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Relative Clause Processing and Attachment Resolution across Languages: Tatar–Russian–English Trilinguals

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Abstract: The study investigates psycholinguistic mechanisms of sentence parsing and ambiguity resolution by balanced Tatar–Russian bilinguals who learnt English as their additional language. We check the parser's sensitivity to the selectional properties of the matrix verb and/or social conventions in processing and attachment resolution of ambiguous relative clauses (RCs). We chose English and Russian because they have a documented preference for low attachment (LA) and high attachment (HA), respectively, and Tatar, as we have found out in earlier work, has no attachment ambiguity. We conducted a self-paced reading task in English and Russian which returned 61% HA in Russian, 49% HA in English. It was followed by a pen-and-paper translation task. The translation post-test checked whether an attachment preference demonstrated in either English or Russian showed in RC translations into Tatar. The results return an 80% preference for LA in English–Tatar translations and 61% in Russian–Tatar translations. Both syntactic information and world knowledge influence online RC processing in Russian and English. Therefore, the multilingual parser incorporates information from multiple sources in either L1 or Ln processing. The parser may favor LA as a default parsing option while maintaining sensitivity to individual grammars (Russian), where this preference should be overridden.

Keywords: human language processing; non-native languages; third language acquisition; balanced bilingualism

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1. Introduction

This study approaches multilingual processing for relative clause (RC) ambiguity resolution from a new angle and adds experimental data from a new population of multilinguals to the existing data pool. Formally, our participants speak three languages: Tatar, Russian and English. They are balanced bilinguals in Tatar and Russian who started learning their additional language, English, at school. This linguistic profile allows comparisons with sequential bilinguals and trilinguals previously studied in the field (Sokolova and Slabakova 2019, 2021, 2022; Llama 2017; Witzel et al. 2012; Pan et al. 2015; Rah 2010; Rothman 2010; Dekydtspotter et al. 2008; Papadopoulou and Clahsen 2003).

We perform a deeper investigation of sentence parsing across three languages and pay special attention to how different types of linguistic and socio-linguistic information shape the parsing process. Our linguistic target is ambiguous RCs, as exemplified in (1).

(1) Bill saw the granddaughter of the woman that was playing with a kitten in the yard.
Who was playing with the kitten?
(a) the granddaughter of the woman (b) the woman

In (1), the target sentence is followed by a comprehension question, eliciting two grammatically possible answers. However, answer (1a) whose parsing is exemplified

in (2a), is generally preferred by native speakers of Russian, whereas native speakers of English would stick to option (1b) and parse the sentence as demonstrated in (2b) (Fodor 2002; see also Cuetos and Mitchell 1988; Gibson et al. 1996 for a full review).

(2) a. Bill saw [$_{DP}$ [$_{DP}$ the granddaughter of the woman] [$_{RC}$ that was playing with a kitten in the yard]].
b. Bill saw [$_{DP}$ the granddaughter of [$_{DP}$ the woman [$_{RC}$ that was playing with a kitten in the yard]]].

Unlike Russian and English, Tatar does not allow structurally ambiguous RCs (3). The RC immediately precedes the noun it modifies. Thus, the equivalent of HA (2a) would cause noun scrambling in Tatar, and the sentence would look like (3a). The example in (3b) is equivalent to LA of the RC (2b).

(3) a. Min [$_{DP}$ khatynnyn [$_{DP}$ [$_{RC}$ kofe ech*ken*] enisen]] kurdem
I woman-GEN coffee drinking mother-ACC saw
Tatar: I saw the woman's coffee drinking mother.
b. Min [$_{DP}$ [$_{DP}$ [$_{RC}$ kofe ech*ken*] khatynnyn] enisen] kurdem
I coffee drinking woman-GEN mother-ACC saw
Tatar: I saw the coffee drinking woman's mother.

Our participants first took part in a self-paced reading experiment in either Russian or English. The software Linger recorded their preferred answers as well as their reading and response time. The main experiment was followed by a pen-and-paper post-test asking the participants to translate a set of sentences from either Russian or English into Tatar. It checked whether the RC attachment established in either English or Russian would be maintained in Tatar translations. Since Tatar does not allow RC ambiguity (3), we can anticipate a definitive attachment preference in written translations.

1.1. Multilingual Processing of Relative Clauses: Theoretical Gap

Even though the phenomenon of the ambiguous RC has received a lot of scholarly attention, the article studies with non-native speakers mainly concern L2 processing and very few investigate L3 speakers. Partly, this can be explained by the controversial nature of the phenomenon itself. RC attachment is not constrained by any grammatical rule and is a matter of the speakers' preference in light of the context, world knowledge, etc. The latter makes it very difficult to define the learning task for non-native speakers and measure whether the right property has been acquired.

The existing research in non-native processing was inspired by monolingual studies explaining an established cross-linguistic variation in RC resolution (Frazier and Traxler 2008; Traxler et al. 1998, 2000; Frazier and Clifton 1997; Traxler and Pickering 1996; Frazier 1990; Ferreira and Clifton 1986; Rayner et al. 1983; Frazier and Fodor 1978 among many others). It is known that native speakers (NSs) of Russian, French, Dutch, German, Greek and Spanish prefer HA (Cuetos and Mitchell 1988; Hemforth et al. 1998; Zagar et al. 1997; Sekerina 1997), but NSs of English, Norwegian, Romanian and Swedish prefer LA (Fodor 2002; Fernandez 1999).

The monolingual research formulated two main principles for RC resolution, the principle of Predicate Proximity and the principle of Late Closure (Frazier and Fodor 1978) or Recency (Gibson et al. 1996), which stand in opposition to each other. Following Gibson et al. (1996), different grammars (languages) require different parsing strategies. Therefore, some languages favor the parsing principle of Predicate Proximity and attach the new constituent as close to the predicate head as possible, which results in HA. Other languages favor the principle of Late Closure (Frazier and Fodor 1978) or Recency (Gibson et al. 1996) and attach the RC locally, to the nearest possible noun phrase (NP), which is the case of LA.

If the above holds true, the learning task for L2ers would be to figure out what parsing principle is stronger in a given language, Recency or Predicate Proximity, and stick to it in RC ambiguity resolution. In other words, L2 parsing is based on gradual acquisition of the parsing strategies typical for a given language, and L2 research should benefit from direct

comparisons of the processing behavior in NSs and L2ers. This approach has been widely employed in the field.

In the early experiments by Felser et al. (2003a, 2003b) and Papadopoulou and Clahsen (2003), the participants demonstrated a strong preference for a certain type of RC resolution in their NLs, but no clear preference for RC attachment in their L2s. L2ers were also sensitive to various non-syntactic prompts suggesting a certain RC parse. These findings motivated the Shallow Structure Hypothesis (SSH) (Clahsen and Felser 2006). In its current version, the SSH argues that non-native speakers apply their L2 knowledge differently from NSs in online sentence processing: The non-native parser relies on non-structural information more than the parser in the NL (Clahsen and Felser 2018).

The SSH was opposed by scholars advocating fundamental similarity in mechanisms of native and non-native processing (Sprouse 2011; Dekydtspotter et al. 2006). One of the first pieces of experimental evidence for syntax-based processing in ambiguous RCs came from Dekydtspotter et al. (2008). The study tested the Implicit Prosody Hypothesis (IPH) (Fodor 2002) with a population of non-native speakers.

The IPH appeared at the same time as the processing-based accounts formulated by Gibson et al. (1996) but offered an alternative explanation for the cross-linguistic variation in RC attachment. The IPH claims that HA languages impose a prosodic break between the complex DP *the granddaughter of the woman* and the RC *that was playing with a kitten* (1). It makes the RC a separate prosodic unit that attaches higher in the tree. In an LA language, a prosodic break occurs within the complex DP putting the lower noun and the RC together in one prosodic unit *of the woman that was playing with a kitten* (1), thus insuring LA of the RC.

Compared to Gibson et al. (1996), Fodor's (2002) account prompts a clearer learning task for non-native speakers. Target-like parsing of the RC can be achieved through implicit acquisition of the prosodic structure of a given language. This assumption was tested by Dekydtspotter et al. (2008).

The study targeted two languages with different preferences in RC resolution, English (LA) and French (HA). The participants were low-intermediate learners of French and native speakers of American English. The authors reported sensitivity to the default prosody of French in low-intermediate L2 learners. The participants switched to HA in French, even though their preference in L1 English remained LA (see Goad et al. 2021; Hwang et al. 2011 for similar findings). These findings were interpreted as evidence for the learners' developing sensitivity to the parsing strategies typical of their new language.

At this point, L2 research merged together two assumptions from the field of monolingual studies. It agrees with Gibson et al. (1996) that different languages favor different processing strategies and, consequently, these strategies can be acquired in L2. At the same time, Dekydtspotter et al. (2008) demonstrated that new parsing strategies are acquired through the implicit acquisition of the RC prosody in the new language.

The possibility of target-like processing behavior in the L2 stems from an approach to L2 acquisition, called Full Transfer/Full Access/Full Parse (FT/FA/FP, Sprouse 2011; Dekydtspotter et al. 2006). It claims that human language processing is fundamentally similar in every language because full comprehension is not possible without a full structural analysis of the sentence. Therefore, non-native processing should unavoidably perform the same full structural analysis as processing in NL.

The FT/FA/FP approach challenges the SSH and offers a developmental approach to L2 processing, whereas the SSH reports behavioral differences between native and non-native speakers in online processing and claims that real-time L2 processing is fundamentally different from L1 processing. The question becomes particularly sensitive concerning ambiguous RCs in non-native languages. In most studies supporting the FT/FA/FP, RC resolution returns a preference of around 50% in non-native languages (Sokolova and Slabakova 2019, 2021, 2022; Witzel et al. 2012). These results correlate with the early findings by Felser and collaborators (Felser et al. 2003a, 2003b; Papadopoulou and Clahsen 2003) who interpreted these data as performance at chance level. This requires additional explanation.

Sokolova and Slabakova (2021) appeal to the significant difference between RC resolution in native and non-native languages. They used a self-paced reading technique with L2 and L3 speakers of Russian and English. Their intermediate speakers preferred an HA in 67%–77% of RCs in their native Russian and 46%–57% in their L2/L3 English. The mirror-image groups demonstrated a 27%–32% HA preference in their L1 English and 49%–51% in their L2 Russian. Even though their participants did not demonstrate the same clear-cut preference in RC resolution as NSs, the difference between RC resolution in the participants' L1 and L2 was statistically significant, and the tendency goes towards target-like RC resolution. The authors argue that L2 parsing is a proxy for L2 acquisition and a marker of the current state of the speakers' L2 grammar. Sokolova (2020) reported an observable difference in RC resolution within the L2 English group. Participants whose proficiency in English is higher demonstrated a higher preference for the English-like LA (the difference did not reach statistical significance due to the limited number of participants). Therefore, Sokolova and Slabakova (2021) argue that their intermediate speakers of L2 can demonstrate native-like preference for RC resolution in the target language (TL) when their proficiency in this language increases.

Sokolova and Slabakova (2019, 2022) extended their findings in L2 processing to the field of L3 and reported similar results. They claim that human processing is fundamentally similar in all languages, native and non-native, and the findings in the field of L2 should be generalizable to the field of L3 processing. With this in mind, we should assume that the unfinished debate about the role of structural and non-structural information should also be applicable to the field of L3 processing. Moreover, the studies by Sokolova and Slabakova (2019, 2022) are very different from the approach generally taken in L3 research.

L3 experiments use patterns of RC resolution as an instance of cross-linguistic transfer at the level of syntax (Llama 2017; Rothman 2010; Rah 2010). To be more specific, L3 studies assume that RC processing is based on the transfer of a parsing preference from the most typologically similar language into L3 (Llama 2017; Rothman 2010).

Rothman (2010) tested L3 speakers of Brazilian Portuguese (BP), with balanced bilinguals in Spanish (HA) and English (LA). His results demonstrated the Spanish-like HA of the RC in L3 BP. Rothman (2010) concluded that typological proximity between Spanish and BP determined the source of syntactic transfer into L3. These results were challenged by Rah (2010), who focused on the order of the languages acquired. Their participants were German–French–English and German–English–French trilinguals. The study demonstrated the English-like LA preference for RC resolution in L2 French, even though French was acquired before English. The learners who learnt French after English preferred HA in it. The author argued that transfer was possible from L3 English into L2 French, but not from L2 English into L3 French.

Both studies seem problematic from the processing perspective. They both are set to compare two options for RC resolution in the combination of three languages. In this design, a mere coincidence of parsing preferences between any two languages is very possible, i.e., attachment resolution in L3 will be the same as in either L1 or L2 without any alternative, and it will be explained by transfer as there are no alternative explanations. The problematic nature of this approach is apparent in a study by Llama (2017), where the target group was trilingual speakers of English, French and Spanish. The results came out as inconsistent, and the author reported that RC resolution in L3 cannot be explained by syntactic transfer of a parsing preference established in a previously learnt language.

Our study makes a step towards bridging gaps in multilingual research and introduces a new trilingual group, speakers of Tatar, Russian and English. We compare their RC resolution and processing in the native language Russian and in the non-native language English in a self-paced reading experiment. This addresses the debate in the field of native and non-native processing. We also give our participants a translation task, which elicits cross-linguistic mechanisms of sentence processing and checks whether RC attachment demonstrated in either Russian or English is transferred into Tatar.

The experiment is designed to address the question of whether the multilingual parser weighs syntactic and non-syntactic information in a similar way in native and non-native languages (Clahsen and Felser 2018; Sprouse 2011; Dekydtspotter et al. 2006). To do so, we follow the general design of Sokolova and Slabakova (2022) but take a deeper look at the mechanism underlying ambiguity processing in the RC. The study checks whether a top-down mechanism of structural prediction (Phillips and Schneider 2000) triggered by the matrix verb is challenged or complemented by non-syntactic information integrated in the course of sentence processing in the bottom-up manner (Felser (2018), University of Potsdam Potsdam Research Institute for Multilingualism, Potsdam, Germany, Personal Communication at Generative Approaches to Second Language acquisition, Munich, Germany).

1.2. Structural Prediction in Relative Clause Processing

The effect of structural prediction on RC resolution in native and non-native languages has been studied by Sokolova and Slabakova (2019, 2021, 2022). Their studies compared RC processing in native speakers, L2ers and L3ers in Russian and English. They report that the participants tended to prefer HA of the ambiguous RC more often if the matrix clause had a perception verb. The authors argue that a structural prediction triggered by a perception verb shapes subsequent RC modification towards the higher noun. We support the general approach of Sokolova and Slabakova (2019, 2021, 2022) as it provides additional evidence for the parser's sensitivity to structural information in non-native languages and strengthens the claims by Sprouse (2011), Dekydtspotter et al. (2008) and Dekydtspotter et al. (2006). However, the amount of the effect observed by Sokolova and Slabakova (2019, 2021, 2022) makes the direct influence of a perception verb problematic from the processing perspective.

The assumption that an element outside the relative clause can shape its parsing originates from monolingual studies on predictive processing by (Phillips and Schneider 2000; see also Kazanina et al. 2007). They report that reanalysis is cognitively costly; therefore, the human parser would try to avoid it for as long as possible. Parsing decisions of higher processing cycles are maintained and support subsequent parsing decisions as long as the new linguistic information does not trigger a structural conflict (Phillips and Schneider 2000). According to (Grillo and Costa 2014; see also Grillo et al. 2015), an element influencing the subsequent parsing of a structurally ambiguous RC is a perception verb. If the processing routine explained above is observed, the RC should have HA after a perception verb.

The hypothesis of Grillo and Costa (2014) claims that a perception verb, such as *saw*, triggers an anticipation for the event-oriented continuation. The underlying interpretation of the sentences exemplified in (4) is *Bill saw (what event?) the act of playing with a kitten performed by the granddaughter of the woman*.

(4) Bill saw
  a. [$_{SC}$ the granddaughter of the woman playing with the kitten in the yard]
  b. [$_{CP}$ (that) the granddaughter of the woman was playing with a kitten in the yard]

In English, this eventive complement can have the form of a full subordinate clause (CP, 4b) or a Small Clause (SC, 3a). Crucially, the complex DP *the granddaughter of the woman* is a grammatical subject of either the CP or SC. Thus, the only doer of the action of playing can be *the granddaughter (of the woman)*.

In Romance languages, the eventive complement and the RC have identical word orders. For this reason, Grillo and Costa (2014) called the event-oriented reading a Pseudo Relative (PR). Compare the French examples in (5).

(5) a. Mary a écouté [$_{DP}$ la mère de la femme [$_{RC}$ qui parlait de cosmétiques]]
Mary heard the mother-ACC of the woman-Gen who talked about cosmetics.
French, restrictive RC-reading: Mary heard the mother of the woman who talked about cosmetics.

b. Mary a écouté [$_{CP}$ [$_{DP}$ la mère de la femme] [$_{CP}$ qui parlait de cosmétiques]]]
Mary heard the mother-ACC of the woman-Gen who talked about cosmetics.
French, eventive reading: Mary heard the talking about cosmetics by the mother of the woman.

Grillo and Costa (2014) claim that the human parser favors the analysis in (5b) when it processes a perception verb. However, if the target sentence is (5a), the human parser replaces the lower CP in (5b) with the RC as in (5a). This hidden modification favors HA and explains the general preference for it in Romance languages (Grillo and Costa 2014). However, this explanation happens to be problematic if we take a closer look at the proposed structural adjustment.

Knowing that the human parser favors the eventive complement over the restrictive RC (Aguilar et al. 2021; Pozniak et al. 2019), we assume that the parser predictively generates a structure for a clause upon processing a perception verb. Compare the restrictive RC in (6c) to the eventive complements in (6a) and (6b).

(6) Bill saw
a. [$_{SC}$ [$_{DP}$ the granddaughter of the woman] [$_{VP}$ playing with the kitten in the yard]]
b. [$_{CP}$ that [$_{DP}$ the granddaughter of the woman [$_{VP}$ was playing with a kitten in the yard]]
c. [$_{DP}$ the granddaughter of the woman [$_{RC}$ that was playing with a kitten in the yard]]

In (6a) and (6b), the complement of the matrix verb is a clause, where the complex DP *the granddaughter of the woman* is sister to the VP *(was) paying with a kitten*. In (6c), the complement of V is a complex DP subsequently modified by the RC. This structural mismatch does not allow the modification proposed by Grillo and Costa (2014). In their logic, the RC in (6c) should replace the VP in (6a) or (6b) skipping over one level of structure, i.e., it stops being part of a clause complement and becomes part of a DP complement to the matrix verb. Therefore, the effect of a perception reported to favor HA needs additional verification (see Sokolova and Slabakova 2019, 2021, 2022; Grillo et al. 2015 for experimental evidence).

The first question is why a perception verb does not change RC attachment in English completely but only increases the preference for HA a little bit. According to Sokolova and Slabakova (2019, 2021, 2022), the effect of a perception verb results in a preference for HA that is about 7% higher than in sentences with a non-perception verb in English. A possible answer would be a structural reanalysis caused by the mismatch in the linear word order between (6a)/(6b) and (6c). Upon processing the complementizer *that* in (6c), the parser knows that the upcoming structure is an RC. According to (Phillips and Schneider 2000) (see also Crocker 1999), the complementizer signals a structural conflict and triggers reanalysis. Sokolova and Slabakova (2021) report an increased reading time at the embedded verb and argue that this is due to the reanalysis triggered by the complementizer *that*. If this holds true, then why is there any effect of a perception verb on RC resolution at all? The eventive structure should be discarded mid-sentence and the parsing should proceed as normal for an RC.

To address the questions above, we ran a self-paced reading study and took the participants' preferred answers as a marker of the preferred option for RC attachment. We measured their reading time mid-sentence, at the embedded verb and at the complementizer, and checked for possible slowdowns in processing time after a perception verb, which would mean structural reanalysis. We also checked the participants' response time to see whether there is any processing conflict between the RC parsing prompted by a perception verb and world knowledge at the stage of linguistic decision making.

1.3. World Knowledge in Relative Clause Processing

By world knowledge we mean any information of a non-linguistic nature that can affect sentence processing. An example of such information is the social conventions introduced by Sokolova and Slabakova (2019, 2021, 2022) as one of the dependent variables in their studies. They referred to the paper by Clahsen and Felser (2018) where the authors claimed there was a lack of research on the role of semantic and/or pragmatic information in processing studies with L2 speakers. Sokolova and Slabakova (2019, 2021, 2022) bridged this gap and tested the effect of social conventions against the effect of a perception verb on RC resolution in a self-paced reading experiment with native and non-native speakers of Russian and English.

By social conventions, the studies (Sokolova and Slabakova 2019, 2021, 2022) mean some established conventions that suggest certain activities are most likely to be performed by representatives of certain social groups. For example, *talking about cosmetics* would be most often conducted by females rather than males or children. Another example is conventional division by age. Thus, any activity that involves playing would be assigned to a child rather than an adult.

In their (Sokolova and Slabakova 2019, 2022) papers, Sokolova and Slabakova report no effect of social conventions on RC resolution in either L1, L2 or L3. Both studies manipulated the order of the head nouns, such as *the sister of the boy* vs. *the brother of the girl*, to ensure a balanced distribution of the experimental tokens to favor either HA or LA. In their paper of (Sokolova and Slabakova 2021), Sokolova and Slabakova improved their design and included a no-bias condition alongside the HA-bias and LA-bias conditions. The no-bias condition allowed the authors to measure the default preference for RC resolution in a given language and elicited the effect in the biased conditions. The paper reports the participants' sensitivity to social bias in both native and non-native languages but claims that the effect of non-linguistic information does not override the default RC resolution in a given language.

We follow Sokolova and Slabakova (2021) and maintain the three-level design for the factor *world knowledge*, which is synonymic with social conventions in the studies by Sokolova and Slabakova (2019, 2021, 2022). Taken together the effect of the matrix verb and the effect of world knowledge can create either a congruent processing condition, if both favor HA, or a non-congruent condition, when world knowledge prompts LA against the HA favored by the matrix verb. This allows us to measure the relative weight of each factor on RC processing and shed light on the long-standing debates on the role of structural and non-structural information in native and non-native languages.

1.4. Research Questions

Our overarching Research Question (RQ) is the following:

Do speakers follow the same routines in processing and attachment resolution of ambiguous RCs in their native and non-native languages?

To provide a detailed analysis of the matter, we break the main RQ into four subquestions that guide our experiment description and data presentation.

RQ1: Are both native and non-native speakers sensitive to a structural prediction triggered by a perception verb in the matrix clause?

Prediction 1: We anticipate that a perception verb triggers a structural prediction for an eventive complement across languages. This prediction entails a structural mismatch when the parser encounters the complementizer; it causes reanalysis and a slowdown in the reading and response time. We do not anticipate any effect of a perception verb on RC resolution since the structural analysis that could favor it is discarded mid-sentence.

RQ2: Do both native and non-native speakers rely on world knowledge during RC processing and attachment resolution?

Prediction 2: We anticipate a similar effect of world knowledge on RC attachment resolution to that in Sokolova and Slabakova (2021): native and non-native speakers are sensitive to non-syntactic information in RC processing and attachment resolution.

RQ3: Do translations from English and Russian into Tatar maintain the RC attachment generally preferred in each language?

Prediction 3: We anticipate that the preferred pattern of RC resolution in either English or Russian is maintained in Tatar translations. We believe that translation per se requires the transfer of meaning from one language into another. Therefore, a sentence will be translated into Tatar the way it was understood in the source language, i.e., reflecting the preference for HA in Russian and for LA in English.

RQ4: Do translations from English and Russian into Tatar follow the social bias prompted in the source sentence?

Prediction 4: Bearing in mind that the translation task is an offline task administered as a pen-and-paper post-test, we assume an effect of social conventions in Tatar translations when there is a clear HA/LA bias in the source sentence and the default preference for RC attachment demonstrated in the source language in the no-bias condition.

2. Materials and Methods

2.1. Design

This study consisted of a self-paced reading experiment administered via software for linguistic experiments, Linger, and a pen-and-paper post-test. The self-paced reading experiment was conducted in either Russian or English and targeted RC processing and attachment resolution. The post-test was a written translation task aimed at eliciting the type of RC resolution in the Tatar translations.

The *self-paced reading* experiment used a 2-by-3 design manipulating two independent variables: the type of matrix predicate and social conventions. Both variables were turned into factors. The first factor—type of matrix predicate (Vtype_factor)—was a two-level factor with the contrasts set as 0.5 for a perception verb and −0.5 for a non-perception matrix verb. The second factor—world knowledge (Bias_factor)—was set for a three-level analysis with contrasts set as −0.66 for HA bias, 0.33 for LA bias and −0.33 for no bias. Table 1 provides a sample set of experimental tokens.

Table 1. Sample set of tokens for a self-paced reading experiment.

Bias	Perception Verb	Non-Perception Verb
HA bias	Bill **saw** the nanny of the girl that was baking cookies in the kitchen	Bill **called** the nanny of the girl that was baking cookies in the kitchen
LA bias	Bill **saw** the granddaughter of the nanny that was baking cookies in the kitchen	Bill **called** the granddaughter of the nanny that was baking cookies in the kitchen
No bias	Bill **saw** the friend of the neighbor that was talking about football on the phone	Bill **called** the friend of the neighbor that was talking about football on the phone
Bias	**Perception Verb**	**Non-Perception Verb**
HA bias	Bill **videl** nyanu devochki kotoraya pekla pechenie na kukhnehe girl *Bill-NOM see-PAST nanny-ACC girl-GEN that-COMP bake-PAST cookies-ACC in-PREP kitchen-LOC*	Bill **pozval** nyanu devochki kotoraya pekla pechenie na kukhnehe girl *Bill-NOM call-PAST nanny-ACC girl-GEN that-COMP bake-PAST cookies-ACC in-PREP kitchen-LOC*
LA bias	Bill **videl** vnuchku nyani kotoraya pekla pechenie na kukhnehe girl *Bill-NOM see-PAST granddaughter-ACC nanny-GEN that-COMP bake-PAST cookies-ACC in-PREP kitchen-LOC*	Bill **pozval** vnuchku nyani kotoraya pekla pechenie na kukhnehe girl *Bill-NOM call-PAST granddaughter-ACC nanny-GEN that-COMP bake-PAST cookies-ACC in-PREP kitchen-LOC*
No bias	Bill **videl** druga soseda kotoryj govoril o futbole po telephonu *Bill-NOM see-PAST friend-ACC neighbor-GEN that-COMP talk-PAST about-PREP football-PREP.C on-PREP phone-LOC*	Bill **pozval** druga soseda kotoryj govoril o futbole po telephonu *Bill-NOM call-PAST friend-ACC neighbor-GEN that-COMP talk-PAST about-PREP football-PREP.C on-PREP phone-LOC*

The number of items was 112 in total in each language: 48 target sentences and 64 distractors. Each sentence was followed by a comprehension question targeting the doer of the activity stated in the RC. For example, a sentence such as *Bill saw the friend of the neighbor that was talking about football on the phone* was followed by a question, such as *Who was talking about football?* The answer choices were *(a) friend (b) neighbor*.

The translation task was a small-scale assignment where the participants had to translate a total number of 32 sentences from either Russian or English into Tatar. There were 8 target sentences and 32 distractors.

The total number of experimental items in each task was calculated so that the experiment would not last longer than 90 min altogether and the participants would not be too tired. The translation task also weighed the risk that the participants may have remembered some items from the self-paced reading task. Therefore, the number of distractors exceeded the number of target sentences by four times.

2.2. Procedure

The experiment was a self-paced reading task administered via software for linguistic experiments, Linger. It was followed by an offline pen-and-paper translation task. Prior to the experiment, the participants were informed that their participation was fully voluntary and they could quit any time without consequences. They signed a consent form and filled in the background questionnaire before starting the experiment.

The self-paced reading task was conducted on a standard computer with a standard keyboard, imposing no health risks beyond the risks of daily use of a personal PC. The tokens were presented word-by-word in the moving window. The experiment started with a training session. The participants were instructed how to navigate through the experiment and prompted to try all the necessary keys. They were to press keys 'K' or 'J' to select answers on the screen, and the space key to move forward through the experiment. There was no 'go back' option.

Upon completion of the self-paced reading task, the participants were offered a written translation task. The task provided them with a set of sentences in either Russian or English. Those who did the self-paced reading task in Russian had the translation task in Russian. The participants who did the first experiment in English received the translation task in English. In both cases, the participants translated the sentences provided from the target language into Tatar.

2.3. Participants

The participants of the study formed two groups Tatar–Russian (TR) bilinguals and Tatar–Russian–English (TRE) trilinguals. The total number of respondents was 63: there were 33 people in the bilingual group and 30 in the trilingual group. The main difference between the two groups was in the state of activation of their third language, English.

All participants grew up in the Republic of Tatarstan where they received an equivalent amount of classroom instruction in each of the three languages, i.e., they studied Tatar, Russian and English as school subjects throughout the entire course of their school education. Unlike English, Tatar and Russian are used in the participants' daily life, and Russian is the language of instruction at school and University.

English is a foreign language that the participants started learning at school. The TR group limited their studies to fulfilling the basic minimum requirement to pass the subject. They did not use English outside the classroom and reported no exposure to English after school. The participants claimed no knowledge of English and assessed their level of reading and listening comprehension in it at 2 points out of 9. This group was tested in Russian, one of their native languages. The data were used to confirm the preference for RC resolution established for monolingual populations by Sekerina (1997) and Sokolova and Slabakova (2019, 2021, 2022).

The trilingual participants formed the TRE group. The same as group TR, they started learning English as an academic subject. Unlike group TR, they continued learning English

after school and extended its use to everyday life and professional communication. At the time of testing, the participants counted themselves as fluent speakers of English and assessed their level of reading and listening comprehension as 7 out of 9. The TRE group did the experiment in English only. Even though group TRE were native speakers of Russian, we decided not to test them in two languages, Russian and English, to make sure they would not memorize the target sentences and would not guess the purpose of the experiment. Thus, we had two groups balanced by the level of proficiency in their native languages, TR and TRE. Group TR was tested in Russian only, group TRE did the experiment in English only.

Prior to the main experiment, we assessed the participants' language proficiency. We used a standard C-test (Park 1998). The participants were provided with three short texts on general topics. The texts were about 100 words long, and the length of each sentence was 7–10 words. The first sentence in each text was kept in full. After this, every other word had its second half deleted with gaps provided for them to fill. When the number of gaps reached 20, the text was maintained in full. The C-test was balanced across languages and validated with native speakers of each language. The participants were asked to fill in the gaps. The total number of gaps in the entire C-test was 60. The inclusion criterion was at least 30% of the gaps filled correctly, and the correct completions had to occur in each of the three texts.

To keep the intellectual load balanced, each group was tested in two languages, the target language of the experiment, English or Russian, respectively, and in Tatar. Due to the socio-political reality in the republic, Tatar is becoming marginalized. Most often the younger generation speak Russian and English, and their Tatar is very limited. At the same time, older people are balanced in their use of Tatar and Russian. Because of the social reality of language use, our TR group included people who were a bit older than those in group TRE. This age gap did not affect the results: there was no significant correlation between the participants' age and their performance in the experiment. However, it was essential to make sure the groups were balanced Tatar–Russian bilinguals, and we asked all of them to take a C-test in Tatar.

The necessity to check the participants' proficiency in English is self-evident as it is their non-native language. The participants demonstrated an intermediate level of proficiency in English, scoring 30–77%. We also tested the TR group in Russian. This was mostly carried out to keep the level of fatigue balanced across both groups. All participants had completed school and University studies in Russian, and Russian is now the official language in the Republic of Tatarstan. There is no reason to think that any participant would score below 85% on the Russian C-test. The key background data of the participants are summarized in Table 2.

Table 2. Background data on the participants of the study.

	TR	**TRE**
Number	33	30
C-test Tatar, % correct	93% (69–100%)	86% (58–100%)
C-test LofT, % correct	96% (87–100%)	57% (30–77%)
Mean age	31 (range 20–65)	27 (range 20–41)

* LofT stands for the Language of Testing.

The participants were adults with a BA degree or higher. Some of the participants tried learning other foreign languages, but this was limited to up to 3 months of classroom learning. There was no significant effect of exposure to other languages on the participants' performance.

3. Results

This section provides the main findings of the experiment. It is organized in the following order: the results on RC attachment resolution (Section 3.1) and processing effects (Section 3.2).

For data analysis, we used the Generalized Linear Mixed Model (GLMM) in R, version 4.2.3-win. The main factors were Group, Social bias and Verb type. The factors Social bias and Verb type are described in the previous section. The Group factor corresponds to the participants being either bilingual (TR) or trilingual (TRE). It is important to note that the last letter of the acronym for the group indicates the languages of testing. Thus, the bilingual group T**R** was tested in **R**ussian, while the participants in the trilingual group TR**E** were tested in **E**nglish.

3.1. Relative Clause Attachment

RC attachment, or answers chosen in response to the comprehension questions, was significantly affected by the factors Group ($\beta = 0.11$, SE = 0.03, z = 3.32, $p = 0.01$) and Social bias ($\beta = 0.29$, SE = 0.04, z = 4.68, $p = 0.001$).

As anticipated, there was a difference in RC attachment when the sentences were processed in English and in Russian (see Figure 1). The effect was significant in that group TR were more likely to choose HA in Russian, 61%, than group TRE in English, 49%. Even though, the difference in RC attachment was not very big, it was statistically significant, and LA was preferred in English more often than in Russian. Please see the distribution of answers by participant in Figure 2.

The participants were also sensitive to social conventional information when they interpreted ambiguous RCs (Figure 3), and this factor influenced both groups in a very similar way (see Figure 4).

There was no effect of Verb type on RC resolution ($\beta = 0.03$, SE = 0.03, z = 1.08, $p = 0.28$). Even though there was a small change in RC preference after a perception verb in both groups, the number did not reach statistical significance. HA after a perception verb was preferred in 57% of cases, and after a non-perception verb in 53%.

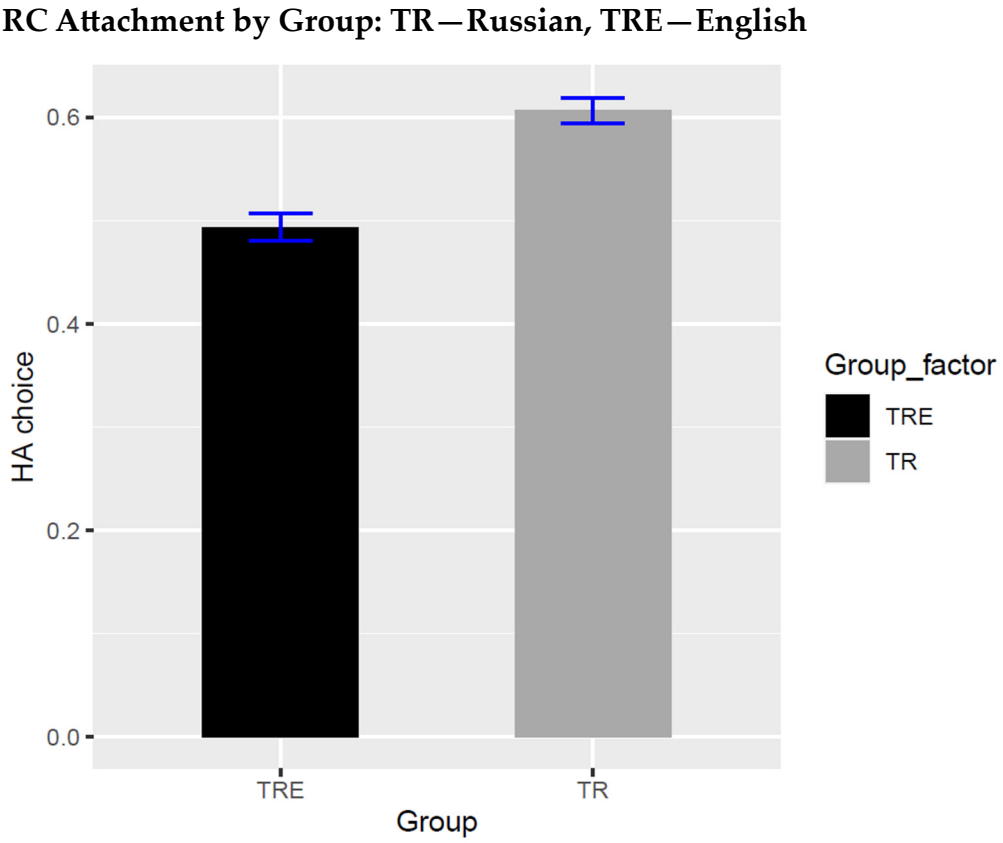

Figure 1. Overall preference for HA in each group, TR and TRE.

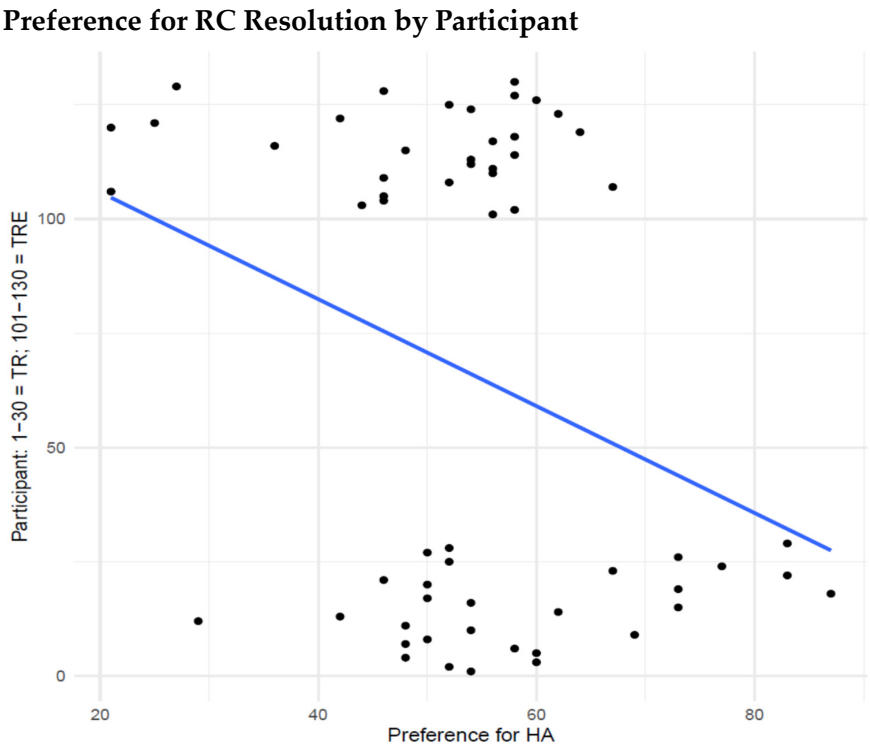

Figure 2. Preference for HA demonstrated by participant, the range of 1–30 on the Y-axix demonstrates the individual choices in the group TR, the range of 101–130 in the group TRE.

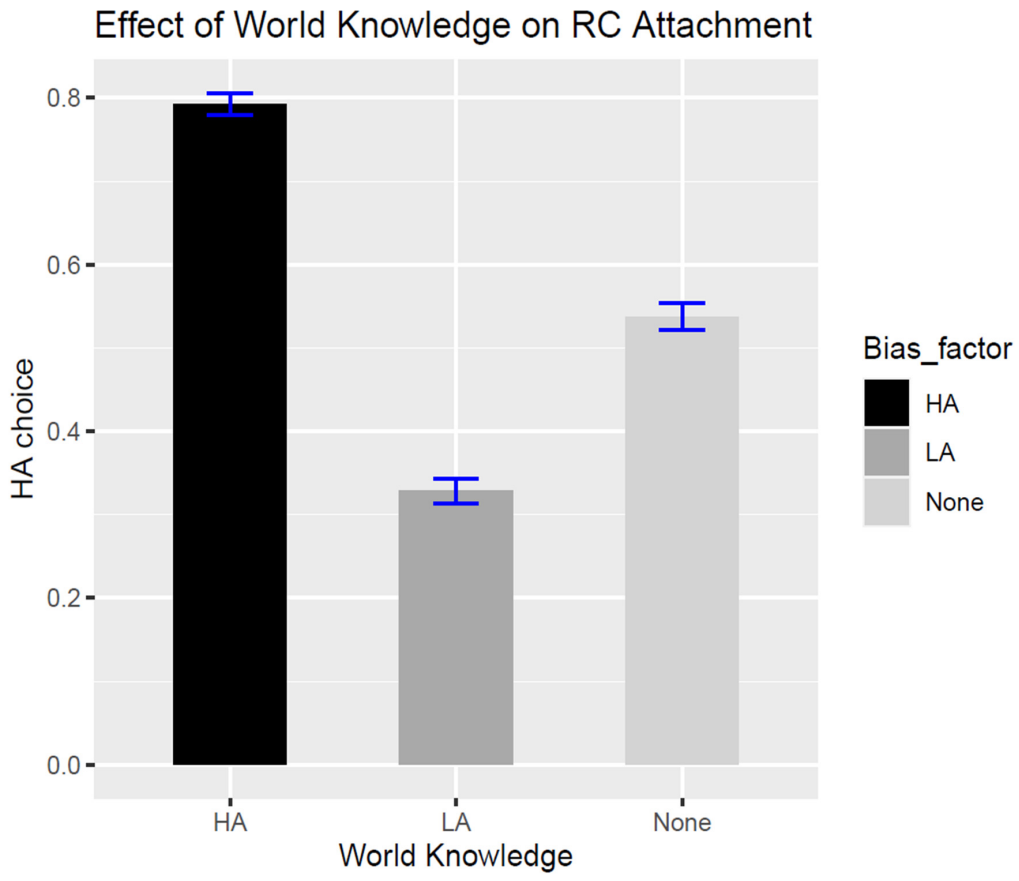

Figure 3. Overall preference for HA in the three experimental conditions: HA bias, LA bias and No bias.

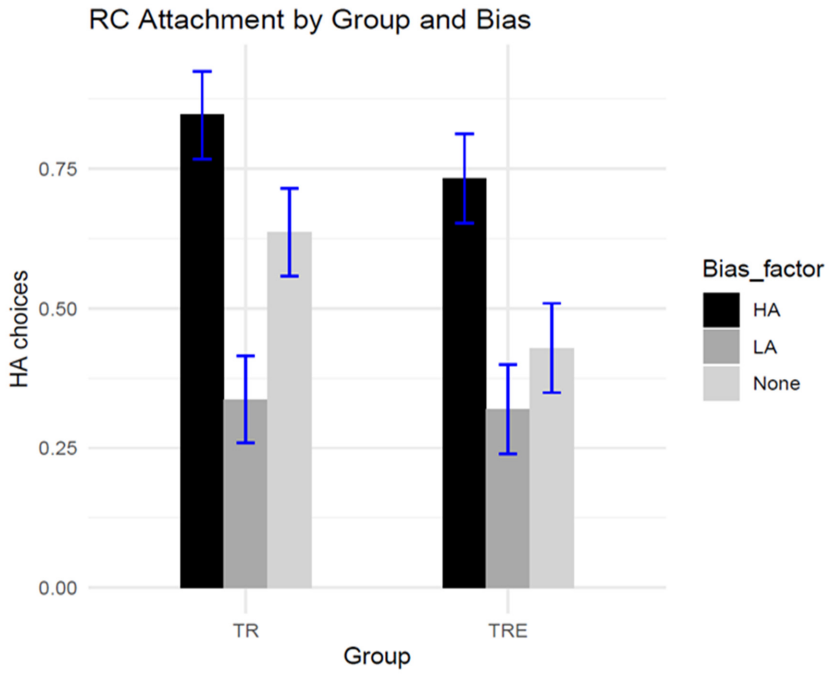

Figure 4. Effect of world knowledge on RC resolution in each group.

RC Attachment in Translation

In the translation task, the participants preferred LA (65%), irrespective of the source language. There was no significant effect of any factor, Group, Social bias or Verb type, on RC attachment preference in translation. The only significant factor was the participants' proficiency in Tatar ($\beta = -0.40$, SE = 0.19, $z = -2.03$, $p = 0.04$): the higher the proficiency in Tatar, the more likely LA was preferred (see Figure 5). Figure 6 demonstrates the preference for LA in the translation task by participant.

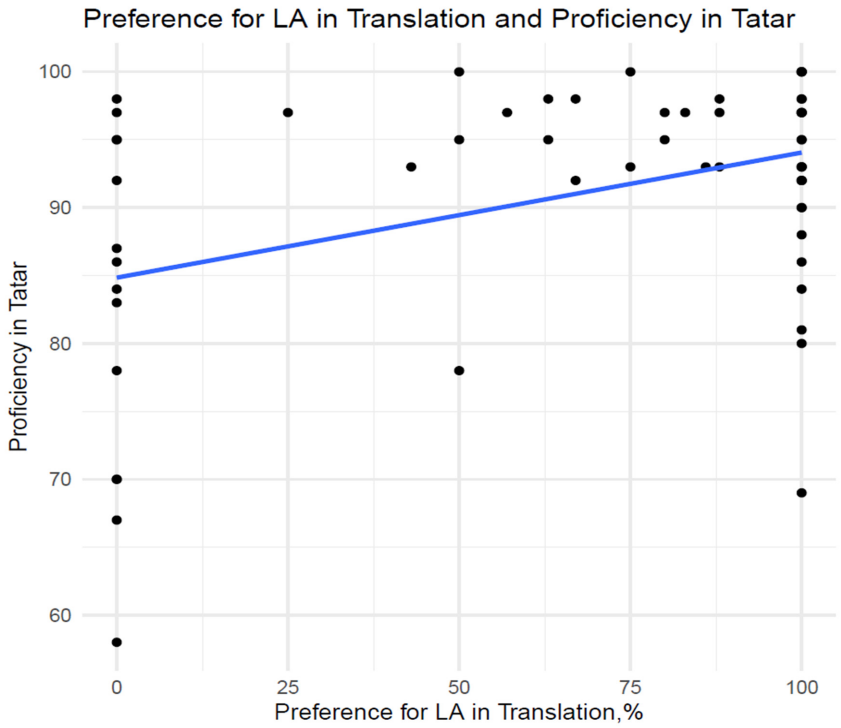

Figure 5. Correlation between the LA preference in Tatar translations and the participants proficiency in the Tatar language.

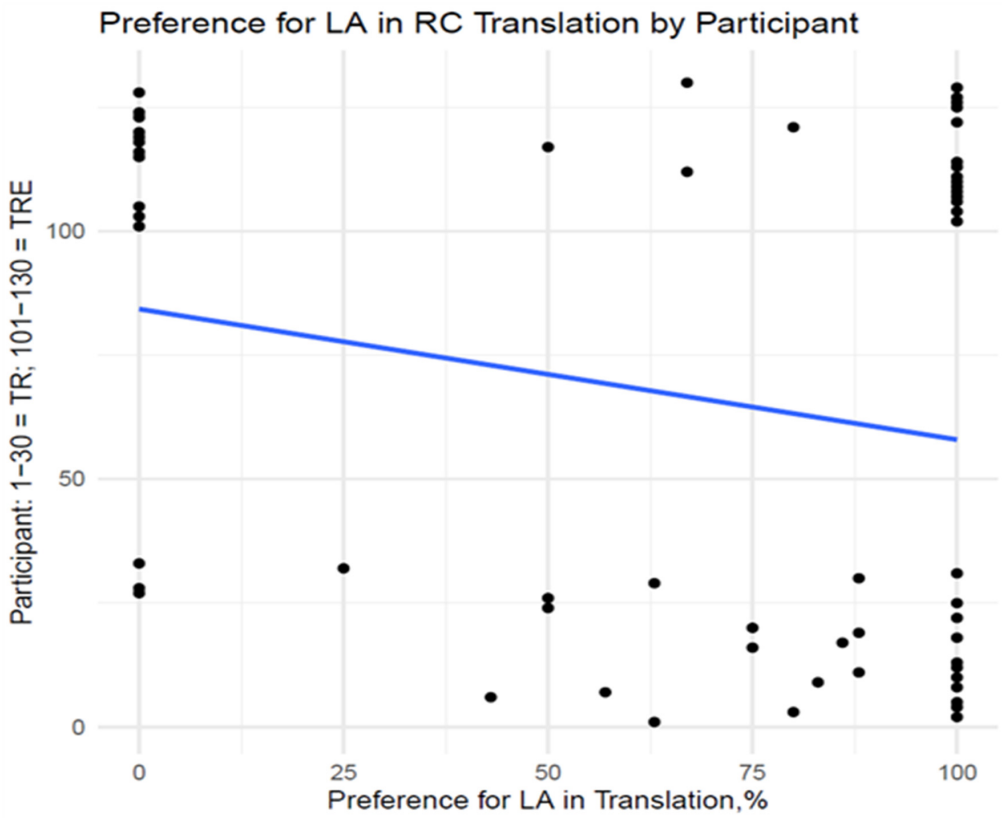

Figure 6. Preference for LA in the translation task by participant, the range of 1–30 on the Y-axix demonstrates the individual choices in the group TR, the range of 101–130 in the group TRE.

3.2. Processing Effects

To register processing effects, we checked the reading time (RT) mid-sentence, i.e., at the complementizer and at the embedded verb, as well as the response time (RespTime). A slower RT indicates processing difficulties. By RespTime we mean the time taken by the participants to select the answer to a comprehension question. A slower RespTime indicates difficulty to respond to a comprehension question in certain experimental conditions.

There is some scholarly disagreement concerning the place where the effect of reanalysis should be observed: at the word that triggers the reanalysis (the complementizer *that*, in English) or at the following word. We checked the reading time at both the complementizer and the following embedded verb. We provide a detailed explanation of the processing effects mid-sentence in the Discussion. The main factors in the analysis were the same as in Section 3.1.

3.2.1. Complementizer

There was a significant effect of Verb type ($\beta = 41.6$, SE = 19.8, $z = 2.11$, $p = 0.03$) on the RT at the complementizer *that* in both groups. In sentences with a perception verb, the participants slowed down their RT upon encountering the complementizer (see Figure 7).

There were no other significant effects influencing the RT at the complementizer.

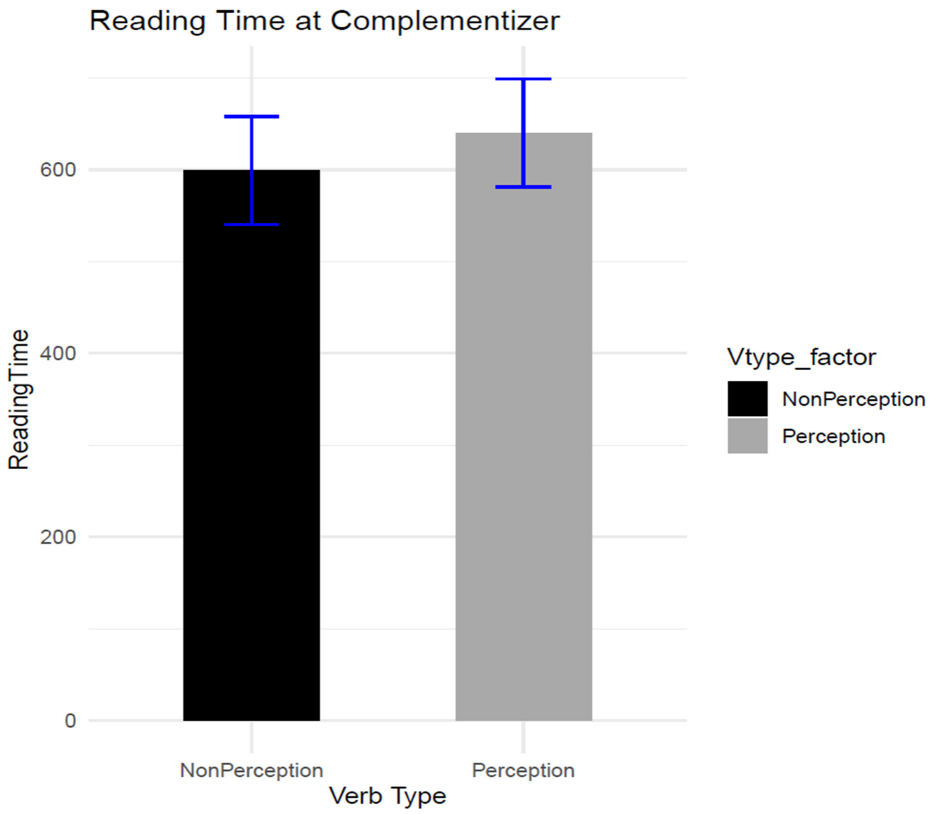

Figure 7. Effect of the type of the matrix verb on the reading time at the complementizer.

3.2.2. Embedded Verb

There was only one significant factor that influenced the RT at the embedded verb—Social bias ($\beta = 29.4$, SE = 13.3, z = 2.12, $p = 0.03$); the data are illustrated in Figure 8. There was no effect of Verb type or Group on the RT at the embedded verb.

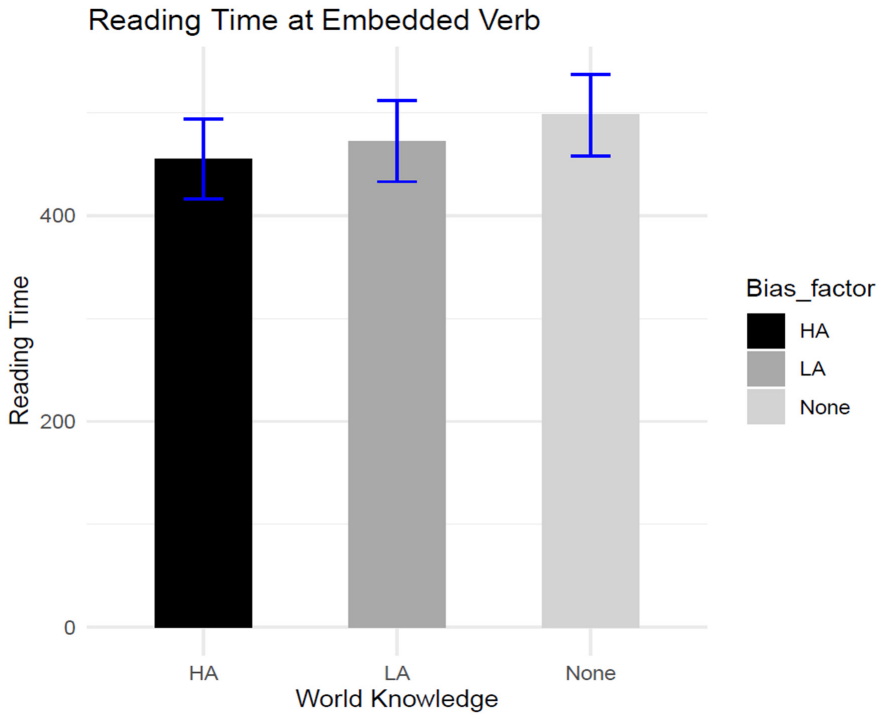

Figure 8. Effect of world knowledge on the reading time at the complementizer.

3.2.3. Response Time

RespTime was significantly influenced by Social bias (β = 251.2, SE = 92.8, z = 2.70, $p = 0.01$). It came out as a significant simple effect, illustrated in Figure 9. Please note that the amount of effect is very similar to the effect of Social bias on RT and the embedded verb (Figure 8).

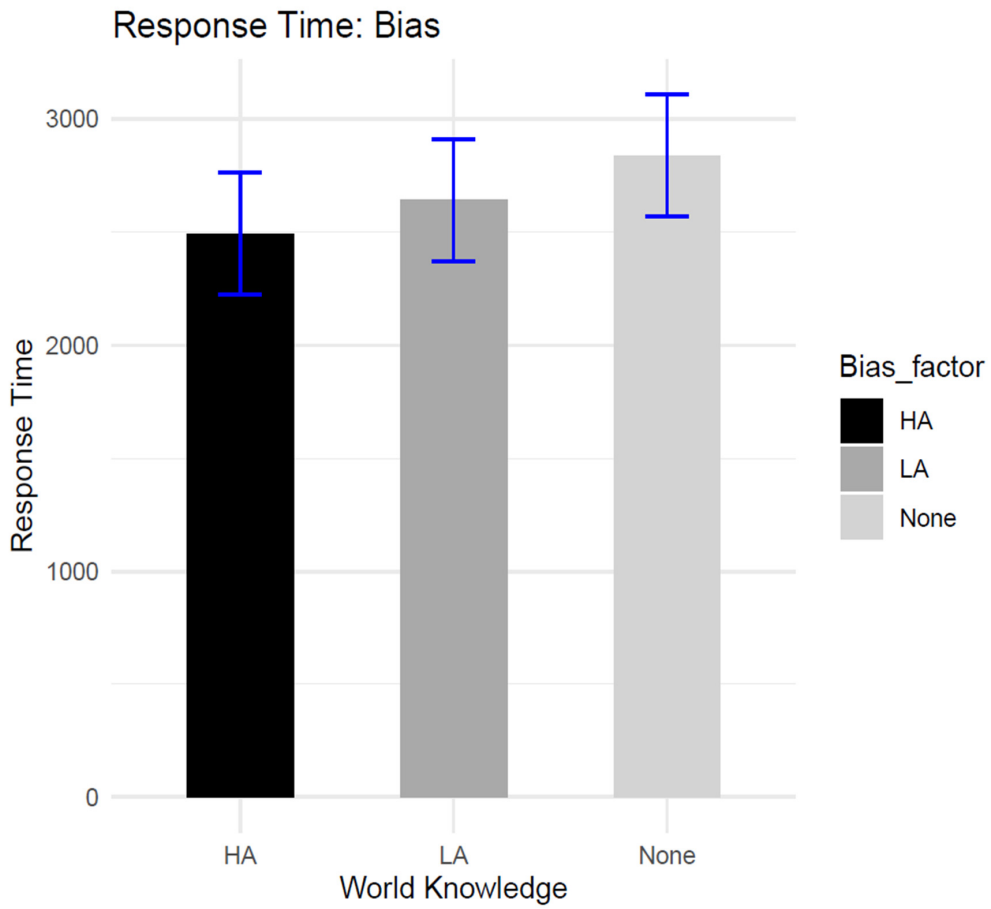

Figure 9. Effect of world knowledge on the response time at the complementizer.

There were significant interactions between the factors Verb type and Group (VerbType * Group) (β = −247.8, SE = 133.9, z = −1.85, $p = 0.06$), and between Verb type and Social bias (Verb type * Social bias) (β = −651.3, SE = 214.4, z = −3.03, $p = 0.003$). There was also a significant interaction for Verb type * Social bias * Group (β = −747.3, SE = −2.27, z = −2.27, $p = 0.02$), which meant that the factors Verb type and Social bias influenced the two experimental groups differently.

Figure 10 illustrates the RespTime in each group. The participants tested in Russian (TR) found the sentences with a perception verb easier to interpret than the sentences with a non-perception verb. Group TRE did not show any effect of a perception verb on RespTime.

The effect of Social bias on RespTime is demonstrated in Figure 11. The established sensitivity to Social bias (see Figures 8 and 9) was maintained in the 'non-perception' condition, Figure 11. In sentences with a perception verb, the pattern changed, and sentences where Social bias favored LA became more difficult to interpret.

The interaction of factors Verb type and Social bias worked differently in each group. There was a significant interaction for Verb type * Social bias * Group (β = −747.3, SE = −2.27, z = −2.27, $p = 0.02$). Figures 12 and 13 demonstrate the results in groups TRE and TR, respectively.

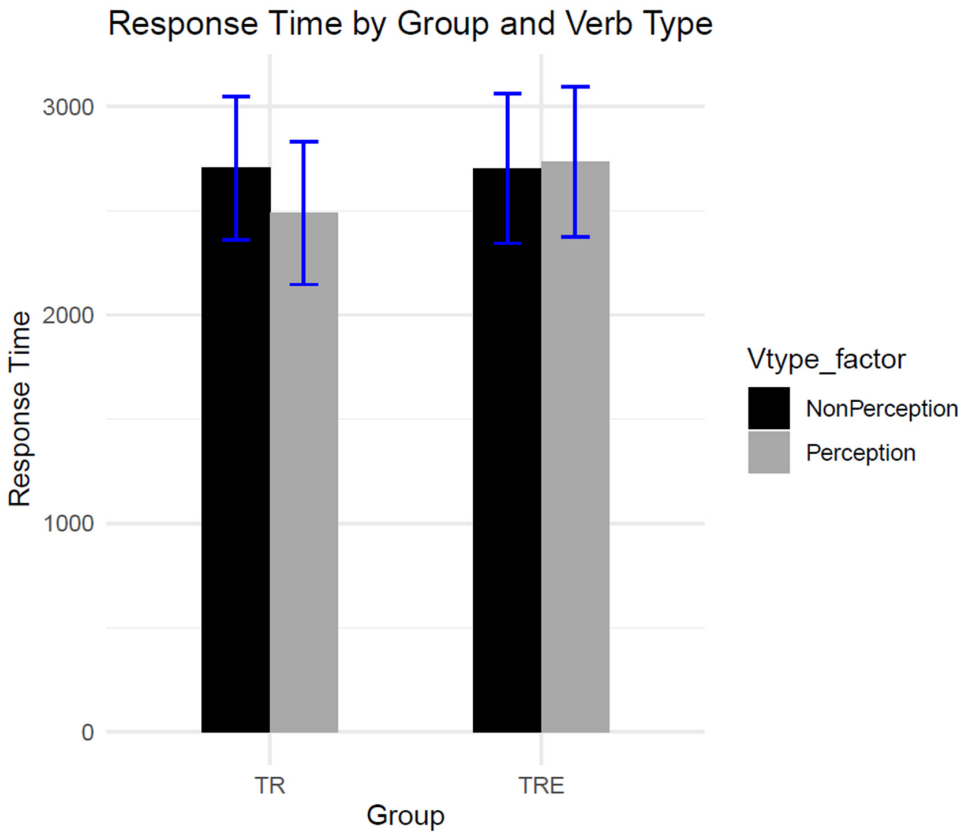

Figure 10. Effect of the type of the matrix verb on the response time in each group, TR and TRE.

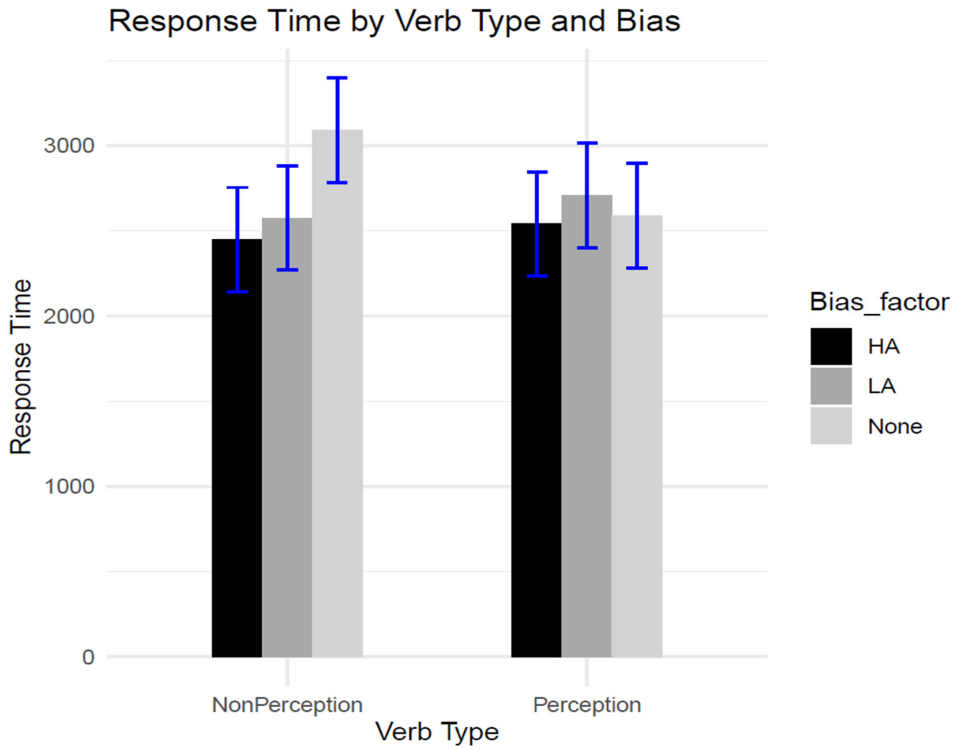

Figure 11. Effect of the type of the matrix verb and world knowledge on the response time.

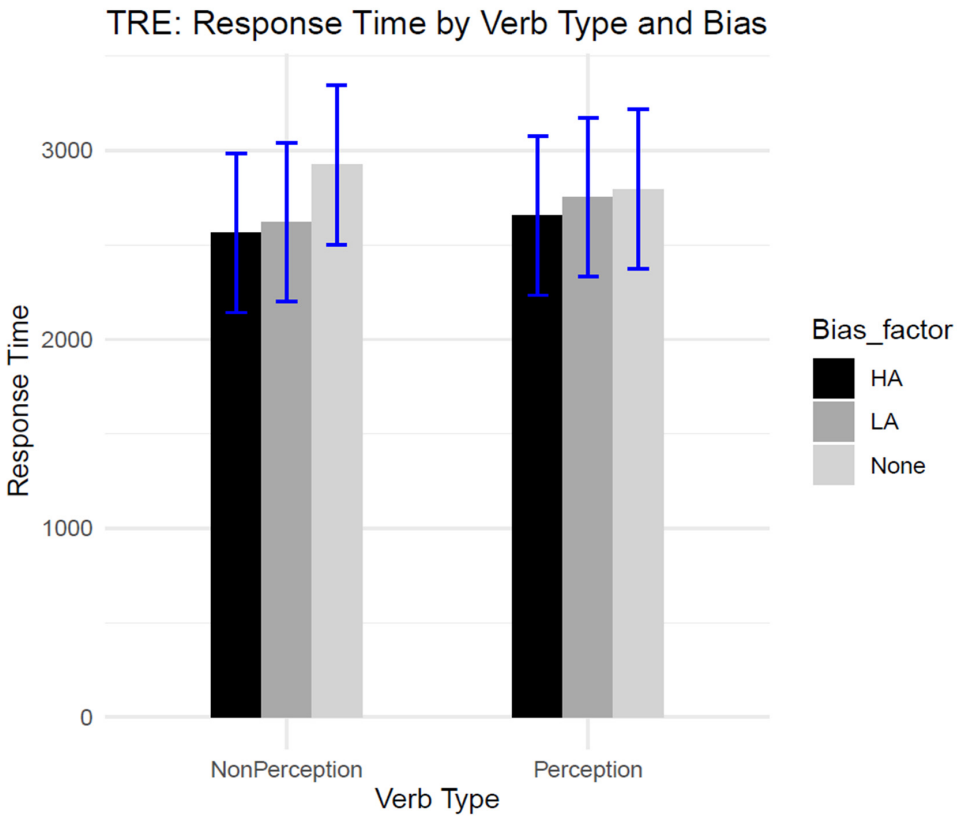

Figure 12. Effect of the type of the matrix verb and world knowledge on the response time in group TRE.

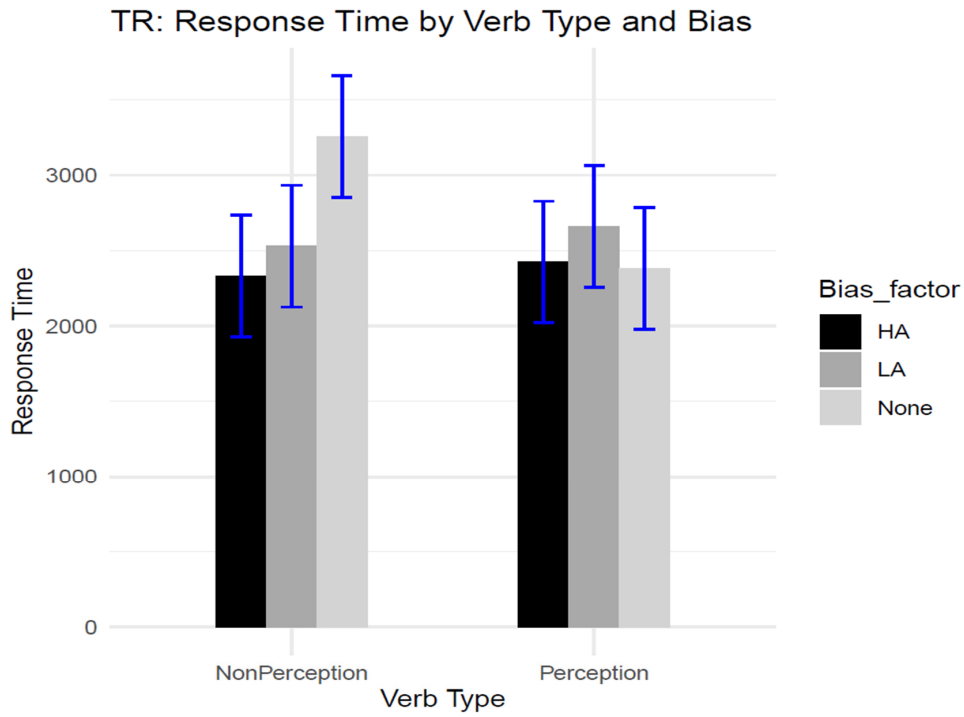

Figure 13. Effect of the type of the matrix verb and world knowledge on the response time in group TR.

As is evident from Figures 8, 9 and 12, the participants in group TRE, non-native speakers of English tested in their non-native language, tended to maintain sensitivity to the factor Social bias in RC processing and interpretation.

The participants in group TR (Figure 13), who were tested in their native language Russian, demonstrated a different processing pattern at the RespTime. They had difficulty interpreting the sentences with the incongruent processing conditions, i.e., where the matrix verb prompted HA but social conventions prompted LA.

4. Discussion

The study reported in this paper investigates mechanisms of RC processing and attachment resolution by multilingual speakers of Tatar and Russian. Our participants are bilingual speakers of Tatar and Russian, TR, and bilinguals who also speak an L3: Tatar, Russian and English, TRE. The study investigates how the multilingual parser operates different types of linguistic information during sentence processing for comprehension. The main RQ is—do native and non-native speakers follow the same routines in processing and attachment resolution of ambiguous RCs? This question revives the long-lasting debate concerning the online use of structural and non-structural information in L2 processing taking place between the proponents of the Shallow Structure Hypothesis (Clahsen and Felser 2006, 2018) and the scholars who argue for the Full Structural Parsing in non-native languages (Dekydtspotter et al. 2006, 2008). If narrowed down to the scope of our study, the non-native parser should be sensitive to the selectional properties of the matrix verb in RC resolution if Ln processing is structure-based (Sprouse 2011; Dekydtspotter et al. 2006, 2008). Alternatively, our participants can rely on social conventions in their L3 English more than in their L1 Russian or Tatar (Clahsen and Felser 2006, 2018; Pan et al. 2015). Our findings partly support both approaches.

To begin with, our participants prefer HA in 61% of the RCs in Russian and in 49% in English. There is no agreement on how to interpret results in attachment resolution, when the data are around 50%. The early studies by Felser et al. (2003a, 2003b) and Papadopoulou and Clahsen (2003) interpreted this preference as performance at chance. Witzel et al. (2012) and Sokolova and Slabakova (2019, 2021, 2022) tend to interpret a very similar percentage score as a sign of a developing tendency to switch to the target-like RC attachment when the participants improve their level of proficiency in Ln. Our results show quite a narrow gap in RC preference between Russian (61% HA) and English (49% HA), but it is statistically significant. In addition, the effect of world knowledge does not override the default pattern of RC resolution in any language. Putting these findings together, we join Sokolova and Slabakova (2019, 2021, 2022) and claim that intermediate speakers of English show a developing sensitivity to the parsing strategies generally employed in English.

We also tend to agree with Sokolova and Slabakova (2021) when they report equal sensitivity to world knowledge in RC resolution in native and non-native languages. Our participants demonstrate a homogenous sensitivity to social bias in English and Russian. This influences the RT at the embedded verb, the RespTime and the interpretation decision in both groups. We do not find a statistically significant difference in sensitivity to non-syntactic information between L3ers and L1ers. The effects of LA bias and HA bias shape RC resolution within a very similar range of the preference established in no bias. This pattern is the same in each group. The latter is problematic for the SSH (see Clahsen and Felser 2006, 2018), where non-native speakers are expected to rely on non-structural information more than native speakers. It is worth mentioning that non-structural information remains relevant till the end of sentence processing. The *no-bias* condition is the most difficult to process in both groups, which means the multilingual parser considers non-structural information at all stages of sentence processing and adjusts its parsing accordingly (Figures 8, 9 and 11).

The participants are sensitive to the selectional properties of the matrix verb, as we register processing effects in the RT at the embedded verb and in RespTime. A slower RT at the complementizer *that* indicates a structural reanalysis triggered by it. At this point,

the initial structural prediction for an eventive complement is discarded. The rest of the sentence is processed as a regular RC. That is why there is no effect of a perception verb on RC resolution. The verb increases the preference for HA. However, the effect does not reach statistical significance in our study. It is interesting that Sokolova and Slabakova (2019, 2021, 2022) reported a significant effect of the matrix verb on RC resolution. A possible explanation is a lingering effect (Fujita and Cunnings 2021), which means that the structure discarded during the reanalysis is not erased completely and still favors HA in some cases.

Our findings contribute to the debate in the field of L3 processing, where RC attachment is explained by the transfer of parsing preferences established in either of the previously acquired languages (Llama 2017; Rah 2010; Rothman 2010). The question is: if the L1 and L2 have distinct preferences, which one would you choose when processing the L3? Since Tatar does not allow RC ambiguity, one could anticipate the Russian-like HA preference in English. However, our results do not support this expectation: our subjects tend to prefer LA in their L3 English. We argue that parsing preferences do not transfer from language to language in the case of balanced bilinguals who speak their additional language at an intermediate level of proficiency. We support this claim with the data from the post-test translation task.

When translating RCs from either Russian or English into Tatar, our participants attach them to the lower noun (5b). Moreover, there is a significant correlation between the participants' proficiency in Tatar and their preference for LA in Tatar translations. These findings bring back the early theories of RC processing (see Frazier and Fodor 1978), where LA was considered a universal parsing preference. This assumption was challenged by Cuetos and Mitchell (1988) when they found an HA preference for RC resolution in Spanish and started the debate about a cross-linguistic variation in RC resolution.

Our findings demonstrate an LA preference in Tatar translations even though our participants speak an HA language, Russian, as their second L1. To our understanding, this can be interpreted as evidence for LA being a universal parsing preference for a multilingual mind. If this holds true, there are languages where this preference is overridden due to various factors, prosodic structure being one of them (Fodor 2002).

Summarizing our findings, we argue for the similarity in processing mechanisms in L1 and Ln in general. We also consider the existence of an integrated parsing mechanism that governs multilingual processing across languages. This multilingual parser is sensitive to the constraints posed by individual grammars and uses all types of information to adjust sentence parsing online.

5. Conclusions

Our study addresses several questions in the field of multilingual processing and makes a step towards a better understanding of how a multilingual mind operates several languages at the same time. We demonstrate that native and non-native processing rely on similar parsing mechanisms in general. The multilingual parser is sensitive to structural and non-structural information during sentence processing and adjusts the parsing accordingly.

In this study, we compared the data from two experimental modes, processing for comprehension (self-paced reading) and processing for production (written translation). The correlation between these two modes of language processing has not been investigated extensively so far, and this gap needs bridging.

Our results in the translation task speak against transfer-based RC parsing (Rah 2010; Rothman 2010). There is an overall preference for LA in Tatar, and it does not matter whether the translation is from Russian or English. Most likely, the human mind does not capture the preferred parsing in language A and transfers it over to language B, but rather, it generates a brand-new parsing within the limits of grammatical options in both languages. These findings prompt a new question: How does coordination between two individual grammars (languages) happen? This question deserves special study. However, our tentative assumption would be that there is a unified parsing mechanism that 'knows'

the range of possible parsings in I-language and assigns the most suitable one when the parsing is performed in a given language.

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