the dominant hand with the FOUR handshape contacts the palm of the non-dominant hand, which is held in neutral signing space with a handshape FIVE, as illustrated in figure 2.

The RSL numeral system has a base of ten with a sub-base of five, as does DGS (Iversen et al. 2006; Pfau, Steinbach, and Woll 2012). The base of a numeral system is the value n such that numeral expressions are constructed according to the pattern $\dots xn + y$ (Comrie 2013). Multiples of ten (such as tens, hundreds, thousands) in sign languages are often formed through a multiplication strategy (Sagara and Zeshan 2013). In RSL, simultaneous morphological processes are used to create higher-magnitude representations: the basic handshapes ONE through NINE are combined with a specific movement that indicates, for example, thousand. The number signs FIFTEEN, FIFTY, FIVE HUNDRED, and FIVE THOUSAND are derived from FIVE and differ from it (and from each other) only in movement. The number FIFTY differs from FIVE by the diagonal movement downwards. The number fifty-five is signed as FIFTY FIVE, in which both hands have a FIVE handshape, but FIFTY contains diagonal movement.

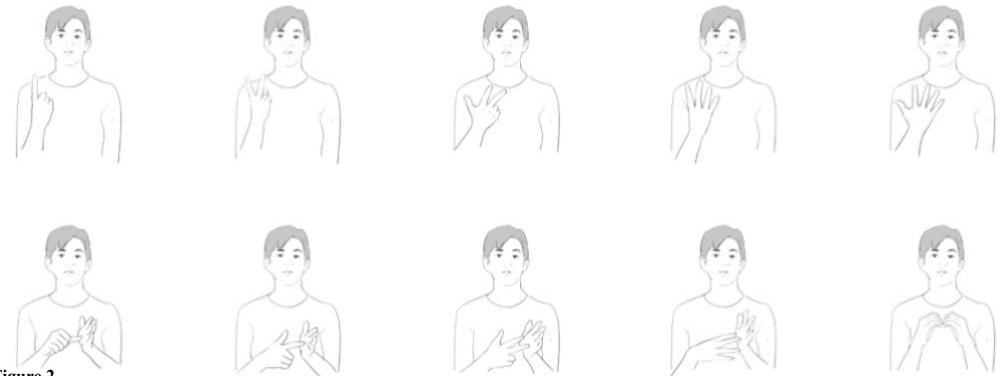


Figure 2.
Cardinal numbers 1 – 10 in RSL.

This patterning is not universal across sign languages. In ASL, digits are also signed in linear finger order, but round numbers (for example, TWENTY) have a specific movement, while other numbers are signed as a sequence of digits (TWENTY-THREE is a combination of TWO and THREE, and not TWENTY and THREE). In DGS the order is inverse, and TWENTY-THREE is a combination of THREE and TWENTY (Pfau, Steinbach, and Woll 2012).

In RSL, the cardinal numbers ELEVEN through FIFTEEN begin with a fist and have a quick extension of the selected fingers. The numbers SIXTEEN through NINETEEN have a distinct arc movement: the dominant hand touches the non-dominant palm twice, as shown in figure 3. Round numbers TWENTY through NINETY have a diagonal downward movement (figures 4 and 5). Cardinal numbers ONE HUNDRED through NINE HUNDRED have a quick single bending movement (in two-handed numerals it begins with the fingers of the dominant hand touching the palm of the non-dominant one). The RSL sign for FIFTY-FIVE is a sequential combination of FIFTY and FIVE; 555 is a combination of FIVE HUNDRED, FIFTY and FIVE, and so on. The signs THOUSAND and MILLION are both initialized; forms ONE THOUSAND through FIVE THOUSAND are formed through numeral incorporation with suppletion and are discussed below in section 4.4.



Figure 3.
Cardinal number 17 in RSL.



Figure 4.
Cardinal number 20 in RSL.



Figure 5.
Cardinal number 60 in RSL.



According to our consultants, this numeral system is common and universally understood in all regions of Russia, but there exists some variation on the numbers eleven through fifteen. Besides one-handed numerals with a quick extension of selected fingers, there is also a two-handed version in which the non-dominant hand holds the same handshape as in TEN, while the number of fingers is extended on the dominant hand (for example, three for THIRTEEN), while the other fingers are held in the TEN handshape. According to our language consultants, these variants for eleven through thirteen are less common in contemporary RSL, and the source of this variation is unknown. However, in his RSL textbooks, Iosif Geilman (Geilman 1957, 1980, 2001), presents the following rule for the numbers ELEVEN and TWELVE: first, the number TEN should be signed, and then ONE or TWO. This rule is close to the two-handed numerals that described above and may be the predecessor of the current version. One-handed variants for these numerals are not represented in Geilman's work.

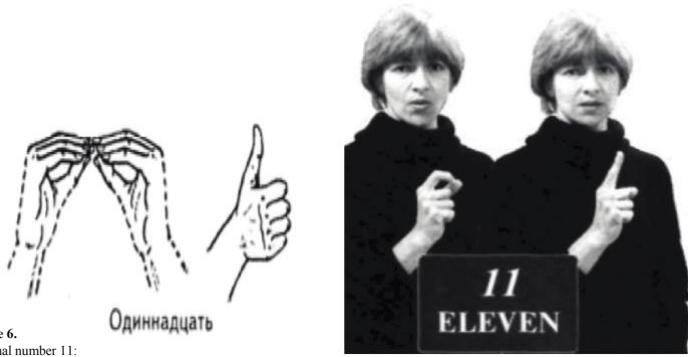


Figure 6.
Cardinal number 11:
Left - from Geilman (2000, p. 25), right – from Fradkina (2001, p.20)

However, other RSL Dictionaries (Bazoev et al. 2009; Fradkina 2001) issued by the Moscow Deaf Society and Zaitseva (2000), do not list the two-handed variants and only present one-handed numbers with internal movement for the range ELEVEN through FIFTEEN. As our

fieldwork shows, both variants are understood by native signers of RSL, but most people today use the one-handed versions.

The difference may be generational or dialectal: Geilman, a hearing native signer, grew up in St. Petersburg, while the group of Deaf authors working on the dictionary (Bazoev et al. 2009) and Fradkina (2001) publish and work in Moscow. Further discussion is beyond the scope of this paper. However, as the two versions of these numbers behave differently in the context of numeral incorporation, it is important to keep both versions in mind.

This kind of variation in number signs has also been attested for British Sign Language (BSL) (Stamp et al. 2014). In addition, McKee, McKee, and Major (2011) working on New Zealand Sign Language (NZSL), point out a high level of dialectal variation for the numbers one through twenty across groups of NZSL signers as a function of age, gender, region, and ethnicity. This might relate to the fact that NZSL has dialectal variants associated with five centers of Deaf education in New Zealand. Sociolinguistic explanations may also be relevant for RSL variation, taking into account both the factors of geography and the fact that Deaf and hard of hearing students were historically educated in different schools in Russia (Basova and Yegorov 1984).

2.4. Signs Allowing (and Not Allowing) Numeral Incorporation

According to Sagara and Zeshan (2016), the most frequent paradigms of numeral incorporation are time signs such as years, hours, and minutes (which are attested for in twenty sign languages); money or currency (attested for in fifteen sign languages); and school grade (attested for in thirteen sign languages). Although RSL generally fits this pattern, there are some peculiarities. Numeral incorporation is a general preference for time signs (YEAR_a [*a* stands for *age*], MONTH, WEEK, HOUR₁, WORKING_HOUR, O'CLOCK_{old,new,Novosibirsk}, MINUTE_{1,2}, TIME [*occurrence*], YESTERDAY, TOMORROW). In addition, numeral incorporation occurs in one measurement sign (KILOGRAMS), currency (RUBLE), and one paradigm that has not been described to incorporate numerals in other sign languages, namely PERSON/PEOPLE. At the same time, not all calendric terms in RSL incorporate number: the signs DAY, SECOND, YEAR_c (*c* stands for *calendar*, the glosses will be discussed later in the subchapter about signs allowing numeral incorporation) and some others do not allow it. As for school grades, we did not manage to elicit any forms allowing numeral incorporation. There are several ways to sign school grade, but our language consultants mainly used the sign ROOM (in spoken Russian, *кабинет* means both school grade and room, and RSL may have borrowed this lexeme), which does not allow numeral incorporation in any context.

RSL has a complex and elaborate system of time expressions and calendric terms that do not mirror spoken Russian (see Burkova et al. 2018). Numeral incorporation is systematic and consistent in RSL, but there is some variation in our data. Because it was not always immediately clear whether this variation was lexical (different signs), phonological (within one sign), or diachronic (between different generations), we briefly discuss these variants and give examples below. Note that all of these types of variation have been described for other sign languages (Frishberg 1975; Lucas et al. 2001; Stamp et al. 2014). Table 1 summarizes the numeral incorporation paradigms analyzed for the present RSL data set.³

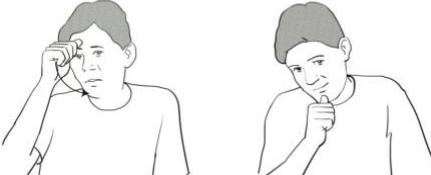
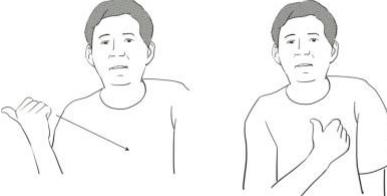
With respect to variation, some signs differ only by handshape: for example, the signs HOUR₁ and HOUR₂ (figures 7a and 7b) have the same circular clockwise movement in neutral signing space, but HOUR₂ is initialized (it has a handshape Σ, which is the first letter of the spoken Russian word *hour* – *час*), while HOUR₁ has a handshape 1, typical for most calendric terms (Burkova et al. 2018). The RSL dictionary by Fradkina (2001) has separate entries for these signs.

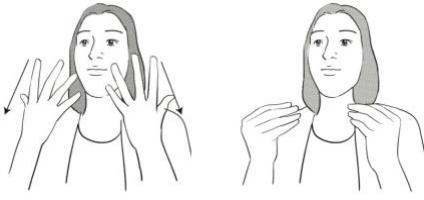
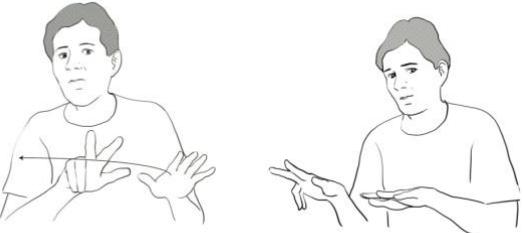
In our data, both signs were understood, but our consultants tended to consistently use only one of them, either HOUR₁ or HOUR₂. HOUR₁ more frequently appeared in our data. Importantly, these signs behave differently in the context of numeral incorporation: HOUR₁ incorporates numbers up to five, while HOUR₂ in our data does not allow any numeral incorporation, presumably due to the initialized handshape. In our data, HOUR₁ and HOUR₂ were considered phonological variants.

Table 1. *Numeral-incorporating paradigms of RSL*

The first column gives an English translation of the time or measurement sign. The subtitles indicate variants or dialectal differences. The second column illustrates the sign in citation form (usually beginning and final location). The third column indicates whether the sign is one- or two-handed, while the fourth and the fifth columns indicate whether the sign allows incorporation and, if so, the numeral incorporation limit.

The source videos for the last 3 illustrations are from spreadthesign.com.

CALENDRIC TERM	LEXICAL BASE SIGN	One/two-handed in citation form	Incorporation	Number Limit
YEAR _c		1	-/2,3,4	4
YEAR _a		1	+	5
MONTH		1	+	9
WEEK		1	+	5

DAY		2	-	-
HOUR		1	+	14
O'CLOCK		1	+	5
WORKING HOUR (example: 8_WH, incorporated form)		No citation form	+	9
MINUTE		1	+	5
SECOND		1	-	-

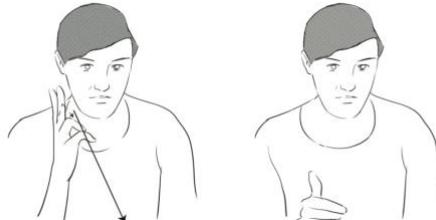
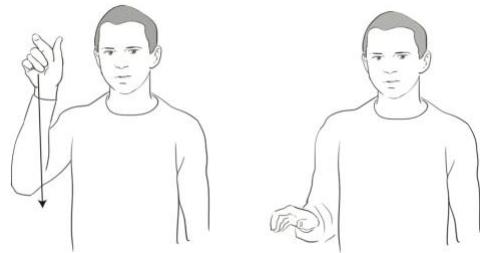
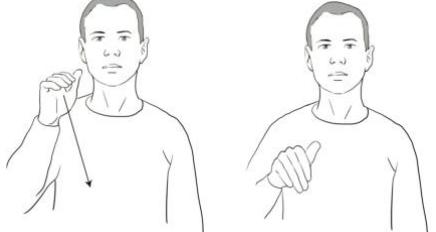
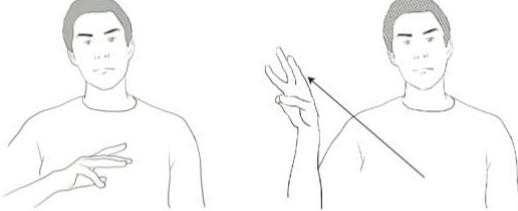
TIME (occurrence, incorporated form 3_TIMES)		1	+	5
RUBLE (Russian currency)		1	+	1, 3, 5, 10
KG		1		
PEOPLE		1	+	5
THOUSAND		1	+	5
MILLION		1	-	-



Figure 7a.
RSL sign HOUR₁.

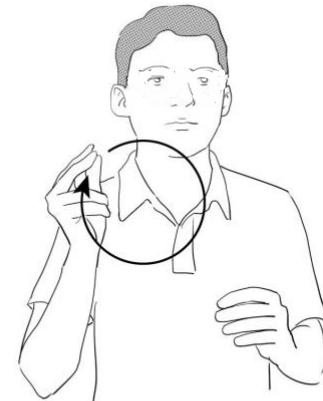


Figure 7b.
RSL sign HOUR₂.

In another case, the difference between the two variants is in location, as in O'CLOCK_{old} and O'CLOCK_{new} (figures 8 and 9, respectively). In this case, our language consultants explicitly labeled the sign that starts at the forehead as the old sign and the sign that starts on the cheek as contemporary (the same distinction is made by lexicographic sources). Zaitseva (2000) describes the old sign, while contemporary online RSL dictionaries provide only the new version. As for numeral incorporation, both variants incorporate the numbers one through five. These signs were considered diachronic variants.



Figure 8.
RSL sign O'CLOCK_{old}.



Figure 9.
RSL sign O'CLOCK_{new}.

Besides these two diachronic variants, there exists a third variant, O'CLOCK_{Novosibirsk} (figure 10), which has both a different movement and place of articulation and is used by our consultants from Novosibirsk. It is signed in neutral signing space and contains a slight repetitive movement of the wrist to the right and to the left. This sign also allows numeral incorporation (one through five) and was understood but never used by our language consultants from Moscow.⁴ Thus, O'CLOCK has two diachronic and one regional variants.



Figure 10.
RSL sign O'CLOCK_{Novosibirsk}*

Finally, there are signs that have a similar meaning but are used in different contexts in RSL (figure 11). Two signs refer to year (a period of 365 days) but occur in different contexts. The sign YEAR_c (where *c* stands for *calendar*) refers to a period of 365 days and is used in calendric contexts (e.g. *year 1965*) and frozen expressions (e.g., *New Year*). When referring to an age (*ten years old*) or a period (*the three years that I have spent in Moscow* or *three years of famine*) the sign YEAR_a is used (*a* in our glossing stands for *age*). Native signers from both Novosibirsk and Moscow had strong unanimous intuitions that these signs are not variants. In this case, numeral incorporation occurs only in YEAR_a; YEAR_c does not usually incorporate numbers and does not occur in contexts of plurality. Instead, the sign TIME is used, which functions as a suppletive form for both YEAR_a (when sequential forms are used) and YEAR_c. However, in our data and on the Internet, we can observe cases of numeral incorporation in YEAR_c, which we discuss below in relation to the influence of spoken Russian on RSL.



Figure 11a.
RSL sign YEAR_c, used to refer to year as a calendar unit.



Figure 11b.
RSL sign YEAR_a, used to refer to age.

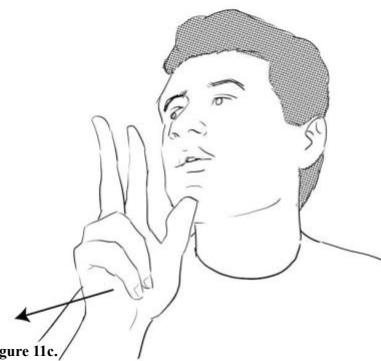


Figure 11c.
RSL sign 3 YEAR_c, incorporated form.

In the present analyses, we treat the pair YEAR_a and YEAR_c as unrelated signs; the signs HOUR₁ and HOUR₂ as different, but historically related (as they share the same movement); and O'CLOCK_{old} and O'CLOCK_{new} as diachronic variants of one sign, while O'CLOCK₂ is a dialectal sign with the same meaning.

3. Phonological constraints on numeral incorporation in RSL.

Functional complexity is defined as a hierarchy of principles that govern a system and the corresponding degrees of freedom that are allowed in that system (Gierut 2007). Phonological complexity limits the number and structure of forms allowed in a language. The level of complexity allowed in a language has previously been described as a constraint on numeral incorporation limits. Mathur and Rathmann (2010) concluded that both ASL and DGS show a

preference towards simultaneous forms over sequential ones, which favors numeral incorporation, but in some cases simultaneous forms are blocked by constraints arising from the complexity of articulation.

Mathur and Rathmann (2010) formalize their finding in an Optimality Theory (OT) framework that explains the surfacing of linguistic forms as the result of optimal satisfaction of conflicting constraints. Faithfulness constraints require that a certain feature present in the input be preserved in the output, while markedness constraints impose limits on what the possible output can be (de Lacy 2011). Mathur and Rathmann explain the preference towards simultaneity by the markedness constraint, which they named *SEQ and which prefers forms with one movement over ones with a sequence of movements. However, not all incorporating forms are possible because *SEQ interacts with other constraints.

This has been observed cross-linguistically (Ktejik 2013). In RSL numeral incorporation, this is also a general preference. If there is a possibility of numeral incorporation, it is done obligatorily. Below we discuss the calendric paradigms of RSL in detail and propose that the constraints that govern numeral incorporation arise from all featural levels. The order of presentation is as follows: first, we discuss the constraints on movement, then handshape, location, and orientation.

3.1. *Movement constraints.*

Constraints on movement complexity have been posited as a major limiting factor for numeral incorporation in ASL, DGS (Mathur and Rathmann 2010), and TID (Kubuṣ 2008). These authors suggest that no more than one movement specification is allowed per sign, which disallows incorporation of numerals that have internal movements. This constraint also operates in RSL, as our data show. Numerals that have internal movements (both two-handed, as seventeen [figure 12], or one-handed, as twenty [figure 13]) are never incorporated in RSL. If these numeral signs were to be incorporated, their internal movement would have to coincide with the path movement of the lexical sign.



Figure 12.
Cardinal number 17 in RSL.

One possible solution would be to delete the movement segment from the numeral, but movements cannot be deleted without a loss of information. One-handed numerals of different ranges (for example, three, thirteen, and thirty) share a handshape and differ only in movement, so movement deletion would make the forms of 3_MINUTE and 13_MINUTE indiscernible. At the same time, deletion of the path movement from the lexical base sign would result in the loss of lexical meaning. Thus, to refer to the period of three minutes, the incorporating form 3_MINUTE is used, while thirteen minutes is referred to with the sequential noun phrase 13_MINUTE.



Figure 13.
Cardinal number 20 in RSL.

Only one paradigm in RSL has a double movement specification (i.e., both path and internal movement): PERSON/PEOPLE. However, in this case the lexical sign itself has two specifications for movement: the active fingers bend, and simultaneously the hand moves down (figure 15).⁵ Thus, the incorporating form 2_PEOPLE is a minimal pair with the sign 200: the two signs differ only in path movement, while the internal movement is shared. Correspondingly, the same is true for the numeral-incorporated signs 3_PEOPLE through 5_PEOPLE and the number signs 300 through 500. Thus, even in this particular case of unusual complexity, it is important to note that both movements come from the lexical base time sign and not the numeral.

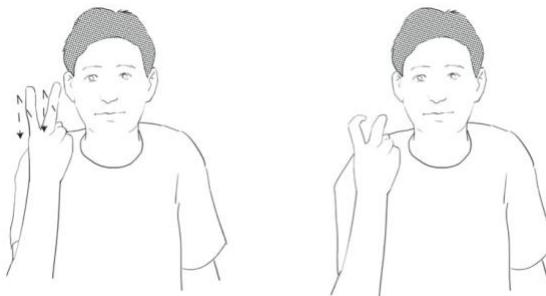


Figure 14.
Cardinal number 200 in RSL.

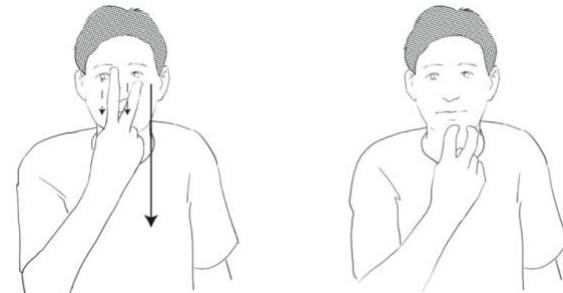


Figure 15.
RSL sign 2_PEOPLE, incorporated form.

The two-handed numerals eleven through fifteen (older version discussed above) are a special case. Having peculiar combinations of handshapes that are distinct from all other numerals, these number signs can lose their internal movement specification without creating ambiguity. We argue that this characteristic allows these numerals to be incorporated. Indeed, the sign HOUR₁ (one-handed sign with circular clockwise movement in neutral signing space) incorporates one- and two-handed numerals up to fifteen. This paradigm shows the highest limit in RSL (see figure

16a-d). Next, we ask what distinguishes this paradigm from the other paradigms to allow for such robust incorporation.

As noted above, two-handed signs like 7_HOUR or 10_HOUR would not be possible from the point of view of the classic definition of the dominance condition (Battison 1978). However, the expanded dominance condition (Napoli and Wu 2003), motivated by the necessity to account for two-handed signs in ASL in which the hands move as one unit, accounts for these forms in RSL as well. It is important to note that these forms are polymorphemic.



Figure 16a.
RSL sign 3_HOUR_i, incorporated form.



Figure 16b.
RSL sign 7_HOUR_i, incorporated form.

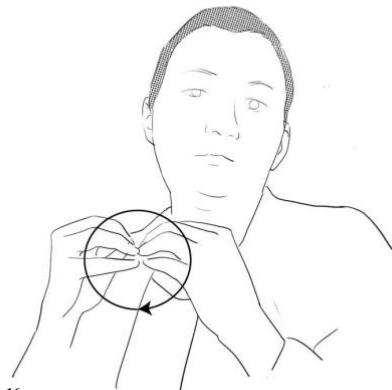


Figure 16c.
RSL sign 10_HOUR, incorporated form.



Figure 16d.
RSL sign 12_HOUR_i, incorporated form.

3.2. Handshape Constraints

As discussed above, in RSL, as in many other sign languages described to date (Fisher, Hung, and Liu 2010; Fuentes et al. 2010; Ktejik 2013; Mathur and Rathmann 2010; Morgan 2013), numeral incorporation is a general preference for calendric terms and measurement units, and simultaneous expression of morphemes is preferred over sequential expression. At the same time, in RSL—as in ASL, DGS, TID and other sign languages—time and measurement signs exist that do not allow any incorporation. Mathur and Rathmann (2010) proposed that this is due to a faithfulness constraint that preserves the marked featural specification in the input from deletion. In their example, the DGS sign MINUTE does not incorporate numerals because of its marked F handshape, which cannot be deleted. To be preserved, the handshape requires that all the fingers be selected, i.e., fingers that can change their aperture during the articulation of a sign (Brentari 2010).

The role of the handshape is also crucial in RSL. In their bare forms, most calendric and measurement signs in RSL have an unmarked 1 handshape with index or thumb extended (which was interchangeable both across and within our consultants). All of these signs allow numeral incorporation. However, several signs have handshapes with all fingers selected: DAY (figures 17

and 18), SECOND, HOUR₂, MINUTE, and KILOGRAM. Three of these signs do not allow numeral incorporation. In contrast, suppletion occurs for the MINUTE (figure 19) and KILOGRAM paradigms: both signs change handshape and movement direction, and then numerals are incorporated.

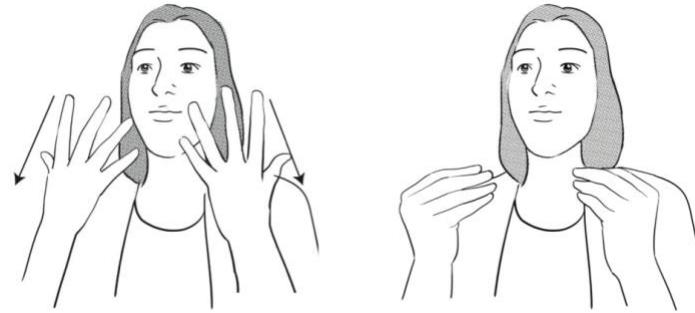


Figure 17.
RSL sign DAY.

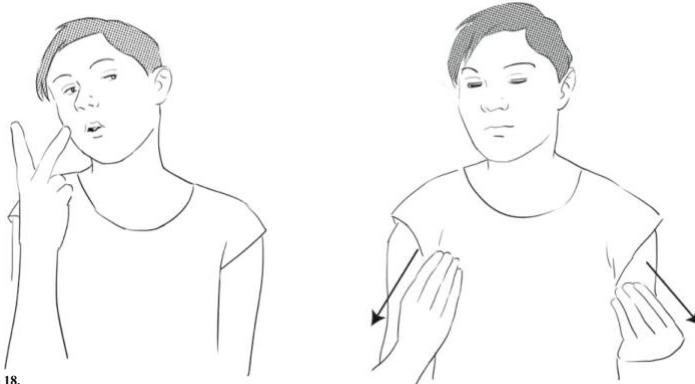


Figure 18.
RSL signs 2 DAY, no numeral incorporation.

The sign MINUTE is initialized (it has the M handshape with palm facing down orientation) and has horizontal ipsilateral movement, while the incorporating forms change orientation (palms face the central line) and movement direction (the hand moves forward), as illustrated in figure 19.

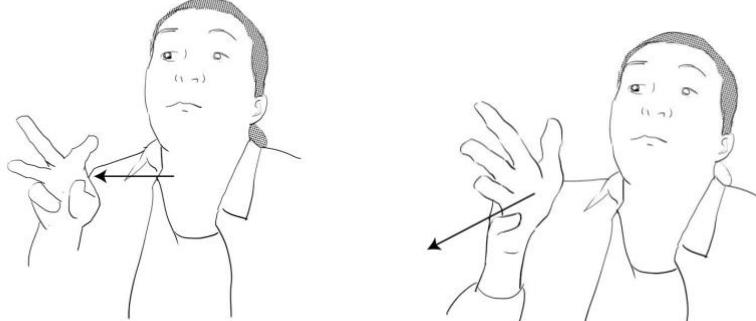


Figure 19a.
RSL sign MINUTE (initialized).

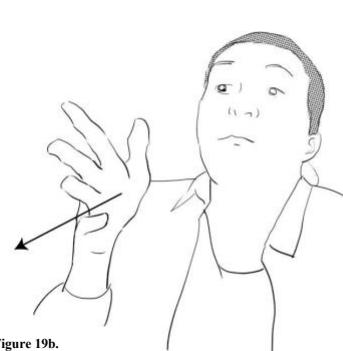


Figure 19b.
RSL sign 5_MINUTE, incorporated form (with suppletion).

Comparison of the signs HOUR₁ (HS 1) and HOUR₂ (HS Ψ) shows that, although the movement, location, and orientation of these signs are the same, they behave differently in relation to numeral incorporation. We discussed earlier that our consultants tended to systematically use one of the variants, but not both. While signers who typically used the sign HOUR₁ incorporated numerals one through fifteen, in our data the consultants who systematically used only the sign HOUR₂ never incorporated numerals,⁶ signing instead a sequential combination (for example, THREE HOUR₂). Since handshape constitutes the only difference between these signs, we assume

that the meaningful handshape with all fingers selected in the sign HOUR2 prevents it from incorporating numbers.

It is important to note here that initialized numerals (for example, MILLION that has the handshape M, or THOUSAND that has the handshape T) either do not allow incorporation or have suppletion. For example, the incorporated forms TWO THOUSAND through FIVE THOUSAND recruit suppletion. Beyond the number five, only the initialized sign THOUSAND (with the T handshape) is used in sequential combination with a numeral.

One paradigm in RSL that allows more than one finger specification is the currency paradigm, RUBLE. This sign is initialized (the bare form has P handshape, as in Russian word “Ruble”; thumb and middle finger contact each other twice). When incorporating the numerals one, two, and four, suppletion of the lexical sign occurs: the numeral handshape is incorporated and the movement is changed to wrist twisting. However, the forms 3_RUBLE, 5_RUBLE, and 10_RUBLE have specific forms that allow double handshape specification, as shown in figure 20. In other cases, meaning is expressed sequentially without numeral incorporation.



Figure 20a.
RSL sign RUBLE.



Figure 20b.
RSL sign 3_RUBLE, incorporated form.



Figure 20c.
RSL sign 4_RUBLE, incorporated form (with suppletion).

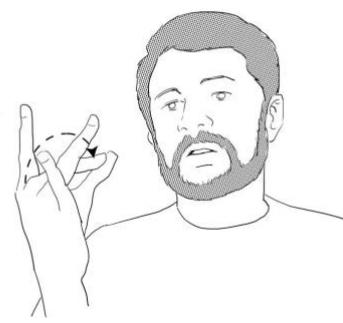


Figure 20d.
RSL sign 5_RUBLE, incorporated form.



Figure 20e.
RSL sign 10_RUBLE, incorporated form.

In 3_RUBLE, the 3 handshape is produced and then the middle finger contacts the thumb (turning to original P handshape); the same pattern is followed in 5_RUBLE. In 10_RUBLE, both hands touch each other in the P handshape, thus maintaining the original handshape and the

movement and orientation from the sign 10. Because the original handshape of RUBLE has only three fingers selected rather than all fingers, these forms manage to maintain both finger specifications from the input.⁷

Another possible explanation for signs that do not incorporate may lie in the nature of calendric terms. Fuentes et al. (2010) in their analysis of numeral incorporation in Catalan Sign Language (LSC) and Argentine Sign Language (LSA) note that across sign languages the distribution of paradigms that allow numeral incorporation resembles the distribution of numeric classifiers in spoken languages. Fuentes et al. analyze numeral incorporation as a simultaneous compounding of classifiers (calendric terms) and numerical roots. The signs that have specific handshapes and do not allow numeral incorporation in this framework do not resemble classifiers. We note that this approach does not fully account for the individual limits of paradigms. The question of whether the morphology of calendric terms is akin to classifier morphology awaits future research.

3.3. Location Constraints

Thus far we have described the phonological constraints that prevent certain numerals from being incorporated (internal movement) and certain calendric terms from incorporating (handshape with all fingers selected). However, most time signs in RSL incorporate numerals but show limits arising from different phonological constraints. For example, the paradigm HOUR₁, discussed above, incorporates the numbers one through fifteen; the paradigm MONTH incorporates the numbers one through nine; and YEAR_a and MINUTE allow incorporation up to five. How are these limits conditioned? This becomes apparent by comparing the signs HOUR, YEAR_a, and MONTH.



Figure 21a.
RSL sign HOUR.



Figure 21b.
RSL sign YEAR_a.



Figure 21c.
RSL sign MONTH.

The sign HOUR is located in neutral signing space, while MONTH and YEAR_a are signed on the head, and both start with contact. As is the case for the sign DEAF in ASL and RSL, MONTH can start either in its higher (ear) or lower (chin) location, depending on the preceding and following signs. The sign YEAR_a only allows incorporation up to five. Incorporation of the two-handed numerals six through nine would result in asymmetric two-handed signs located on the head, and signs of this type are never observed in RSL in either the present data set, the RSL Swadesh-Woodward list for the RSL dialect project (Davidenko et al. 2013), or in RSL dictionaries (Bazoev et al., 2009; Fradkina 2001; Geilman 2001). The sign O'CLOCK_{new}, also signed on the head and discussed above, behaves like YEAR_a in that it only incorporates one-handed numerals.

The sign MONTH, however, behaves differently. If the original location is preserved, it cannot incorporate numerals six through nine. But suppletion occurs in this case; the sign's location lowers to neutral signing space and changes orientation (see figures 22 and 23). The movement of the original lexical sign (movement down, or up in case of location metathesis) between the two contact points (forehead and chin) is preserved. The number handshape, while incorporated, also

changes; both contacts are substituted with two holds in neutral signing space, and both palms now face outward. This new orientation is part of neither the lexical sign, nor the number sign.

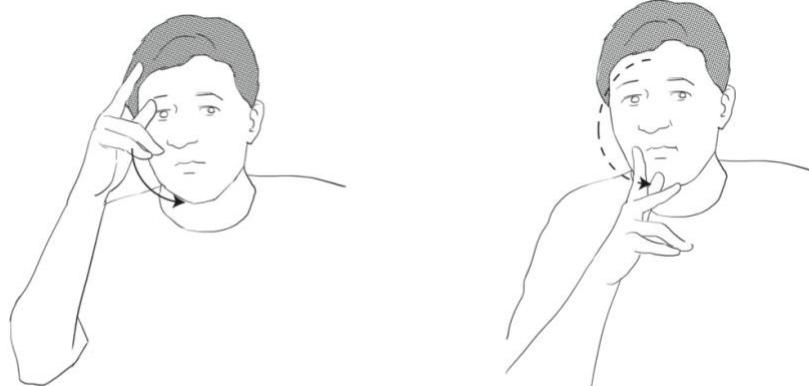


Figure 22.
RSL sign 3_MONTH, incorporated form.

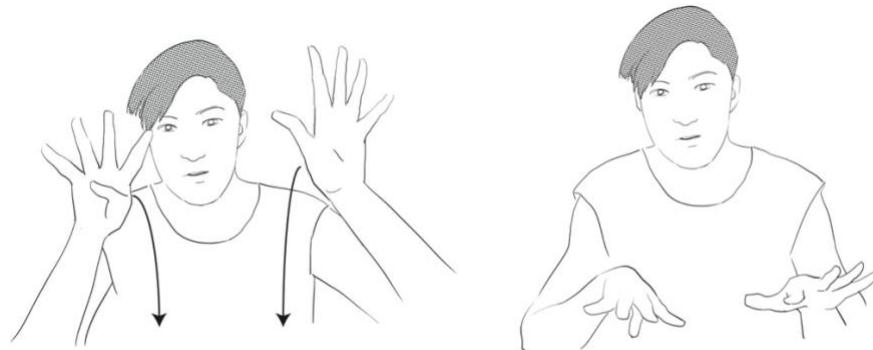


Figure 23.
RSL sign 9_MONTH, incorporated form (with suppletion).

When we discussed this suppletion with our language consultants, all of whom consistently used suppletion, they mentioned that some people may also use non-incorporating sequential forms to refer to six through nine months instead of the suppletive forms and that it is also acceptable except for the numbers two through five months, for which only incorporating forms may be used. Importantly, they noted that incorporation of two-handed numerals without suppletion is ungrammatical and both location and orientation are obligatorily changed.

3.4. **Orientation Constraints**

The sign MONTH, discussed above, allows incorporation of the two-handed numerals six through nine. Through incorporation, it changes not only location but also orientation. This led us to hypothesize that orientation might also be involved in the articulatory constraints preventing two-handed numerals from incorporation. When analyzing all the calendric and measurement signs that have an orientation facing the central line (lateral to the body), MONTH, MINUTE, and KILOGRAM, we discovered that none of these signs incorporate two-handed numerals.

The signs MINUTE and KILOGRAM are signed in neutral signing space and, yet, incorporate only one-handed numerals. This contrasts with the paradigms HOUR₁, which incorporates two-handed numbers six through thirteen, and WORKING_HOUR (figure 24), which has an outward orientation and allows incorporation of two-handed numerals up to ten (we describe this lexicalization process in more detail below in the discussion). This observation indicates that no paradigm that has lateral orientation allows two-handed signs with asymmetrical handshapes.

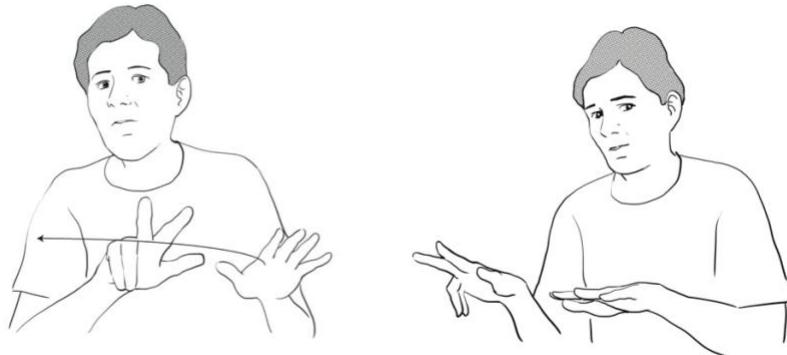


Figure 24.
RSL sign 8_WORKING-HOUR (8 hours of working day).

Checking RSL dictionaries and the Swadesh-Woodward list of RSL signs, we again found no signs with lateral orientation and asymmetrical handshapes. If a sign has two hands with this orientation, then it also has identical handshapes and movements that are synchronized (for example, READY) or alternating (COOK). If the handshapes are different, then one hand also has a different orientation (KILL; BREAD). Preliminary analysis of 321 signs collected and published online by Davidenko et al. (2013) as a part of the RSL dialect project (signs from the Swadesh list, including regional variants from different parts of Russia) revealed a low frequency of two-handed signs with lateral orientation (palms facing each other). Among the 321 signs examined, only twenty-nine have an orientation facing the central line, and only 4 percent (or nine) of these signs are two-handed. All nine signs have either an internal separate movement of the dominant hand or do not have contact. The handshapes occurring in this orientation are also highly restricted and include only handshapes that are unmarked, according to Battison's classification (1978). We propose that these handshapes are sufficiently perceptually salient to be distinguishable even when the hand faces the central line.

In addition, no two-handed signs have the same orientation (facing central line) with different handshapes in either the Swadesh list or any of the RSL dictionaries we consulted (Bazoev et al. 2009; Fradkina 2001; Geilman 1957, 1980, 2001). So, signs like *6_MINUTE are apparently ill-formed, not only for a particular numeral incorporation paradigm but also for RSL in general. This suggests that asymmetry in sign languages is compositional, that there are asymmetries on different featural levels that interact with other parameters. Therefore, we propose that, together with a location constraint, a constraint for orientation exists in RSL phonology that disallows signs with asymmetric handshapes to appear with an orientation lateral to the signer's body. The preliminary corpus data and analysis of RSL dictionaries provide additional support for our finding that orientation facing the central line in RSL strongly disfavors handshape asymmetry.

Another orientation restriction applies to the sign THOUSAND (figure 25) which has a downward palm orientation. This sign incorporates numbers one through five. After the number five, sequential phrases are used with a suppletive initialized form: ONE_THOUSAND versus EIGHT THOUSAND (see figure 26). This constraint may be anatomical and perceptual, that is, a two-handed sign with downward orientation in which one palm completely blocks the other from the interlocutor's sight is both hard to produce and impossible to distinguish.

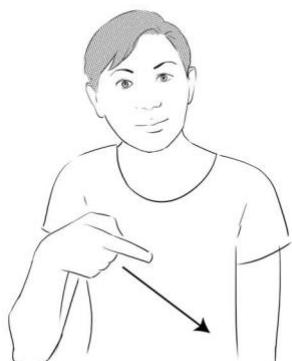


Figure 25.
RSL sign 1_THOUSAND, incorporated form.



Figure 26.
RSL signs 8 THOUSANDS (initialized sign), no numeral incorporation.



Thus, our analyses show that the parameter of palm orientation serves as one major factor that constrains the numeral incorporation limits of the various paradigms in RSL. This is an important finding, especially taking into account the controversial status of this parameter in the sign language literature. In Stokoe's (1960) original analyses, orientation was not included as a sign parameter. Battison (1978) later added palm orientation as a sign parameter, but its status remains a matter of some debate. Some phonological models of sign language consider orientation to be a parameter by itself, while others analyze it as a subcomponent of hand configuration (Brentari 1998; Sandler 2012; van der Hulst 1996). We argue, based on the analyses presented here, that orientation is not redundant and does not inherit its specification from location. To the contrary, orientation mostly interacts with handshape, in line with Sandler's Hand-Tier model (Sandler 1986).

3.5. *Contact Preservation*

In addition to the constraints discussed above, other factors may condition incorporation limits. Thus far, we have only discussed one-handed lexical signs, but among paradigms allowing numeral incorporation there is one paradigm that is two-handed: TIME.

The sign TIME refers to the number of occurrences of a certain event (as in, "She failed the statistics test three times"). It is articulated in neutral signing space, with the dominant hand moving down to contact the non-moving, non-dominant hand and then returning to the initial position, as figure 27 shows. This sign only incorporates one-handed numerals; two-handed numeral incorporation would cause the sign to lose the contact present in the input. Analyses of weak drop and compounding in ASL (Brentari 1998; Del Giudice 2007) have shown that a segment with a contact feature is always preserved in the output. Apparently, this is also true for RSL, although specific analyses of compounds in RSL are required to confirm this hypothesis.



Figure 27.
RSL sign 3_TIMES, incorporated form.

4. Alternative Explanations: Frequency, Borrowings, and Lexicalization.

Other factors may also impact numeral incorporation patterns in RSL. However, none of them fully account for numeral incorporation in RSL. Productivity is often considered an opposing factor with frequency and lexicalization. Highly frequent units are stored together as a holistic gestalt (and are thus lexicalized), while word formation is the product of combination of less frequent units (Fernández-Domínguez 2010). Word formation has to “overcome” numerous phonological, syntactic, semantic, and pragmatic constraints, as Fernández-Domínguez puts it.

Calendric paradigms in RSL differ in frequency as do the individual members of paradigm. The question is whether the frequency of occurrence of particular combinations of numbers and particular lexical items lead to numeral incorporation and thus account for the limiting conditions described here. For example, the paradigm *WORKING_HOUR*, discussed above, incorporates only the two-handed numerals six, seven, and eight. Our language consultants explained that this sign does not have a bare, non-incorporating form and refers to the typical length of the working day. Thus, “ten-hour working day” or “ninth working hour” do not typically occur in RSL discourse. Although our language consultants reported never producing such forms, they could imagine them. Thus, even if these forms are lexicalized, all the incorporating forms of the paradigm are faithful to all of the phonological constraints described here. Moreover, the pattern is productive.

Another group of signs that may have been influenced by spoken Russian in a way that impacts numeral incorporation limits, for example, is the sign *YEAR_p*, discussed above. According to five of our RSL consultants, this sign never incorporates numerals because it refers to one calendar unit and is never used in plural contexts. However, three of our younger language consultants noticed that incorporation of the numbers two, three, and four in this sign may be used when referring to a child’s age but that the incorporation of the number five does not occur. This may be an influence from spoken Russian. When referring to an age or a period of time, the lexeme *зод* [got] is used together with numbers one through four, while other numbers require a different lexeme, *лем* [let]. Thus, it is likely that RSL borrowed this paradigm from spoken Russian, as other numerals (even the phonologically possible five) cannot be incorporated.

It is important to note, however, that neither lexicalization and frequency nor the influence of spoken Russian alone can account for the variety of numeral incorporation paradigms and limits in RSL we have found here, which are highly consistent and predictable from a phonological standpoint. Together, our data and analyses demonstrate that, even in the case of lexicalization or language contact, phonology is always in play. Phonological constraints on numeral incorporation are apparent even in highly similar signs. For example, *HOUR₁* allows numeral incorporation but *HOUR₂* does not because the phonological form of the lexical sign specifies that all fingers are selected.

5. Summary

In this paper, we have described how phonological constraints occur across different featural levels to govern the numeral incorporation process in RSL. The present findings thus extend our understanding of the phenomenon. These results (paradigms, limits, and constraints responsible for the limits) are summarized in Table 2.

Our results extend previous work on these morphological processes in sign language. First, constraints on movement complexity have been posited as a major limiting factor for numeral incorporation in ASL, DGS (Mathur and Rathmann 2010), and TID (Kubuš 2008). The fact that no more than one movement specification is allowed per sign disallows incorporating numerals that have internal movements. As our data show, this constraint also operates in RSL. Handshape

complexity has also been posited as a constraint on numeral incorporation in sign languages. Calendric terms that have a handshape with all fingers selected do not incorporate numerals in DGS (Mathur and Rathmann 2010). This is also the case for Russian Sign Language. The location and orientation parameters of sign have not been previously described as constraints, either in numeral incorporation limits or the maximum sign complexity allowed in a sign, but Frishberg (1975) mentions that two-handed signs on the head are less preferred in ASL than one-handed signs, and they often change in this direction. However, based on our present analyses of the data, both from our language consultants about numeral incorporation and RSL lexicographic materials, we find that location and orientation also operate as constraints in the composition of two-handed signs. Specifically, they interact with symmetry restrictions. Two-handed signs with asymmetrical handshapes are not allowed in RSL if they have an orientation lateral to the body (facing the central line) or are signed on the head location, or both. At the same time, two-handed signs with asymmetrical handshapes exist in numeral incorporation paradigms and in the RSL lexicon in general, but only if they have other orientations (such as palm outwards) and locations (neutral signing space). Finally, an important factor that also influences numeral incorporation is contact preservation; a contact segment present in the input cannot be deleted, consistent with previous research (Del Giudice 2007).

In sum, the results of our data and analyses add to typological studies of numeral incorporation, increasing our understanding of constraints on two-handed signs and the interaction of phonology and morphology in RSL. Our results also underscore the importance of sign orientation and its interaction with other parameters, such as handshape and location, in sign language phonology.

Table 2.. Incorporation of numbers and constraints that influence it.

The first column contains English translations of RSL signs, and the second column shows whether a particular sign incorporates one-handed numerals. The third column shows whether this sign incorporates two-handed numerals six through nine. The fourth column indicates whether the sign incorporates two-handed numerals ten through fifteen. If incorporation does not occur, the columns also explain which constraint prevents it.

Lexical base sign	1–5 (one-handed)	6–9 (two-handed)	10–15
HOUR ₁	+	+	+ (only two-handed)
MONTH	+	+ suppletion: orientation change	- movement
MINUTE	+	- blocked by orientation	- movement
KG	+	- blocked by orientation	- movement
YEAR _a	+	- blocked by location	- movement
O'CLOCK	+	- blocked by location	- movement
TIME (occurrence)	+	- blocked by contact preservation	- movement
PEOPLE	+	- movement	
WEEK	+	- orientation	
DAY	- handshape with all fingers selected		
SECOND	- handshape with all fingers selected		
MILLION	- handshape with all fingers selected		
HOUR ₂	- handshape with all fingers selected		

YEAR _c	- semantic reason	
RUBLE	+ suppletion	- movement
WORKING HOUR	+ (lexicalized)	- movement
THOUSAND	+ suppletion	- orientation

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The illustrations contained in this paper were created by Lisa Marie Brennan. Illustrations do not bear photographic resemblance to their models.

Notes

1. The term paradigm is adopted from Liddell (1996).
2. For detailed analyses of calendric and time signs of RSL, see Burkova et al. 2018.
3. are also two dialectal centers. More information about differences between Siberian and Moscow dialects of RSL can be found in Burkova and Varinova (2012).
4. Despite the presence of two movements, this sign is well-formed, according to Brentari's syllable constraint (1998).
5. A related explanation may be that HOUR₂ is initialized. In the literature, a proliferation of initialized signs have been described as showing an influence from the signed version of a spoken language used extensively in Deaf education (Newell 1983). To date, there are no studies of the frequency of initialization in RSL, but manually coded Russian (MCR), which does not use numeral incorporation, may be the source of this initialization. It is known that signs from MCR often enter RSL vocabulary (Zaitseva 2000). In our data, HOUR₂ appeared in RSL discourse and not in an MCR context, and yet it did not incorporate number. Signers using HOUR₂ did not avoid numeral incorporation in other common paradigms. Although our data are in RSL, all signers had been exposed to MCR at some point in their lives.
6. According to one of our language consultants, these incorporated forms may soon disappear from RSL discourse for extralinguistic reasons related to economic inflation.

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