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#### **Title**

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#### **Permalink**

<https://escholarship.org/uc/item/16b5s7hq>

#### **Journal**

Proceedings of the Annual Meeting of the Cognitive Science Society, 46(0)

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#### **Publication Date**

2024

Peer reviewed

# Acquisition of gender agreement depends on frequency distributions in specific contexts

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## Abstract

Learning to understand and use agreement is an integral part of children's linguistic development. In Romance languages, this includes gender and number agreement between the controller and attributive or predicative adjectives or participles. We examine the development of this category in a case where children's task is complicated by syncretisms, multiple paradigms, and unequal input distributions. Romansh Tuatschin (Romance, Indo-European, Switzerland) presents children with two distinct paradigms for attributive (masculine and feminine only) and predicative (masculine, feminine, and neuter/unmarked) contexts of adjective and participle use. The masculine form in predicative use is the same as the neuter form in attributive usage. Thus the masculine form in these two paradigms differs. This could be challenging for the language learner. The distribution of these forms is heavily skewed towards the *neuter* in predicative contexts but balanced in attributives. Examining production errors in children between 2;0 and 4;3, we evaluate the effects of frequency and syncretism and find that error-rate is affected by skewed distributions and less affected by syncretisms. This demonstrates the strong effect of input distributions on first language acquisition.

**Keywords:** language development; agreement marking; frequency distributions

## Introduction

Children learning Romance languages must learn to use and understand agreement, including number and gender marking (Pizzuto & Caselli, 1992; Rubino & Pine, 1998; Kupisch, Müller, & Cantone, 2002). While the acquisition of morphology and morphosyntax is well studied in other Romance languages, the acquisition of agreement in Romansh is completely uninvestigated so far. In Romansh Tuatschin, a Rhaeto-Romance variety spoken in the Swiss canton of Grisons, children encounter a particular challenge. They must learn that they can make more distinctions when using adjectives or participles in predicative contexts as opposed to attributives and that agreement markers do not follow the same pattern across the two contexts.

While some studies point to the low error rates in 2 to 3 year-old's production (Caprin & Guasti, 2009), others highlight the piecemeal nature of this acquisition (Pizzuto & Caselli, 1992; Rubino & Pine, 1998; Mueller Gathercole, Sebastián, & Soto, 1999).

In this study, we analyze the errors in the production of adjective and participle agreement of 6 children aged 2;0 - 4;3 who learn Tuatschin as their native language. We examine the distributions of these forms in a naturalistic longitudinal corpus, both in the input as well as in the children's production. We show that children's errors can be explained better by the skew in frequency distributions rather than the presence of syncretisms, which require children to use the same form for different agreement properties in different contexts. We focus on the production of singular forms, since plurals are far less represented and do not provide enough material for a reliable analysis.

## Romansh Tuatschin

The Romansh varieties of Switzerland are spoken in the trilingual canton of Grisons (German, Romansch, Italian) in South-Eastern Switzerland as well as by a sizable diaspora in the other linguistic parts of Switzerland. Up to two thirds of Romansch speakers live in the non-Romansch speaking Swiss diaspora (Cathomas & Graf, 2023). There are six written varieties of Romansch spoken in the Grisons, one of which (Rumansch Grischun) was developed artificially in an attempt at unifying the written varieties. In the present, however, schooling happens in the local written varieties. The most widely used variety of the 5 naturally developed standard varieties is Sursilvan, spoken by about 54,8% (approx. 18,000 people) of the population of the Surselva region, according to the 2000 census (bfs.admin.ch, 2022). These speakers speak either the standard variety or one of the sub-dialects. Romansh Tuatschin, the primary language examined in this paper, is the westernmost and most distinctive dialect of Sursilvan, spoken primarily in the Tujetsch valley by approximately 1,000 speakers. However, a sizable number of native Tuatschin speakers live in other Sursilvan speaking parts of the Grisons as well as in Swiss German speaking regions of the country.

All Romansch speakers are bilingual and multi-dialectal. They learn Swiss German from an early age, and can be considered completely bilingual in Romansch and (Swiss) German, sounding indistinguishable from the L1 Swiss Ger-

man speakers of the Grisons region. The language of elementary school instruction in officially Sursilvan speaking towns and villages of the Surselva region is standard Sursilvan. However, German occupies an important role from early on and German instruction is gradually increased throughout elementary school to allow for a smooth transition into secondary and higher education. English is taught as a second foreign language from fifth grade and French or Italian as a third foreign language can be studied from middle school age (gr.ch, 2023).

The Tuatschin-native adults in the corpus used for this study speak Tuatschin, Sursilvan, Swiss German and Standard German. They are used to writing in at least Standard Sursilvan and Standard German. The younger generations also commonly use Tuatschin and Swiss German in informal written communication (Maurer-Cecchini, 2021). The umbrella-variety of Sursilvan and the Tuatschin dialect do not differ with regard to the grammatical distinctions discussed in this paper. In fully Romansch Sursilvan and/or Tuatschin speaking families, first language acquisition occurs almost exclusively in Romansch, with relatively little influence from (Swiss-)German varieties, unless the children attend a Swiss-German speaking daycare. This is only the case for children who grow up outside the linguistic area, and those children usually attend daycare for a maximum of two or three days of the week, while spending other days when they are not with their primary caregivers with family members who are also Romansch speakers (grandparents, aunts).

### Gender agreement in Romansh Tuatschin

The majority of modern Romance languages distinguish two genders: masculine and feminine. Historically, there was a third, the neuter. The reduction to a two gender system has led to the collapse of masculine and neuter forms and the use of the masculine form as a default form for contexts, where no gender is marked, e.g. in constructions using the neuter third person pronoun *it* (Loporcaro 2015).

Standard Sursilvan and its dialects, however, are one of the few remaining varieties that have undergone this development only partially (Loporcaro 2015). Like most other Romance languages, they only distinguish masculine and feminine nouns, the majority of formerly neuter nouns having switched to masculine (Loporcaro, 2017). However, rather than collapsing the neuter and masculine across all contexts, Sursilvan varieties have retained vestiges of a third form in predicative agreement contexts.

Due to this incomplete development, speakers have to acquire two paradigms: Attributive agreement has only *m* and *f*, since attributives need nominal controllers and Sursilvan nouns can only be masculine or feminine, see examples (1a) and (1b). Here, the masculine singular form is unmarked (-Ø, while the feminine form is marked with an *-a*. In predicative contexts, however, neuter agreement is frequently required (see section *Frequency distributions* for more detailed frequency distributions). It is the correct form in the cases exemplified in (2a-c). In predicative contexts, the neutral agree-

ment form is the unmarked form (-Ø, while the masculine is marked with an *-s* and feminine with an *-a*, see examples (3a-b).

- (1) M and F in attributive contexts:
  - a. in                    tgèr            magnùc  
INDEF.M.SG expensive. cheese  
'An expensive cheese'
  - b. ina                 tgèr-a           tescha  
INDEF.F.SG expensive-F.SG bag  
'An expensive bag'
- (2) N ("neutral") in predicative contexts:
  - a. tüt è stermentus tgèr.  
all is terribly expensive.  
'Everything is terribly expensive.'
  - b. i                 ò da tgèsa è bi.  
go-INF out of house is nice.  
'Going out is nice.'
  - c. Sedrùn è ampernaivel.  
Sedrun is pleasant.  
'Sedrun is pleasant.'
- (3) M and F in predicative contexts:
  - a. al                 paun è tgèr-s.  
DEF.M.SG bread is expensive-M.SG  
'Bread is expensive.'
  - b. la                 tgarn è tgèr-a.  
DEF.F.SG meat is expensive-F.SG  
'Meat is expensive.'

The paradigms are illustrated in Table 1 and show the syncretism between the neutral (N) form of the predicative paradigm and the masculine singular of the attributive agreement as well as between the predicative masculine singular *-s* and the masculine plural forms of both attributive and predicative contexts. Feminine forms remain unchanged across both contexts.

Table 1: The attributive and predicative paradigms exemplified using the adjective *tgèr* 'expensive'.

	attributive		predicative	
	singular	plural	singular	plural
masculine	tgèr-Ø	tgèr-s	tgèr-s	tgèr-s
feminine	tgèr-a	tgèr-as	tgèr-a	tgèr-as
neutral	—	—	tgèr-Ø	—

Past participles that are used with the auxiliary verb *èssar* 'to be' are treated like adjectives and agree with the subject of the verb, this includes the neutral form for genderless subjects. Participles used with the auxiliary *vaj* 'to have' are always unmarked (N) (Maurer-Cecchini, 2021). Since the majority of participles occur with the auxiliary *vaj*, the predominantly used form is the unmarked N (see section *Frequency distributions* for details).

## Data and methods

### Data and annotation

We use data from a longitudinal audio-visual corpus of 6 children learning Tuatschin as their first and dominant language (Mažara, Walther, Loporcaro, Cathomas, & Stoll, Unpublished). The recordings were conducted in Val Tujetsch as well as in other majority Sursilvan or Swiss German locations. Two children were recorded from 2;3 to 4;3, two from 2;0 to 3;1 and two between the ages of 3;0 and 4;1. They were video-recorded by their parents in monthly intervals. Within each month, parents were given a week to record a minimum of 4.5 hours of everyday interactions. To keep the recordings as naturalistic as possible, there were no requirements as to the length of individual recordings. Parents were instructed to keep the recordings as natural as possible in terms of settings and who or how many other people appear on the recordings. The contexts of the recordings include: indoor and outdoor free play, food preparation involving the target child and their mother, lunch or dinner table conversations in groups of varying size, game playing, book reading, but also car rides for children who like to talk during car rides, and many other contexts.

All of the mothers of the recorded children are native Romansch Tuatschin speakers who grew up in the valley. This meant that the mothers were primarily responsible for the recordings, and had to be present to ensure that the children would not be influenced by speakers of other languages. However, the children's linguistic backgrounds vary in terms of their paternal primary language as well as their primary place of residence. Since all mothers are Romansch Tuatschin speakers and also serve as the primary or majority caregivers of the children, Tuatschin is the dominant variety of all children included in the corpus. In two families, Romansch Tuatschin was the language spoken by both parents, two more families had a Romansch Tuatschin speaking mother and a Romansch Sursilvan speaking father. Romansch Sursilvan is not only related to Tuatschin but also exhibits the pattern analyzed in this study. This means that the presence of Sursilvan would not affect children's exposure to this particular linguistic pattern. Two more children have fathers who do not speak any Romansch varieties natively. However, Romansch Tuatschin is still their dominant language and they use it daily with their mother (who is their primary caregiver) as well as grandparents and cousins who use Romansch Tuatschin exclusively. An overview of the children's linguistic situation is given in Table 2. All of the children were typical in their linguistic development and there were no significant differences between the children who live in bilingual households and those who grow up in an exclusively Romansch Tuatschin/Sursilvan household. The two children whose fathers are not native speakers of any Romansch varieties, were recorded from the age of 3;0.

For the children who grow up in strictly Romansch Tuatschin/Sursilvan speaking households, bilingualism is not yet a significant factor, since their exposure to Standard and

Swiss-German is highly limited. Three of four exclusively Romansch Tuatschin/Sursilvan speaking children do not go to day care or go to a Tuatschin speaking day care. One of four lives in a Swiss-German speaking area but goes to day care only 1 day of the week for 6 hours, while spending the other days with their mother, their aunts, or grandparents who are all Romansch Tuatschin speakers. One of the children in a bilingual family spends their days with Romansch Tuatschin speakers (mother, aunt, grandparents) exclusively. Only one child, who lives in a bilingual family and in a Swiss-German area of Switzerland, goes to a Swiss-German day care. However, their data represent a minority of the data analyzed for this study and show no significant difference in terms of the use of agreement morphology.

Finally, it is important to note that Romansch Sursilvan (including R. Tuatschin) speakers take pride in being Romansch speakers and particularly in speaking a special dialect of Romansch. This leads to a high investment in preserving the language and passing it on to their children. This means that adherence to speaking Romansch Tuatschin is high and readiness to mix or code switch with German or Swiss-German is relatively low.

Table 2: The linguistic situation of the target children.

Target child	Mother's language	Father's language	Place of residence
Child 1	Tuatschin	Sursilvan	Sursilvan speaking area
Child 2	Tuatschin	Tuatschin	Swiss German speaking area (close to Sursilvan area)
Child 3	Tuatschin	Sursilvan	Sursilvan speaking area
Child 4	Tuatschin	Tuatschin	Tuatschin speaking area
Child 5	Tuatschin	Swiss German	Swiss German speaking area (close to Sursilvan area)
Child 6	Tuatschin	Italian/German	Swiss German speaking area

The entire corpus comprises approximately 450 hours, of which 280 were transcribed and analyzed at the time of the study. The linguistic production of all participants was transcribed, translated, and morphosyntactically glossed. While transcription and annotation of the corpus are still ongoing, the initial transcriptions and annotations were spaced out evenly across all children and their monthly recordings. This means that the amount of data from each child is similar in the amount of transcribed hours as well as the samples distribution across time (e.g., 1 hour per month of recording for each child across the entire recording period). The only exception is child 6, whose recording started later and whose sample was smaller at the time these analyzes were performed.

For this study, all adjectives and participles in children's production were extracted and annotated by a trained linguist who is also a native speaker of Sursilvan. These additional annotations consisted of assessing whether the forms produced by children were correct or not. Each form was annotated for i) context of use for adjectives (attributive, predicative, adverbial, not clear) and correct auxiliary for participles (*èssar* 'to be' and *vaj* 'to have') and ii) whether or not the contextually required agreement marking was produced correctly. If not, the annotations provided information about the *required* and *actually produced* form. Adults' forms were also analyzed to assess whether errors in these forms are produced only by children or could also occur in adult speech.

To evaluate this, a sample of adult speech consisting of 90k tokens was similarly hand-annotated for correctness of agreement marking. The sample included 1720 participle and 1625 adjective forms. Errors in this sample were negligible: adults across all recordings produced only 3 errors in participle form marking and 2 errors in adjective forms.

Preliminary analyses showed no effect of age or linguistic situation on error production. Therefore, all children’s error production data were pooled for the purposes of the models described in this paper.

### Frequency distributions in input and children’s production

Children’s use of adjectives consists of attributive, predicative, adverbial and stand-alone uses of adjectives, which cannot be categorized properly. For the purposes of this study, we examine only attributive and predicative use, which can be evaluated as to whether they appear with the correct agreement or not. The predicative use includes predicative adjectives as well as participles. Due to the low frequency of plural forms in children’s production, we focus on singular contexts only.

Table 3: Number of forms produced by target children.

Context	Number of forms
Attributive adjectives	744
Predicative adjectives	717
Participles + <i>èssar</i>	468
Participles + <i>vaj</i>	2239

The numbers of forms used by children by category are represented in Table 3. While the use of attributive and predicative adjectives is fairly even, participles that use *vaj* as an auxiliary clearly outweigh those used with *èssar*.

Input distributions and children’s use of forms are not significantly different across the board. Input distributions of the forms according to required gender by context is represented in figures 1 and 2.

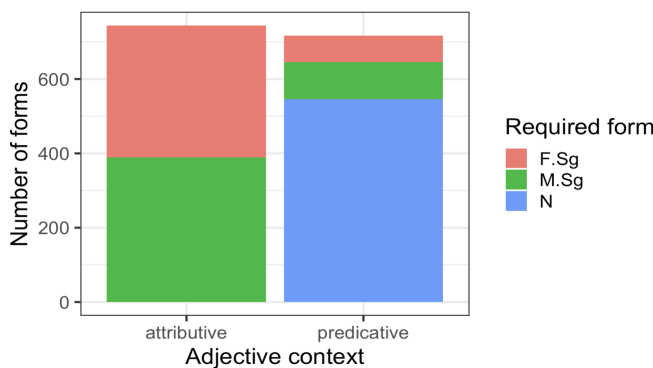


Figure 1: Input distribution of required gender forms across the two adjective contexts.

Despite the possibility of using predicative adjectives in all three forms, there is a clear preference for the use of the neutral agreement form (N). Participles show an even more skewed distribution of agreement. Most participles appear as unmarked forms, since they are used with the auxiliary *vaj* and even those that use *èssar* appear in their unmarked form in more than half of all cases.

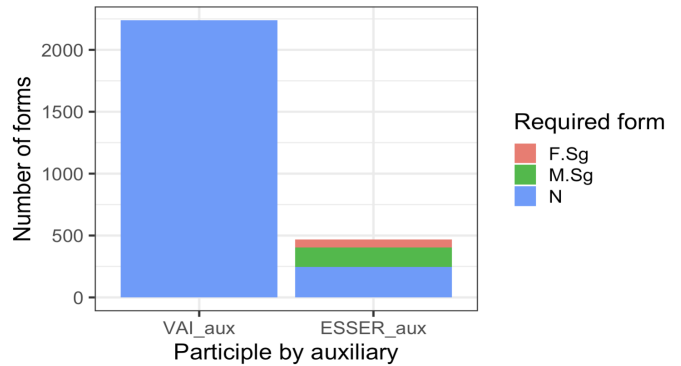


Figure 2: Input distribution of required gender forms across the two participle contexts.

*Hypotheses.* Since the forms are the same and in the case of the feminine marking do not even require the acquisition or formulation of an additional rule to be produced correctly, a rule-based learning account would predict that errors are equally distributed across contexts. Conversely, usage-based accounts would predict that frequency of use of a form in a particular context would influence the learning trajectory, i.e. a less frequently used form would be produced incorrectly more often than a more frequently encountered and used form.

Given the variation of the distribution of forms across contexts of use, we expect some contexts to be less error prone than others. Participle forms used with the auxiliary *vaj* provide children with plenty of evidence for one sole form (the unmarked *neutral* - $\emptyset$ ). Other contexts of use provide either an even distribution of forms, like the use of the *masculine* - $\emptyset$  and *feminine* -*a* in attributive adjectives, or a more skewed distribution as in the case of predicative adjectives and participles with the auxiliary *èssar*, which provide more examples of the neutral agreement form - $\emptyset$  than the predicative feminine and masculine forms -*a* and -*s*.

Based on these distributions, our first prediction is that errors are most likely in predicative adjectives and participles with *èssar*.

Since the overwhelming majority of forms children encounter is unmarked, we hypothesize that neutral agreement requiring forms will be less error prone than masculine or feminine requiring instances. The prediction for masculine and feminine forms is more complex. Masculine requiring contexts outweigh feminine requiring contexts in predicative adjectives and participles with *èssar*. If frequency of form and use combination was the only factor influencing error

rate, it might be a reasonable assumption that feminine requiring contexts will be more error prone than masculine requiring contexts. However, we do not hypothesize this. The syncretism between attributive masculine marking and predicative neutral marking (both  $-\emptyset$ ) presents an added difficulty unparalleled in the feminine part of the paradigm, where both attributive and predicative feminine forms use  $-a$ .

We also predict that context of use will interact with the required agreement form based on the difference between the distributions of forms in predicative adjective use and participle+*èssar* use.

## Methods

To test the predictions formulated above, we use multilevel Bayesian models to estimate the probability of error production in a particular context. Since the outcome is binary ( $\pm$ error), we use a Bernoulli model with a logit link function. All models were fitted in a Bayesian framework using the package *brms* (Bürkner, 2017) as an R front-end to *Stan* (Carpenter et al., 2017).

As predictors we used (i) the context of use coded as follows: attributive adjective, predicative adjective, predicative participle with auxiliary *vaj*, predicative participle with auxiliary *èssar* and (ii) the gender of the contextually required form (M, F, N). We coded the following values as the reference level based on the expectation of the lowest error rate: (i) participle with auxiliary *vaj*; (ii) neutral agreement form (N).

To allow for individual variation between the target children, we treat the children as random effects.

Besides testing each predictor individually, we also ran an additive model and one with an interaction term between context of use and required agreement marking. The 4 models are:

- (i)  $p(\text{error}) \sim \text{context of use} + (1|\text{target child})$
- (ii)  $p(\text{error}) \sim \text{required marking} + (1|\text{target child})$
- (iii)  $p(\text{error}) \sim \text{context} + \text{required marking} + (1|\text{target child})$
- (iv)  $p(\text{error}) \sim (\text{context} * \text{required marking}) + (1|\text{target child})$

## Results

All models converged and model comparison using leave-one-out validation showed the model with the interaction term to provide the best fit, although model stacking gives similar weights to the additive model (Model iii) and the model with the interaction term (Model iv). Since the model with interactions introduces many terms without providing a substantial increase in model performance, we will focus on model iii as the most complex exploration of the different variables. While models i and ii performed worse than model iii, they are nonetheless useful for illustrating the effect of individual variables and will be presented in the following section.

Figure 3 shows the posterior error probabilities of Model i. Since the levels were contrast coded, all posterior distri-

butions must be read relative to the base level, which is participles with the auxiliary *vaj*. Results show that, if we only consider context of use as a predictor, all contexts show a significantly higher error rate than participle + *vaj*.

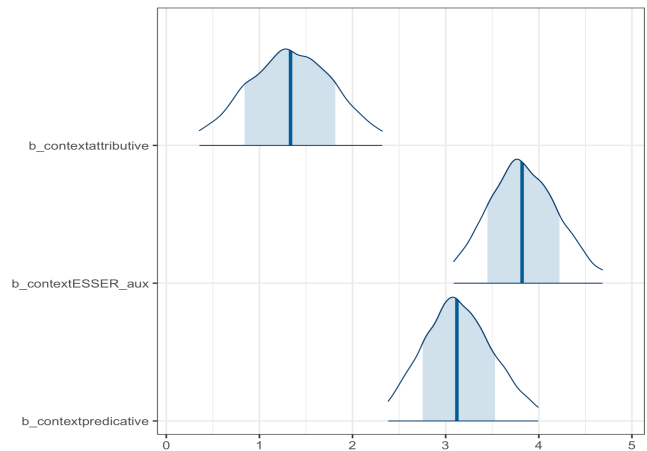


Figure 3: Posterior error probabilities of different contexts.

Figure 4 shows the posterior error probability estimations of Model ii. Both feminine and masculine requiring contexts are far more error prone than neutral agreement requiring contexts. However, the estimates of the distributions are near-identical with very similar means and credible intervals. This suggests that, despite the small imbalance in the distribution of feminine and masculine forms, there is no difference in their propensity for error-production.

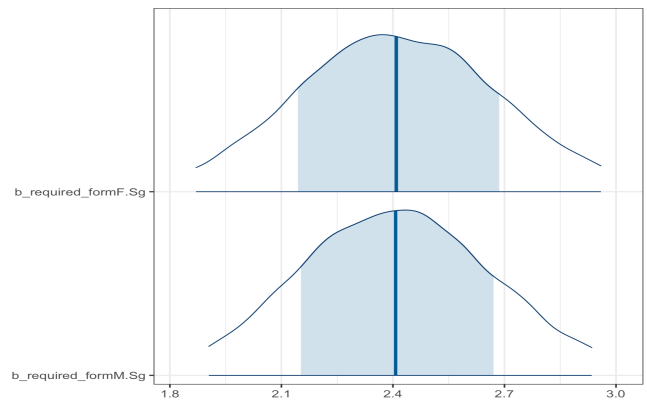


Figure 4: Posterior error probabilities of masculine and feminine marking requiring contexts in comparison to contexts that require the neutral form.

Figure 5 shows the posterior error probability estimations of Model iii, the additive model taking both context of use and required agreement marking into account. This model shows that the attributive adjective context on its own predicts the lowest error rate, even lower than the participle+*vaj* context, which is the reference level. Forms that require feminine or masculine agreement are significantly more likely to be the loci of errors than forms requiring neutral agreement. In this

model, feminine agreement requiring forms have a slightly higher estimate of error probability than masculine forms. However, the credible intervals indicate that the data do not provide enough evidence for a clear distinction. More data might prove this distinction to be more or less pronounced.

Both predicative adjective use as well as participles with *èssar* show a significantly higher error probability than the participle + *vaj* reference level.

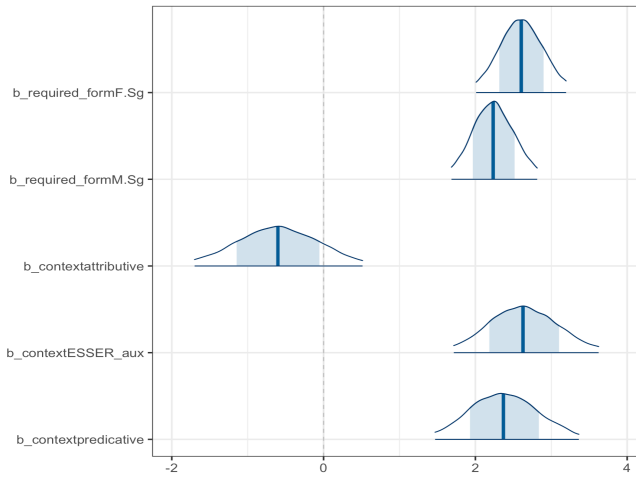


Figure 5: Posterior error probabilities of the additive model of masculine and feminine marking requiring instances in comparison to instances that require the neutral form and contexts of use.

## Discussion

The analyses presented in this paper support the hypothesis that frequency distributions of agreement forms in specific contexts influence children’s production. The forms of attributive agreement in the input show an even distribution between the  $-\emptyset$  form of masculine singular and the *-a* form of feminine singular agreement. The distribution of forms in children’s production is similarly even and the rate of errors is low across the attributive paradigm. Conversely, predicative agreement requires the  $-\emptyset$  form, denoting neuter agreement in a substantial majority of cases in the input. A considerably smaller number of forms in the ambient language require the marking of a form as masculine *-s* or feminine *-a* singular. Children’s production mirrors the distribution found in their input in terms of the large proportion of unmarked  $-\emptyset$  neuter forms. The lowest error rate overall is exhibited in the masculine singular attributive context (the unmarked  $-\emptyset$  form). This is not surprising, since this is the most commonly occurring as well as unmarked form. However, children’s errors in the attributive context are low overall.

In their production of predicative forms, on the other hand, children show a considerably higher error rate in both *-s* and *-a* marked forms.

One possible explanation for the higher rate of errors in predicative contexts might be the fact that the masculine sin-

gular form in attributive contexts is  $-\emptyset$  but masculine singular predicatives must be marked with an *-s*. This represents an additional paradigm children must learn. However, feminine forms mark agreement in the same way across both paradigms, meaning, children would have to develop only one rule. The error rate found in children’s production, however, is virtually the same for predicative feminine and masculine agreement forms.

## Conclusions

Frequency has been claimed to be a main driver in language acquisition (Ambridge, 2010; Ambridge, Kidd, Rowland, & Theakston, 2015). However, frequency often interacts with other factors such as syncretisms and context-dependent distributions. These factors can be hard to disentangle but the Romansh Tuatschin agreement patterns lend themselves as a natural laboratory. While the morpheme inventory of Tuatschin adjective and participle agreement is small enough to allow for a global evaluation of the acquisition process, it also presents an interesting challenge of the same surface form being used for different agreement marking in different contexts.

Our results suggest that, while frequency is a main driver in the acquisition process, it is not the frequency of the forms themselves that predicts children’s correct use of forms but the frequencies of the forms in each particular context. In the attributive context, where children hear the same amount of masculine and feminine forms, children do not produce many agreement errors. In the predicative context, on the other hand, children encounter a highly skewed input distribution with unmarked forms making up the majority of occurrences. This leads to a significantly higher error rate for *-s* and *-a* marked forms. This pattern is not over-written by children’s exposure to and command of the same *-a* marked forms in another context. This means that the children in our sample have developed a solid command of a form in one context but do not generalize that same rule for the use of the same form in the other context. This suggests that a form’s frequency across contexts is not as relevant for children’s ability to correctly generalize its use to different contexts. Instead, children are sensitive to distributions of forms in specific contexts and might generalize rules to different contexts with varying ease. If they hear an even distribution of forms in one context, they will generalize rules faster than in contexts whose distribution is heavily skewed towards only one form.

## Acknowledgments

First and foremost, our warmest thank you to all children and their families, who participated in the corpus collection as well as the community of Val Tavetsch for their help and interest in this project and for providing excellent conditions. We also thank the many people of the Tuatschin corpus team of transcribers, translators, and annotators for their support and Philippe Maurer for creating an excellent reference work (Maurer-Cecchini, 2021). We would particularly like to thank Claudia Cathomas for all error annotations used in this paper

and for providing valuable linguistic expertise throughout our collaboration on this project. This research was supported by Swiss National Science Foundation grant No. 159544 (PIs Michele Loporcaro and Sabine Stoll).

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