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One, Two, Three, Four, Five, Once I Caught a Fish Alive: Numerical Phrases in Child and Adult Heritage Russian

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Abstract: This paper investigates the production of numerically-quantified phrases (NQPs) by monolingual and bilingual speakers of Russian, with Hebrew as the dominant language for the latter group. Russian NQPs exhibit a complex system of noun forms, distinguishing between singular (*odin gorod* 'one city'), paucal (*dva goroda* 'two cities'), and plural (*pjat' gorodov* 'five cities'); the endings of paucal and plural nouns vary depending on nominal declension class, which in turn correlates with gender. Adult and child bilinguals dominant in Hebrew (n = 37 and n = 27, respectively) were compared to monolingual Russian-speaking controls (n = 21 and n = 20, respectively). Production data were collected using a numeral-noun elicitation task, which involved eliciting 24 numerical phrases manipulated for gender (masculine, feminine) and number (paucal, plural). Compared to the monolingual controls, the bilinguals showed lower accuracy, with oversuppliance of nominative plural endings and overtly marked genitive plural endings. These non-target responses indicate the reliance on default forms and phonetically salient inflections, confirming that these factors influence non-target attainment in bilingual (heritage) grammars. The amount of exposure to Russian (as measured by age of bilingualism onset and proficiency) influenced performance significantly, underscoring the role of input in shaping bilingual grammars. The production of NQPs by Hebrew-dominant Russian speakers was similar to that by English-dominant Russian speakers as reported in previous studies, which may appear surprising given that Hebrew is characterized by richer morphology than English, and that may play a role in the maintenance of morphology in the weaker language. We offer some considerations for this lack of effect.

Keywords: Heritage Russian; numerically-quantified phrases; case morphology; trajectories of HL development; attrition; divergence; restructuring

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1. Introduction

The term "heritage language" (HL) denotes a language spoken at home that is not the Majority Language (ML) of the society (Benmamoun et al. 2013; Montrul 2016; Polinsky 2018; Rothman 2009). HL speakers are a subset of bilinguals for whom the ML is dominant; thus, their HL is the weaker one in their bilingual dyad. Typically belonging to the second or third generation of immigrants, HL speakers acquire their HL from birth until the onset of schooling (around ages 4–5) through naturalistic exposure to native input. In broad strokes, HL speakers constitute a special subtype of bilinguals, and in what follows, we will be using the terms "bilingual speakers" and "HL speakers" interchangeably. We understand that this may come across as an oversimplification but nothing in our discussion hinges on the choice of terms.

Despite acquiring HL as their native language in childhood, HL speakers' linguistic performance demonstrates considerable heterogeneity compared to the baseline, i.e., the language spoken in the country of origin or by the first generation of immigrants who dominate in that language. HL speakers demonstrate a wide range of language abilities,

from passive comprehension and minimal production skills to near-baseline proficiency (see Fridman and Meir 2023; Fridman et al. 2024 for lexical abilities; Fridman et al. 2023 for morphosyntax). Systematic divergences and innovations observed in HL grammars have been suggested (e.g., Hopp and Putnam 2015; Rothman 2009). However, ongoing debates persist in formal theoretical linguistics, psycholinguistics, and neurolinguistics regarding the precise mechanisms of HL attainment and the trajectory of HL development.

This study investigates the morphology of nouns in combination with numerals, comparing the production of HL-Russian child and adult speakers to that of baseline Russian child and adult controls. The choice of numerical phrases as a test case for nominal morphology acquisition is deliberate, given the intricate system of noun forms in Russian numerical phrases, which distinguishes between singular, paucal (1.5–4), and plural (>5). Nominal morphology has been extensively investigated and shown to be fragile under HL acquisition: language structures involving concord and case are often among the most vulnerable (for an overview, see Montrul 2016; Polinsky 2018; Albirini et al. 2013). Looking into the existing evidence on HL-Russian in contact with ML-English, the rich case paradigm is shown to be prone to decay; in production, HL-Russian speakers often use the unmarked default form in contexts which require the use of dedicated case inflections (e.g., Isurin and Ivanova-Sullivan 2008; Laleko and Miroshnychenko 2022; Polinsky 2006, 2008; but see Łyskawa and Nagy 2020). On the one hand, this reliance on default strategies is in keeping with general tendencies observed in HL grammars (e.g., Polinsky 2018; Polinsky and Scontras 2020a, 2020b). On the other hand, the loss of nominal morphology may also be due to the heavy influence of English, which does not have much inflection. A question arises: how does the HL change when the ML is also morphologically rich?

Relatedly, a question arises as to how HL morphology changes over the lifespan of an HL speaker. Previous research has yielded conflicting evidence regarding the developmental trajectory of HL grammars. Some studies demonstrate evidence supporting monolingual-like HL development of morphosyntactic phenomena. For instance, a study on a simultaneous bilingual child acquiring HL-Russian and ML-Turkish between the ages of 2;11 to 4;0 found comparable case morphology acquisition to monolingual children, despite reduced input in HL-Russian (Antonova Ünlü and Li 2018). Furthermore, Martinez-Nieto and Restrepo (2023) compared four- and eight-year-old HL-Spanish speakers to age-matched Spanish-speaking monolingual controls. They found that older HL speakers were more accurate than younger HL speakers, suggesting that while HL speakers may differ from monolinguals, their grammatical development is similar, albeit protracted. On the other hand, there is evidence indicating HL divergence that persists into adulthood. For example, N. Meir et al. (2021) found that both child and adult HL-Russian speakers dominant in ML-Hebrew exhibited equally low performance on accusative case morphology compared to the child and adult monolingual baseline speakers. Next, some studies suggest that adult HL speakers outperform their child counterparts, indicating a significant acquisition lag in HL children. Finally, there is evidence for attrition, a scenario in which child HL speakers outperform adult HL speakers. This phenomenon was observed in a study investigating relative clauses in HL-Russian in contact with ML-English, which reported that child HL speakers were indistinguishable from monolingual child peers, whereas adult HL speakers performed significantly lower than both monolingual adults and child HL speakers (Polinsky 2011), thus indicating divergence as a result of attrition.

To address questions pertinent to the mechanisms of HL divergence (if any) and the trajectory of HL development, we will consider HL-Russian in contact with ML-Hebrew, a language with rich inflectional morphology, and we will compare child and adult HL speakers to child and adult monolingual speakers. As the test case for our exploration, we will examine the realization of numeral-noun expressions, or more accurately numerically-quantified phrases (hereafter NQPs), in the Russian language spoken by bilinguals who are dominant in Hebrew.

The majority of work on HL grammars investigate the respective languages in contact with English as the ML (Scontras and Putnam 2020). Since English is characterized by

sparse inflectional morphology, some generalizations concerning morphological change in HLs may be obscured; moreover, rampant loss of morphology in the relevant HLs may be exacerbated by contact with English. It is therefore essential to investigate HL grammar acquisition and maintenance within the context of a ML with richer morphology than English. It is worth noting here that the morphological make-up of Hebrew differs significantly from that of Russian. First, Hebrew employs templatic morphology, which contrasts with the predominantly concatenative morphology of Russian. Second, the richness of Hebrew morphology is most pronounced in the verbal paradigm, whereas our study focuses on the nominal paradigm. Therefore, if the impact of morphological richness manifests at a highly abstract level, reflecting overall morphological complexity, we might anticipate Hebrew-Russian bilinguals to outperform English-Russian bilinguals in their target-like production of NQPs. However, if morphological richness is not subject to abstract transfer, then we would expect Hebrew-dominant bilinguals to exhibit performance similar to their English-dominant counterparts in nominal-form production.

The paper is structured as follows. In Section 2, we present the basics of NQPs in Russian and Hebrew, with a special emphasis on the morphological forms that appear in such expressions. We also offer a brief overview of the data on acquisition of count forms by Russian-speaking children. Section 3 presents our predictions concerning the structure and use of NQPs in monolingual and bilingual Russian. Section 4 describes an experimental study on the production of NQPs by monolingual and bilingual Russian speakers. Section 5 discusses the results of this study vis-à-vis the hypotheses outlined in Section 3. Our conclusions and considerations for further research are presented in Section 6.

2. Setting the Stage

2.1. Numeral-Noun Expressions (NQPs) in Russian

NQPs in Russian exhibit a complicated system of noun forms, differentiating between singular, paucal, and plural. The Russian cardinal numeral *odin/odna/odno* 'one.M./one.F/one.N' has adjectival properties, exhibiting agreement with the noun phrase (NP) in gender, and displaying case concord. Numerals *dva/dve* 'two.M-N/two.F', *poltora/poltory* 'one-and-a-half.M-N/one-and-a-half.F', and the expression *oba/obe* 'both.M-N/both.F' distinguish masculine/neuter and feminine forms (these are not included in our experimental stimuli). All other numerals maintain the same form irrespective of the gender of the NP.

The morphological form of the NP, often referred to as a count form (Zaliznyak 1967), depends on whether the numeral is paucal or plural. Paucal numerals (1½, 2, 3, 4) occur with the paucal form of the NP. The paucal form of most Russian nouns in the masculine and neuter coincides with the genitive singular form, and the paucal form of feminine nouns coincides with the nominative plural (e.g., Bailyn and Nevins 2008; Franks 1995; Rappaport 2002; Zaliznyak 1967). Numerals 5 and up combine with the noun in the genitive plural, as presented in Table 1.

Table 1. Numeral-noun expressions in Russian.

	***Odin* 'one'**		**Paucal (1.5, 2–4)**		**Plural (5 and Above)**	
Masculine	*odin*	*stol*	*tri*	*stol-a*	*pjat'*	*stol-ov*
	one	table	three	tables	five	tables
Neuter	*odno*	*okn-o*	*tri*	*okn-a*	*pjat'*	*okon-∅*
	one	window	three	windows	five	windows
Feminine	*odna*	*knig-a*	*tri*	*knig-i*	*pjat'*	*knig-∅*
	one	book	three	books	five	books

The unique characteristics of NQPs become apparent only when the NQP appears in the nominative case (and accusative for inanimates, which is syncretic with the nominative). In other syntactic positions, the case of the numeral supersedes that of the NQP (Babby 1987;

Bailyn and Nevins 2008; Franks 1995; Grashchenkov 2002; Ionin and Matushansky 2006, 2018; Pesetsky 2013; Xiang et al. 2011, among others), compare (1a–d). The forms in (1c–d) represent uniform case and number values across all constituents of the NQP, while the forms in (1a–b) stand out as non-uniform. The syntactic analysis of Russian NQPs is beyond the scope of this paper (for different versions of the syntactic analysis of NQPs in Russian see Grashchenkov 2002; Ionin and Matushansky 2018; Lyskawa 2021; Mel'čuk 1985, 2024; Zaliznyak 1967, 1980, 1987). As our focus lies on the participants' ability to differentiate between paucal and higher numeral forms, we focus on NQPs in the nominative case.

(1)	a.	*sideli*	*tri*	*zajčik-a*
		sat	[three	bunny-PAUCAL].NOM
	b.	*sideli*	*sem'*	*zajčik-ov*
		sat	[seven	bunny-GEN.PL].NOM
	c.	*s*	*tremja*	*zajčik-ami*
		with	[three	bunny]-INS
	d.	*s*	*sem'ju*	*zajčik-ami*
		with	[seven	bunny]-INS

The actual form of the genitive plural depends on the declension class of the noun, which in turn correlates with its gender. Without grasping the nuances of declension classes, the diverse range of genitive plural endings can seem like total chaos; consider the variation between the *-ov*, *-ej*, and null endings for masculine, (2), and neuter (3), nouns:

(2)	a.	*gorod*	*gorod-ov*
		city.NOM.SG	city-GEN.PL
	b.	*sosed*	*sosed-ej*
		neighbor.NOM.SG	neighbor-GEN.PL
	c.	*čulok*	*čulok-∅*
		stocking.NOM.SG	stocking-GEN.PL
(3)	a.	*oblak-o*	*oblak-ov*
		cloud-NOM.SG	cloud-GEN.PL
	b.	*mor-e*	*mor-ej*
		sea-NOM.SG	sea-GEN.PL
	c.	*jablok-o*	*jablok-∅*
		apple-NOM.SG	apple-GEN.PL

Setting aside vowel alternations in the stem, many feminine nouns have the null ending in the genitive plural, e.g., *sobaka—sobak* 'dog.F.NOM.SG—dog.F.GEN.PL'. Other feminine nouns have the ending *-ej* in the genitive plural, e.g., *dver'—dverej* 'door.F.NOM.SG —door.F.GEN.PL'.

It is worth noting that the structure of Russian NQPs has undergone diachronic change (Zaliznyak 1987; Andersen 2006; Nesset 2020, among others). Old Russian nouns had a tripartite morphological number opposition between singular, dual, and plural (Nesset 2020). The morphological dual was mostly lost, resulting in a unified paucal construction encompassing the numerals 2–4. Additionally, there has been variation and change in external agreement with NQPs (i.e., *pjat' mašin ostalis/ostalos'* 'five cars stayed.PL/stayed.SG'; see Mel'čuk 1985, 2024; Nesset and Janda 2023, among others)[1] as well as variation and change in internal agreement within NQPs (e.g., *dve krasnyx/krasnye lampy* 'two red.GEN.NOM lamps'); consider Pesetsky (2013), for a theoretical discussion and see Gerasimova and Lyutikova (2018), for an experimental investigation of monolinguals.

Furthermore, substantial variation occurs in the speech of adult native Russian monolingual speakers in a variety of structures involving numerals, e.g., *prišlos' zdat' do polutora časa* (instead of *polutora časov*) 'had to wait up to one-and-a-half hour.M.PAUCAL' (instead of hour.M.GEN.PL)', see Kholodionova (2019).

Frequency effects affect language change and they are often observed in L1 acquisition and heritage grammars, so remarks on the frequency of different nominal forms are in order. In the corpus of 1,544,051 nouns (developed on the basis of the Russian National Corpus),

singular forms outnumber plural forms (Slioussar and Samoilova 2015). In particular, nominative singular forms constitute 25% versus 5.5% of nominative plural forms; genitive singular forms are at 17.9% versus genitive plural forms at 7.4%. There is no information on the frequency of paucal compared to higher numeral forms, but as we mentioned above, it mostly overlaps with the form of the genitive singular (for the masculine and neuter) and with nominative plural of feminine nouns. If we consider the frequency of genitive-plural endings (*-ej*, null, and *-ov*), the *-ej* ending is least common, whereas the other two occur at about 3-4% of all the nominal forms in the corpus (Slioussar and Samoilova 2015).

NQPs with paucal numerals are more common than those with higher numerals in child-directed speech (578 vs. 118), based on the data of a longitudinal corpus of six monolingual Russian children aged 1;5–4;0 (Kornishova 2010). Despite the frequency of phrases with paucal numerals, NQPs headed by paucals pose problems for young monolingual children, e.g., **3 griby* '3 mushroom.M.NOM.PL' (Liza, 2;6).

2.2. Numeral-Noun Expressions in Hebrew

In Hebrew, all numerals except 'one' precede the noun they quantify (I. Meir 2015), which contrasts with the word order in adjective-noun attributive expressions (see Table 2). The numeral and the NQPs agree in gender and number. However, in spoken Modern Hebrew, there is a tendency towards the neutralization of gender distinctions on numerals (see Ravid 1995; Gonen and Rubinstein 2015; I. Meir 2015, for an overview). Hebrew differentiates between singular and plural forms. Additionally, Hebrew has dual forms (e.g., *mixnasayim* 'pants', *yomayim* '2 days'), but they are not very productive in Modern Hebrew, and we won't consider them in this work.

Table 2. Numeral-noun expressions in Hebrew.

	'one'		**Plural**	
Masculine	*sefer* book	*axad* one	*šloš-a* three	*sfar-im* books
Feminine	*siml-a* dress	*exat* one	*šaloš* three	*smal-ot* dresses

Comparing Tables 1 and 2 shows that NQPs in Russian and Hebrew are structured differently, both in terms of the number of distinctions (three in Russian, two in Hebrew), inflectional complexity, and the order of numeral and noun. The visible differences in numeral-noun phrases make a comparison between monolingual Russian speakers and Hebrew-dominant Russian speakers highly desirable.

Before we proceed to the discussion of the actual work, we would like to present a brief overview of the acquisition of numeral-noun expressions by monolingual and bilingual speakers of Russian.

2.3. Acquisition of Numeral-Noun Expression in L1 and HL Russian

Although the basics of the nominal case morphology are in place by age 3 in monolingual L1-Russian acquisition, the acquisition of numeral-noun expressions in Russian is a slow process. Production data shows that the numeral 2 appears at around the age of 2, the numeral 3 appears after the age of 2;6, and numerals 4 and 5 appear at around the age of 4 (Voeikova 2007, 2011). Nouns with paucal numerals are sometimes produced with the wrong case inflection on the NQP, as in (4),

(4) *četyre* *bymažek* (correct form: *četyre* *bymažki*)
four paper.F.GEN.PL four paper.F.PAUCAL
(Gvozdev 1961, p. 299)

Gagarina and Voeikova (2009) point out that the use of NQP forms is difficult for monolingual Russian-speaking children, and production errors persist till the age of 5. Children substitute paucal forms for genitive plural forms and vice versa (Gagarina and Voeikova 2009; Voeikova 2007); thus, there is no trend towards oversuppliance of just one count form. Yet,

starting from age 5, children correctly differentiate the two NQP forms: paucal forms are correctly used with paucal numerals (1.5, 2–4) and genitive plural forms are used with numerals 5 and above: *dve lampy* 'two lamps', *sem' časov* 'seven hours', *vosem' kustov* 'eight bushes' (Gvozdev 1961).

Turning to bilinguals, Fridman et al. (2023) compared NQP production in HL-Russian adult speakers dominant in English (living in the US) and in Hebrew (living in Israel). There were no differences between the two groups, and the performance on feminine paucal forms (e.g., *tri knigi* 'three books') was the most accurate. Paucal masculine nouns evoked the highest number of non-target responses in both groups; the respondents used the unmarked (nominative) plural form instead, e.g., **dva stoly* 'two table.M.NOM.PL'. The unmarked (nominative) plural form was also used in place of the genitive plural, regardless of the gender of the quantified noun, e.g., **šest' knigi* 'six book.F.NOM.PL'; **šest' stoly* 'six table.M.NOM.PL'. Another common error had to do with the overextension of the ending *-ov* in the paucal and plural, e.g., **dva stolov* 'two tables'; **šest' knigov* 'six books.' Additionally, there were non-target responses, such as the oblique *-ax* ending (e.g., **pjat' mal'čik-ax* 'five boy.M.PREP.PL'). This latter form is also attested to in a number of Russian dialects (see Kasatkin 2005, pp. 128–29); it is not uncommon to find an overlap between child language and non-standard dialects in deviations from the standard.

Russian NQPs were also evaluated in experimental comprehension studies. For example, Xiang et al. (2011) evaluated sensitivity to ungrammaticalities in numeral-noun expressions in monolingual Russian speakers and Russian-English bilinguals who were proficient enough to read Russian. The participants had to read grammatical and ungrammatical sentences with the numeral *one*, paucal numerals, and numerals 5 and above. Ungrammatical conditions were designed by manipulating the features of number and case. The results indicated that native and immigrant adult speakers of Russian are fully aware of the correct and incorrect forms that nouns may take in different numeral-noun contexts. Across all numeral-noun contexts, participants rated ungrammatical forms significantly lower than grammatical forms. There was no difference among different numeral-noun contexts.

In the same vein, N. Meir and Polinsky (2021) found intact grammatical representations of numerical phrases in immigrant Russian-Hebrew speakers, i.e., those with the age of onset of bilingualism (AoB) after the age of 13. However, HL speakers with AoB before age 5 showed low sensitivity to mismatches in numeral-noun conditions altogether and no differences between the paucal condition and the higher-numeral condition. Both groups of speakers with earlier AoBs (before age 5 and between 5–13) seemed to favor simpler structures within NQPs. HL speakers with an earlier AoB were more likely to accept mismatches within numeral-noun constructions as grammatical altogether (numeral-noun expressions with paucal numbers and numbers 5 and above). HL-Russian speakers, who received exposure to Hebrew starting before the age of 5, showed problems with case forms more generally, possibly under the influence of Hebrew whose case morphology is sparse. Further still, Hebrew does not differentiate between paucal and plural numeral forms, and this is reflected in the morphology of Russian number used by bilinguals, who overgeneralize the form *-ov* (one of the genitive plural markers in the masculine) to both paucal and plural numerical expressions, e.g., *pjat'/tri samoljetov* 'five/three airplane.M.GEN.PL'. The choice of this form over the paucal form may be due to its greater perceptual salience and possibly frequency.

3. Core Questions and Predictions

In the experimental component of this work, we investigate the production of Russian NQPs by monolingual Russian speakers and Hebrew-dominant Russian speakers. By analyzing accuracy scores and non-target production data, we aim to explore potential differences between monolinguals and bilinguals. First, through a comparison of child and adult speakers, our study aims to contribute to the literature on language development in both monolingual and bilingual environments. Second, we seek to identify potential factors contributing to the divergence between monolingual and bilingual groups, with

a focus on the role of exposure and changes in HL grammar over the lifespan. Non-target responses on NQPs in Russian observed in different speakers may also help us understand diachronic change, which is suggested to be mirrored in HL grammars (see Kupisch and Polinsky 2022).

Divergence. Our first research question has to do with differences between monolinguals and bilinguals. Under the null hypothesis, we expect the same performance with respect to the production of NQPs by monolinguals and bilinguals, relativized to age. In other words, monolingual and bilingual children are expected to show the same language patterns, and whatever differences between child and adult performance may exist, they should be the same across the monolingual and bilingual groups. As an alternative hypothesis, we can predict quantitative and qualitative differences between the monolingual groups on the one hand, and the bilinguals, on the other. Specifically, both bilingual groups are expected to score lower than the monolingual control groups and display non-target patterns not observed in the control groups. In terms of the qualitative changes in NQPs, we expect the following:

(i) reliance on the default form: HL speakers will use the unmarked form (nominative plural) in place of the paucal and genitive plural
(ii) frequency effect: HL speakers will overuse more frequent forms in non-target responses
(iii) salience effect: in the marking of masculine genitive plural, HL speakers will overuse the endings *-ov/-ax* as most salient from the phonetic (perceptual) standpoint.

It is worth noting that these expectations are not mutually exclusive, and the study presented below was designed to determine the scale on which the predicted changes can occur.

Role of exposure. Our next research question has to do with the amount of exposure to the HL. (a) We expect individuals with a longer period of exposure to HL-Russian and a later onset of ML-Hebrew to perform better than those who had less exposure to Russian and acquired Hebrew earlier. The exposure and the onset of bilingualism are assessed using the age of onset of bilingualism (AoB), as a rough measure. This measure is not without limitations (in particular, it relies on self-reports), but it has been widely used in bilingualism research and is generally effective (e.g., Unsworth et al. 2014; Mikulski 2010). (b) Related to the amount of exposure and input is an individual's proficiency in the HL; the general assumption here is that proficiency is positively correlated with input. Accordingly, we expect bilinguals with higher proficiency to demonstrate more target-like performance on the NQP task.

Changes in HL over the lifespan. The expectations regarding the two core questions described above are set for both child and adult bilinguals. The third question we would like to address has to do with possible differences between child and adult bilinguals. As before, the null hypothesis is that all the four groups we consider perform the same. If, however the child and adult bilingual group are different from the monolinguals and at the same time are not different from each other, that would indicate that insufficient input leads to divergent grammatical representations. If the bilingual adults' performance is more target-like than the performance of bilingual children that would suggest the need for more input and exposure beyond the child years. It has been shown that bilingual children acquire language structures similarly to their monolingual counterparts, but with a time lag (consider, for example, Antonova Ünlü and Li 2018; Martinez-Nieto and Restrepo 2023).

Finally, if the bilingual children's performance is more target-like than the performance of bilingual adults, that would indicate language attrition and restructuring over the lifespan, possibly (but not necessarily) under the influence of the dominant ML (consider Polinsky (2011) for evidence of such restructuring in the domain of relative clauses). These expectations and possible rationale behind them are summarized in Table 3.

Table 3. Predictions concerning similarities or differences between child and adult groups.

Hypothesis	Predictions
H1: Null hypothesis	All four groups perform the same
H2: Uniform divergence	Both bilingual groups perform less-target like than monolinguals; no difference between child and adult bilinguals
H3: Divergence + acquisition lag	Adult bilinguals perform more target-like than child bilinguals
H4: Divergence + restructuring and attrition over the lifespan	Child bilinguals perform more target-like than adult bilinguals

4. Experimental Study

4.1. Participants and Procedure

A total of 105 participants participated in the study, divided into four groups: two adult groups and two child groups (see Table 4 for details). This study is part of a larger project focused on exploring the characteristics of HL-Russian among adult and child speakers in Israel and the USA.

Table 4. Background information on participants.

	HL-Russian Speakers		Monolingual Russian Speakers	
	HL-Child (n = 27)	**HL-Adult (n = 37)**	**MO-Child (n = 20)**	**MO-Adult (n = 21)**
Age	6 (1)	26 (4)	6 (1)	40 (14)
Sex	19f/8m	23f/14m	10f/10m	18f/3m
AoB	2 (2)	2 (2)	n/a	n/a

The monolingual adult and child groups of Russian speakers, hereafter referred to as MO-Adult and MO-Child, were recruited from the Russian Federation, Belarus, and Kazakhstan. All monolingual Russian-speaking controls reported Russian as their mother tongue and the language of their daily communication.

The HL groups of adults and children, hereafter referred to as HL-Adult and HL-Child, were recruited in Israel. The participants in these groups were either born in Israel or moved to Israel in early childhood. All these participants were raised in Russian-speaking families. The age of onset of bilingualism (AoB), which denotes the onset of learning ML-Hebrew, varied among the HL participants.

There was no significant difference across the groups in gender ($\chi^2 = 6.43$, $p = 0.09$). As intended, there were group differences in age ($F(3,101) = 134.1$, $p < 0.001$). Post-hoc Tukey pairwise comparisons indicated that the child groups did not differ in age ($p = 0.99$). Furthermore, the results indicated that the HL groups, both child and adult, did not differ in AoB ($F(1,60) = 2.04$, $p = 0.16$).

Before participating in the study, adult participants provided their consent by signing a form available in both Russian and Hebrew. Additionally, they completed a background questionnaire. Parents of children signed parental consent forms, and each child provided oral assent before engaging in any task. The sessions were audio-recorded for subsequent transcription and coding. Approval for this study was obtained from the Institutional Review Board of Bar Ilan University, Israel.

4.2. Materials

4.2.1. Lexical Proficiency

To assess lexical proficiency, an expressive noun-production subtask from Fridman and Meir (2023) was administered to all participants. The task included a total of 51 nouns of varying frequency and age of acquisition. The stimuli for the task were sourced from the "Noun and Object: Stimuli Database" (Akinina et al. 2015).

Figure 1 presents the performance of the four groups on noun accuracy production. The results indicated a significant effect of Group ($F(3,101) = 45.55$, $p < 0.001$) for lexical proficiency using a one-way ANOVA. Post-hoc Tukey pairwise comparisons revealed the following significant group differences (MO-Adult > MO-Child > HL-Adult > HL-Child). Thus, the four groups differed in their proficiency as measured by lexical abilities.

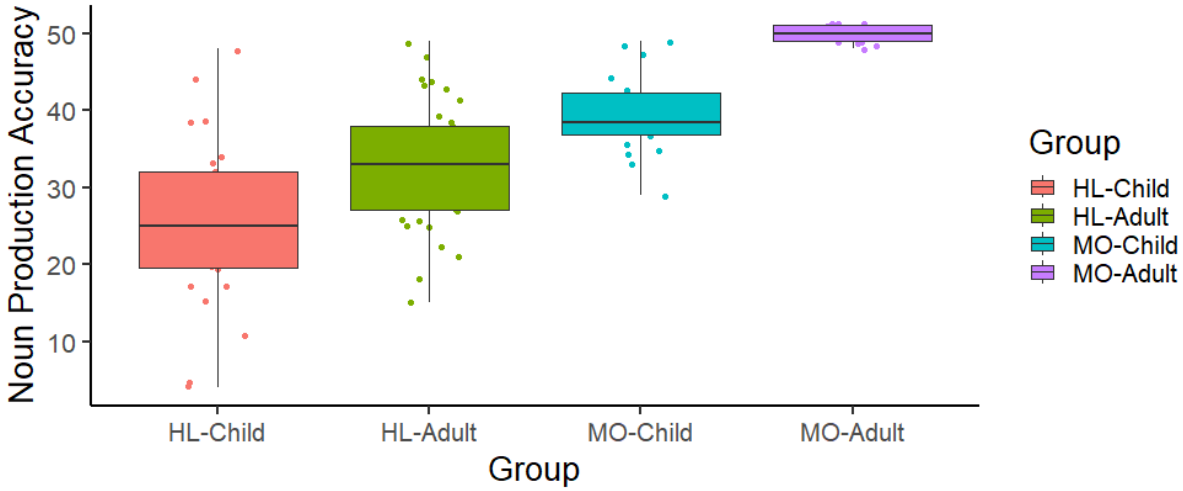
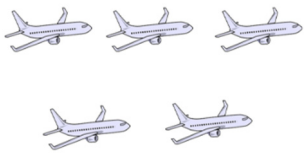


Figure 1. Performance across the groups on noun production.

4.2.2. Experimental Task: Numeral-Noun Phrases (NQPs)

In the NQP task (see Fridman et al. 2023), participants were asked to count the number of objects (and to name the objects) in each of 24 images. This task (see Table 5) manipulated gender (masculine, feminine) and numeral type (paucal, plural). The study did not include neuter nouns; they constitute a smaller proportion of the Russian nominal vocabulary, and since gender distinctions were not directly addressed by the experimental design, a comparison between masculines and feminines was sufficient for our purposes.

Table 5. Numeral-noun phrase production conditions.

	Masculine	**Feminine**
Paucal	 *4 šarf-a* 4 scarves.M-PAUC	 *3 ložk-i* 3 spoons.F-PAUC
Plural	 *5 samoljot-ov* 5 airplanes.M-GEN.PL	 *6 kartin* 6 paintings.F.GEN.PL

4.3. Results

The statistical analysis was conducted using R Version 4.1.2 (R Core Team 2021). Figure 2 presents the target performance on the nominal form in NQPs across the four groups, categorized by noun grammatical gender and condition. There is ceiling perfor-

mance in the monolingual groups (child and adult), except for three children; however, the variation is more notable in the HL groups.

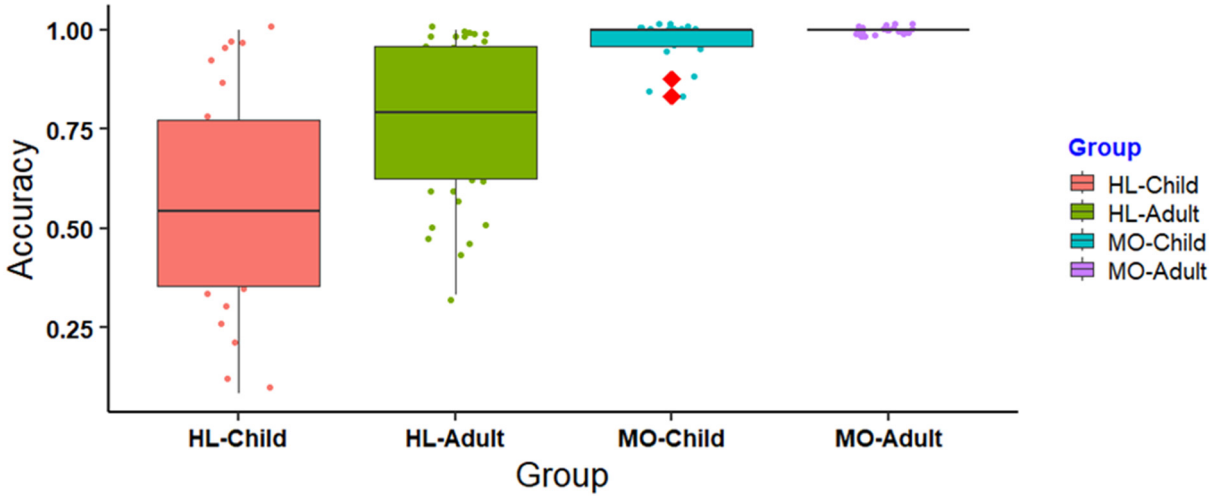


Figure 2. Overall performance on numeral-noun phrases per Group.

A linear mixed-effects model (*lmer*), using the "lme4" package (Bates et al. 2015), was fitted to assess the production accuracy of nominal forms in NQPs, revealing a significant effect of Group (see Table 6). Attempts to fit generalized linear mixed-effects models (*glmer*) with random effects for item and participant, and fixed effects for group and Condition, along with their interactions, did not converge. The *lmer* results indicated that, while the monolingual children performed similarly to monolingual adults, both HL groups exhibited significantly lower performance compared to the monolingual adults (see Table 6). Subsequently, post-hoc pairwise comparisons with Bonferroni corrections were conducted. The results revealed that MO-Child performed significantly more accurately than HL-Child ($p < 0.001$) and HL-Adult ($p = 0.003$). Additionally, significant differences were observed between HL-Child and HL-Adult ($p = 0.0002$), with HL-Adult outperforming HL-Child.

Table 6. Predictors of accuracy on the numeral–noun task (choice of the correct count form).

Predictors	Estimates	SE	CI	Statistic	*p*
▪ (Intercept)	1.00	0.04	0.92–1.08	24.38	<0.001
▪ Group [MO-Child]	−0.03	0.06	−0.15–0.08	−0.53	0.595
▪ Group [HL-Child]	−0.43	0.05	−0.54–−0.32	−7.85	<0.001
▪ Group [HL-Adult]	−0.22	0.05	−0.32–−0.12	−4.30	<0.001
Random Effects					
▪ σ^2	0.05				
▪ $\tau_{00\ Code}$	0.02				
▪ ICC	0.30				
▪ $N_{\ Code}$	105				
▪ Observations	420				
▪ Marginal R^2/Conditional R^2	0.267/0.486				

Since the monolingual controls showed ceiling performance, our subsequent analyses focused on the HL groups. We ran a generalized mixed-effects model to determine which conditions were particularly challenging for these groups. The model indicated a two-way interaction (*EST* = 2.25, *SE* = 0.85, *CI* [1.07–4.74], $z = 2.15$, $p = 0.031$), which is visualized in Figure 3. The two-way interaction was followed up with post-hoc comparisons. In the HL-Child group, the MASC-PAUC condition was significantly lower than FEM-PAUC ($p = 0.01$), FEM-PLUR ($p = 0.03$), and MASC-PLUR conditions ($p = .003$). In the HL-Adult group, MASC-PLUR was lower than FEM-PAUC ($p = 0.01$) and FEM-PLUR ($p = 0.01$).

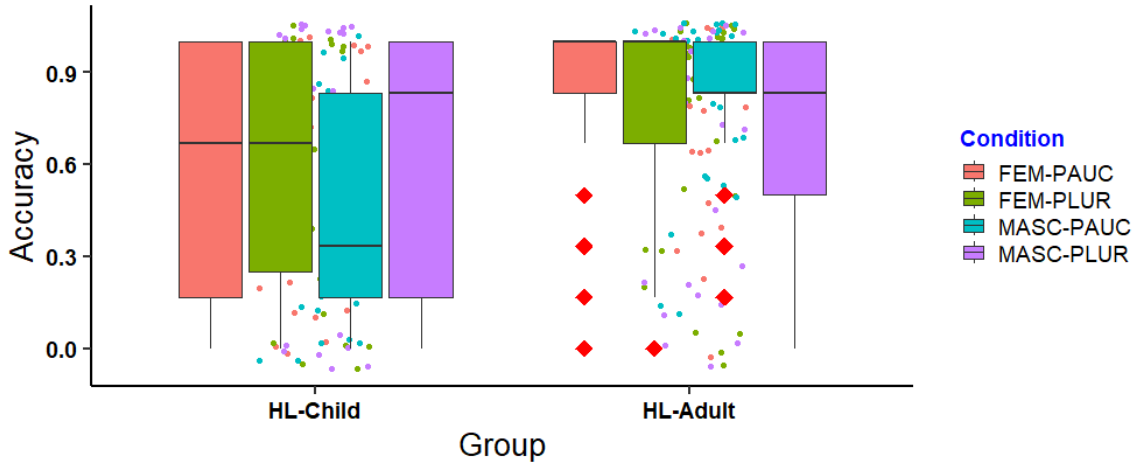


Figure 3. Performance on numeral-noun phrases per Group.

The distribution of non-target responses is presented in Table 7. Looking closely at non-target responses, we find an overuse of the plural form of the noun in the nominative case with masculine forms, across all types of numerals, and with non-paucal (5+) numerals with feminine nouns, e.g., *3/5 krododily/čemodany* and *5 šapki/butylki/banki*. Drilling down into individual responses, some participants used the nominative plural form across all the numeral phrases: *3/5 krokodily* and 3/5 *šapki*. This indicates a unification of all the forms into one plural form without differentiating paucal and plural and without differentiating feminine and masculine forms (see non-target responses for participants 127gal, 133ler, 200ro, 201ma in Figure 4).

Table 7. Non-Target responses in HL-Child and HL-Adult groups.

Condition	Non-Target Inflection Used	Non-Target Response	HL-Child		HL-Adult	
			n	%	n	%
FEM-PAUC	*-ok*	*3 šapok/gorok/ložek*	20	33%	24	60%
	-ov	*3 šapkov/bankov*	19	32%	2	5%
	-a	*3 šapka/gorka/kniga*	8	13%	4	10%
	-ax	*3 šapkax/knigax*	7	12%	1	3%
	zero	*3 knig/gruš*	6	10%	9	23%
	other	*3 knigim* (Hebrew pl.maker)	4	7%		
FEM-PLUR	*-y/i*	*5 šapki/butylki/banki*	30	45%	41	80%
	-ov	*5 šapkov/sobačkov*	22	33%	3	6%
	-a	*5 šapka/lopata*	7	11%	4	8%
	-ax	*5 šapkax/sobakax*	5	8%	3	6%
	other	*5 šakot/šapkim* (Hebrew pl.maker)	2	3%		
MASC-PAUC	*-ov*	*3 šarfov/domov/šakfov*	44	51%	16	43%
	-y/i	*3 šarfy/chemodany*	18	21%	18	48%
	zero	*3 šarf/stol/arbuz*	16	19%	3	8%
	-ax	*3 šarfax*	4	5%		
	other	*3 šarfim* (Hebrew pl.maker)	4	5%		
MASC-PLUR	*-y/i*	*5 šarfy/pakety/arbuzy*	31	51%	35	56%
	zero	*5 šarf/samolet/čemodan*	14	23%	11	17%
	-ax	*5 šarfax/paketax/krokodilax*	9	15%	3	5%
	-a	*5 šarfa*	4	7%	14	22%
	other	*5 šarfim* (Hebrew pl.maker)	3	5%		

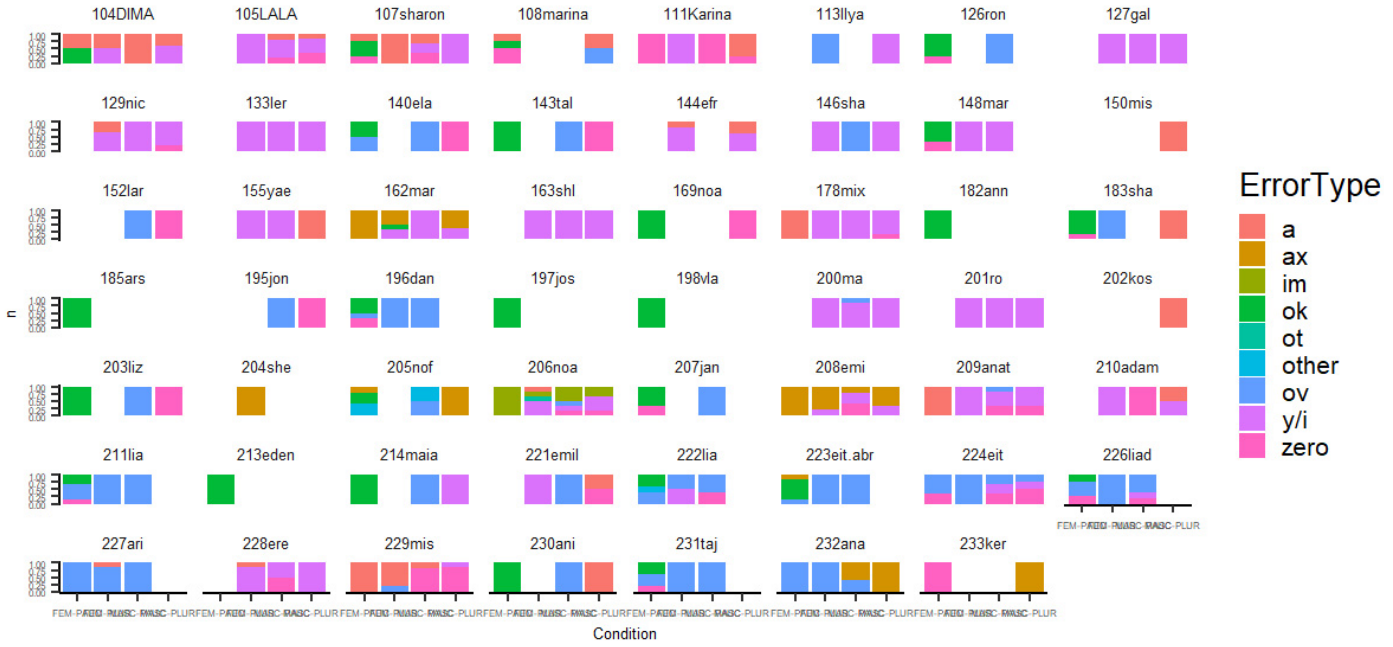


Figure 4. Individual non-target responses in HL-Child and HL-Adult groups.

Some participants resorted to the *-ov* form, which is the target form for some masculine/neuter genitive plural (e.g., 5 *stolov*), and extended it to other environments as well, e.g., *3/5 knigov* and *3 stolov* (see individual responses for 196dan). We also observed the use of *-ax* inflection across all the conditions (e.g., *3/5 šapkax* and *3/5 paketax*). This inflection corresponds to the oblique form assigned by the preposition *o* 'about' (*my govorili o shapkax* 'we spoke about hats.F.PREP'), see responses by 204she and 208emi. Finally, some participants, mainly in the HL-Child group, used Hebrew inflections (*-im/-ot*) to derive plural forms in Russian (see *6 paketim*, *3 škafim*, *4 domim; 7 lopatot*).

Finally, we aimed to evaluate the contribution of proficiency (as indexed by noun production accuracy) and background factors (e.g., AoB) to the production of NQPs in the HL child and adult groups. We fitted a generalized linear model (GLM) with Group, AoB, and Lexical Proficiency as predictors. The results indicated that once AoB and lexical proficiency are added to the model, the effect of Group disappears, whereas the effects of AoB and lexical proficiency are robust (see Table 8). The results are further visualized in Figure 5. Regardless of age, children and adults who are HL speakers of Russian are more likely to be accurate if their AoB was later. The longer the uninterrupted length of HL acquisition, the better the HL grammatical accuracy. Furthermore, lexical proficiency plays an important role: the higher the lexical proficiency, the more accurate HL speakers are on nominal morphology in NQPs.

Table 8. GLM results with Group, AoB and Lexical Proficiency as predictors of numeral-noun production accuracy in the two HL groups.

Predictors	Odds Ratios	SE	CI	Statistic	*p*
(Intercept)	0.08	0.02	0.05–0.12	−11.41	<0.001
Group [HL-Child vs. HL-Adult]	1.31	0.19	1.00–1.73	1.93	0.053
AoB	1.11	0.04	1.02–1.20	2.58	0.010
Lexical Proficiency (Noun production)	1.11	0.01	1.10–1.13	12.52	<0.001
Observations	1487				
R^2	0.208				

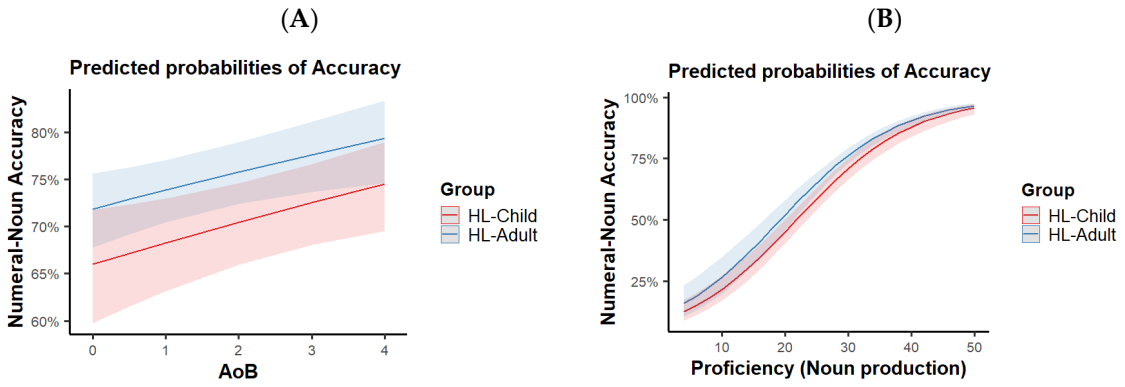


Figure 5. Numeral-noun production accuracy and effects of (**A**) AoB and (**B**) proficiency as a function of Group (HL-Child vs. HL-Adult). (**A**) AoB as a predictor of numeral-noun accuracy; (**B**) Proficiency (noun production) as a predictor of numeral-noun accuracy.

5. Discussion

We examined numeral-noun phrases (NQPs) in HL-Russian speakers in contact with ML-Hebrew, comparing them to both child and adult monolingual speakers. The juxtaposition of Russian and Hebrew offers insights into the acquisition of nominal morphology in a HL (Russian), which is morphologically rich, against the backdrop of another morphologically rich language, Hebrew, albeit with differing morphology realization.

Starting with the monolinguals, our study demonstrated that Russian-speaking monolingual children aged 5–8 were indistinguishable from monolingual Russian-speaking adults and displayed a ceiling effect. Thus, the morphosyntax of Russian NQPs appears to be fully acquired by the age of 5; this result is consistent with observations made in the existing literature on the acquisition of Russian morphology more generally and on NQPs in particular (e.g, Gvozdev 1961; Gagarina and Voeikova 2009; Voeikova 2007, 2011). Recall that NQPs in Russian are subject to variation when it comes to the choice of morphological forms of NPs in some NQPs with higher numerals and in prepositional phrases (Kholodionova 2019), as well as modifying adjectives and substantivized adjectives within NQPs (Gerasimova and Lyutikova 2018). No variation is reported for NQPs with smaller numerals (i.e., *2 stola—5 stolov* 'two tables.M.PAUC.—.five tables.M.GEN.PL.), which were included in the current study, and our data confirmed it for monolingual child and adult Russian-speakers.

In contrast, both HL groups scored lower than their monolingual counterparts: HL children scored lower than their monolingual child peers, and HL adult speakers scored lower than the monolingual adult controls. Both child and adult HL speakers showed quantitative and qualitative differences from their monolingual counterparts. This indicates that the null hypothesis, according to which all the four groups in this study would perform at the same level, cannot be maintained (see Table 3, H1). The HL speakers in this study diverge from their monolingual counterparts.

Next, HL adults showed more accurate responses and generally scored higher than HL child participants. This argues against the possibility of uniform divergence whereby all HL speakers, regardless of age, perform the same (Table 3, H2). Since the adult bilingual group outperformed the child bilingual group, this also argues against the idea that bilingual children acquire the grammar of Russian NQPs and that grammar then undergoes attrition over the lifespan (Table 3, H4). This leaves us with the hypothesis that bilingual children need more time and more input in their HL to acquire the morphosyntax of Russian NQPs as compared to their age-matched monolingual counterparts; this accounts for the poorer performance of the child and adult HL groups compared to the corresponding monolingual groups.

Thus, at the coarse level of group comparisons, our results show differences between child and adult HL speakers. However, these group differences (HL child vs. HL adult)

disappeared once input factors were added to our models. Input factors were indexed by AoB and proficiency (as revealed by noun accuracy production). The results revealed significant effects of AoB and lexical proficiency in both child and adult HL groups. In particular, higher lexical proficiency correlated with increased accuracy in HL speakers' nominal morphology within NQPs. These findings align with prior research indicating that diminished input characteristics play a key role in bilingual development of divergent grammar (Daskalaki et al. 2019, 2020; Fridman et al. 2023; N. Meir and Janssen 2021), and conversely, a longer uninterrupted exposure to the home language and consistency of input contribute to target attainment (see Mitrofanova et al. 2018 and further references there). In sum, input plays a critical role in the setting of morphosyntactic structures in a HL. Operationalizing input and proficiency allows us to predict the accuracy of performance in both children and adults.

Non-target responses on NQPs are informative because they allow us to better understand the underlying mechanisms responsible for the observed divergence in HL grammars. Recall that we considered several factors that may affect the patterns of non-target responses; these factors are not mutually exclusive:

(i) reliance on default forms, wherein HL speakers use the unmarked form (in this case, nominative plural) in place of the paucal and genitive plural;
(ii) reliance on more frequent forms, wherein HL speakers overuse more frequent forms as non-target responses, i.e., they replace the less frequent genitive plural form with the more frequent paucal form
(iii) reliance on perceptually more salient forms: in the marking of the genitive plural, HL speakers will overuse the endings *-ov/-ax* as most salient.

We found strong evidence for (i) in our data. In fact, our participants, HL children and HL adults, overused the nominative plural form (e.g., **dva stoly* 'two table.M.NOM.PL'; **šest' knigi* 'six book.F.NOM.PL'; **šest' stoly* 'six table.M.NOM.PL'). This type of overextension has been documented in studies of NQPs in monolingual younger children (Gagarina and Voeikova 2009; Voeikova 2007); in general, younger monolingual children aged 2-4 tend to resort to default forms (e.g., López 2020). Recall that our child cohort was older (5-8), and it is worth noting that this error pattern was more frequent in the HL adults than in the HL child data (compare, **5 šapki:* 80% in adults vs. 45% in children; *3 šarfy:* 48% in adults vs. 21% in children; *5 šarfy*: 56% vin adults s. 51% in children), which might suggest some attrition over the lifespan as manifested in production. This use of default unmarked plural forms also points at a preference for the unified case and number value across all the constituents within the NQP.

It is likely that HL speakers amplify the tendency for defaults already embedded in the child baseline, but unlike the monolinguals, who recover from their reliance on such defaults after age 4, HL speakers maintain this pattern across the lifespan. We contend that the overuse of the ending *-i/-y* is not arbitrary; it indicates HL speakers' knowledge of plurality yet reflects an overall simplification of plural forms and a reliance on the default plural form to express it.

Turning to (ii), we found the opposite of what was expected; speakers failed to use the paucal form and replaced it with the form of the genitive plural, contrary to the prediction based on frequency effects. The reliance on the genitive plural form of feminine nouns in paucal contexts (i.e., **3 šapok* '3 hats.F.GEN.PL') was more commonly found in the HL adult data compared to the HL child data (60% vs. 33% respectively). However, for masculine nouns, this error pattern distribution (i.e., *3 šarfov* '3 scarves.M.GEN.PL') was relatively similar in the two HL groups (43% and 51%). It is always intriguing and noteworthy to find patterns of production and comprehension that contradict purported frequency effects, so this result warrants future consideration. However, conclusions concerning frequency should be taken with some caution, since frequency counts in the current study are based on monolingual data sources (which might differ in the immigrant context), and we do not have corpora of baseline input for HL speakers. We can also hypothesize that the oversuppliance of the genitive plural form may have to do with the greater perceptual

salience of that form (as compared to the paucal form); see Polinsky (2018, pp. 91–94, for similar considerations). In many cases, the paucal form is expressed by a single vowel ending, while the genitive plural form includes two sounds (*-ej* or *-ov*). The effect of perceptual salience brings us to the next prediction entertained here, (iii).

With respect to (iii), studies of NQPs in monolingual acquisition indicate that young Russian children overuse the genitive plural ending, and our participants also showed that tendency (e.g., **dva stol-ov* 'two table.M-GEN.PL'; **šest' knig-ov* 'six book.F-GEN.PL'), which we attribute to the perceptual salience of these endings. The oversupply of more salient forms *(-ov)* was more frequent compared to *-ax*. The ending *-ov* is one of the target forms for masculine/neuter nouns occurring with a higher numeral (i.e., *6 stol-ov* '6 table.M-GEN.PL'), thus this instance can be viewed as an extension of one form to other environments of NQPs. Alternatively, the *-ax* inflection is non-target in NQPs (as it is an oblique inflection, e.g., *o stol-ax* 'about tables.M-PREP.PL'), and it can be viewed as oversuppliance of a phonetically salient inflection. The use of *-ax* forms was higher in HL children compared to HL adults. This pattern was also observed by Fridman et al. (2023), both in English- and Hebrew-dominant adult HL speakers of Russian. As previously noted, this pattern parallels the documented overextension of *-ax/-ov* in non-standard dialects of Russian, particularly in the regions of Tver, Vladimir, and Ryazan (Kasatkin 2005, p. 129).

Recall that we set out to investigate a morphologically-rich HL, Russian, in contact with another morphologically-rich majority language, Hebrew. In considering possible outcomes, we contemplated two potential options. In the scenario of high-level abstract transfer, the mere presence of rich morphology in the dominant language, irrespective of its actual realization, could lead to better preservation of morphological distinctions in the HL compared to the influence of a morphologically-impoverished language such as English. In the scenario of less-abstract transfer, where the distinction between templatic and concatenative morphology as well as the contrast between nominal and verbal morphology, holds significance, it is reasonable to anticipate that English- and Hebrew-dominant HL speakers of Russian would show no discernible differences in their production of NQPs.

The results presented here align with the findings on HL-Russian in contact with ML-English, thus supporting the latter scenario. Recall that Russian encodes number distinctions through nominal inflection, which often coincides with case forms. Although Hebrew boasts rich morphology, it lacks such case inflections, which may inhibit abstract transfer. Similarly, Fridman et al. (2023) found no differences between English- and Hebrew-dominant adult HL speakers of Russian in terms of NQPs.

6. Conclusions and Prospects for Future Research

In this study, we examined the production of NQPs by monolingual Russian speakers and HL-Russian speakers dominant in Hebrew, comparing children and adults. The juxtaposition of Russian and Hebrew offers valuable insights into the acquisition of nominal morphology in a morphologically-rich HL against the backdrop of another morphologically-rich language, albeit with distinct morphological features. Our findings reveal notable differences between monolingual and bilingual speakers. While monolingual Russian-speaking children displayed fully acquired morphosyntax of Russian NQPs by age 5, both child and adult HL groups exhibited lower accuracy compared to their monolingual peers, pointing to divergences in the domain of nominal morphology. In our data, HL adults demonstrated higher accuracy than HL children, challenging notions of uniform divergence and suggesting that bilingual children may require additional time for acquisition compared to monolingual peers. This was further supported by our findings that input factors, particularly age of bilingualism onset and lexical proficiency, significantly influenced performance across both child and adult HL groups, thus highlighting the critical role of input in the development of HL grammars. These results offer novel support to the conclusions about the role of uninterrupted exposure reached by a group of Norwegian scholars who considered different grammatical domains (Mitrofanova et al. 2018). The analysis of non-target responses by HL speakers revealed their reliance on default forms

and on perceptually salient inflections, thus providing new evidence in support of the role these factors play in the shaping of HL grammars. Furthermore, these factors also play an important role in diachronic language change (Kupisch and Polinsky 2022). Overall, our study underscores the intricate interplay between linguistic input, proficiency, and developmental trends in HL acquisition.

Expanding the scope of this study to encompass a broader array of grammatical structures would undoubtedly yield new insights. By doing so, we could evaluate the generalizability of our findings to a wider range of morphosyntactic phenomena, which in turn would enhance our understanding of HL development. In follow-up studies, it would be valuable to focus on structures or grammatical features that exhibit greater similarity between the languages within a bilingual dyad. Future research endeavors should also delve deeper into the role of input and exposure in HL development, employing a more comprehensive set of measures such as the quantity and quality of input, frequency of code-switching both at home and in the broader community, access to literacy materials, visits to the homeland country, and engagement with HL media. By incorporating these multifaceted input factors, researchers can provide parents and educators with evidence-based strategies to support HL maintenance and foster continued language development in bilingual individuals.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Ethics Committee of Bar-Ilan University, Israel.

Informed Consent Statement: All adult participants provided signed informed consent prior to their participation in the study. For child participants, informed written consent was obtained from their parents or caregivers. Additionally, oral assent was secured from the children themselves before their involvement in the study.

Data Availability Statement: The data and the R scripts for the study are available from https://osf.io/9f7ae/?view_only=3e3ede0b7556468f8b1d3d1fb1956bb9 (accessed on 30 June 2024).

Conflicts of Interest: The authors declare no conflict of interest.

Note

[1] The effect of the frequency of a numeral is observed in the choice of singular vs. plural marking on verbs; lower numerals, which tend to be more frequent, are associated with the plural, while higher numerals, which tend to be less frequent, are associated with the singular (Nesset and Janda 2023).

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