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ORIGINAL ARTICLE

The real-time processing of morphological case by German L1 speakers in Norway: A case of attrition?

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Abstract
The present study compares the use of morphological case for argument interpretation between German L1 speakers in Norway and Germany to investigate whether and how processing may be affected by attrition. Participants were presented with a spoken sentence and pictures of two scenes, one showing an event as described by a transitive or ditransitive sentence and another showing the same event, with the roles of agent and patient (transitives) or recipient and theme (ditransitives) reversed. Their task was to select the scene that matched the sentence. End-of-sentence responses show no between-group differences in comprehension. Moreover, eye movements show that both groups exploit case marking on the first noun phrase in transitive sentences in the same way. However, differences in processing between groups emerge for the use of case marking on the first object following a ditransitive verb. While the home country group shows a higher likelihood of looks to the target after a dative-marked article than after an accusative-marked article prior to the second object, the reverse holds for the expat group, at least temporarily. Altogether, the results indicate subtle changes in the processing of alternating argument orders in ditransitive sentences in L1 German, potentially as a result of the bi-/multilingual experience.

Keywords: L1 attrition; listening comprehension; morphological case; sentence processing

Introduction

What happens to the first language (L1) of a person when they live abroad? Can the language(s) spoken in the new country, as well as reduced exposure to the L1, influence the processing of the L1? In the following, we address these questions in a brief literature review before we report the results from our eye-tracking study, in which we contrasted the processing of transitive and ditransitive sentences in German between L1 speakers in Germany and L1 speakers residing abroad. More

specifically, we examined speakers' real-time processing of morphological case. The present study provides new insights into effects of bi-/multilingual experience on L1 processing and adds to the existing knowledge of potential L1 attrition.

L1 attrition

Traditionally, the term "attrition" defines the non-pathological loss of an individual's previously acquired language skills (Köpke & Schmid, 2004, p. 5). L1 attrition has been observed and described in the literature in the context of contact with a second language (L2 input), often together with an increasing proficiency in that language, and reduced exposure/usage of the L1 (e.g., Hicks & Domínguez, 2020; Schmid & Köpke, 2017; Steinhauer & Kasparian, 2020). Immigration to another country has been put forward as a common cause for L1 attrition. Throughout this paper, we consider all changes in the L1 of sequential bi-/multilinguals, be they the result of cross-linguistic influence or L1 disuse, as effects of attrition. This way, we follow Schmid and Köpke (2017), who view attrition as a continuum that sets in together with L2 development and, critically, who also consider differences in processing as an indication of attrition. Against the background of previous research showing an effect of age on the severity of L1 attrition (e.g., Bylund, 2009, 2019), we focus on late bi-/multilingual adults. In these individuals, changes to the L1 may be more subtle and are better explained by non-maturational factors. Since the present study is on real-time processing, we do not discuss studies that exclusively test for effects of attrition by means of acceptability/grammaticality judgment or sentence production tasks; for a systematic review and a meta-analysis focusing on behavioral measures, see Román and Gómez-Gómez (2022). To foreshadow the conclusion of the literature review, there is an indication of attrition at the level of processing, but there are open questions as regards the circumstances under which processing is affected.

Effects of attrition in real-time language processing

To investigate L1 attrition, researchers typically compare a group of L1 speakers in the country where the L1 is the societal language and a group of L1 speakers residing abroad. Alternatively, researchers may compare more long-term expats with a group of L1 speakers who have only recently arrived in the same country. Group differences may then be taken as effects of attrition. For example, Kasparian et al. (2017) compared Italian L1 speakers in Italy to Italian L1 speakers residing in Canada on the processing of number (mis)matches in Italian by recording event-related potentials (ERP). The comparison revealed between-group differences in amplitude, scalp distribution, and duration of ERP responses, which Kasparian and colleagues interpreted as effects of attrition in the expat group.[1] In another ERP study by Kasparian and Steinhauer (2016) investigating the processing of lexical-semantic violations, a group of Italian L1 speakers in Canada showed enhanced P600 responses relative to the control group in the home country. The authors took this as an indication of increased conflict monitoring in the expat group due to their specific linguistic experience.

Even though the L1 groups in Kasparian and Steinhauer (2016) showed subtle differences in processing, they did not differ in their acceptability judgments for

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the same sentences. This finding is in line with Chamorro et al. (2016a), who, in an eye-tracking during reading experiment, investigated the processing of null and overt pronouns in Spanish. The authors compared L1 speakers who had only recently arrived in the UK (control group) and speakers who had resided in the UK for a minimum of five years. The latter were further divided into two groups, with one re-exposed to Spanish prior to testing during a stay in the home country. The long-term expats with no recent re-exposure to Spanish showed no online sensitivity to infelicitous pronouns (i.e., a null pronoun referring to an object antecedent and an overt pronoun referring to a subject antecedent), unlike the control group and the re-exposed group. The group differences were detectable only in the eye-tracking data, not in the judgment task, where all groups were equally sensitive to infelicitous pronouns. The findings indicate that attrition may affect processing but not knowledge representations, and that this can be overcome by re-exposure.

Findings from Ito and Sakai (2021) underline the subtlety of attrition effects. In a visual-word eye-tracking study, they tested the prediction of an upcoming noun after a semantically constraining sentence context in a group of L1 speakers of Japanese in Tokyo and compared their results to those of a group of Japanese L1 speakers living in Berlin.[2] The two groups were presented with a four-object display and listened to a sentence in one of four experimental conditions. Both groups were found to predict the target noun. However, the Berlin group showed fewer target fixations than the Tokyo group, indicating that they were less certain in their prediction. Moreover, only the Tokyo group showed an effect of prediction in the orthographic condition, in which the critical object in the display corresponded to a noun that overlapped orthographically with the target noun, indicating that the Tokyo group, but not the Berlin group, had pre-activated the target noun's orthographic form. The results from this study suggest that regular exposure to other languages had an impact on L1 processing (Ito & Sakai, 2021, p. 11), here on the prediction of an upcoming noun.

One factor that may promote L1 attrition is competition between L1 and L2 (Steinhauer & Kasparian, 2020). However, studies that systematically investigate the role of cross-linguistic differences show mixed results. In an eye-tracking during reading study, Dussias and Sagarra (2007) studied relative clause attachment in Spanish and found that, with increasing immersion in the L2 environment, late L1 Spanish-L2 English speakers shifted from the Spanish high-attachment pattern to the English low-attachment pattern when reading Spanish sentences in which a relative clause could either be attached to the first or second noun of a complex NP. Thus, the results indicate L2-to-L1 influence. Similarly, a study by Kasparian and Steinhauer (2017) not only showed a difference in ERP responses between an L1 Italian control group and a group of Italian expats, but the expats also rated grammatical relative clause constructions in Italian that happened to be ungrammatical in English when translated word-by-word as less acceptable than the controls. The authors found that ERP responses and acceptability judgments in the expat group were furthermore influenced by the length of immersion, but also the amount of L1 exposure and L2 proficiency.

On the other hand, no L2-to-L1 influence was observed in a visual-world eye-tracking study by Grüter and Hopp (2021), who investigated the processing of

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structurally ambiguous *wh*-questions in German in four groups of late bilinguals: German L1-English L2 speakers and English L1-German L2 speakers in Germany and the US. The structures under investigation are frequently used in German and have word order equivalents in English, but they differ in their interpretation. For example, while a *wh*-question in the perfect tense in English (e.g., *What has the kangaroo licked?*) can only be interpreted as an object question, it can be a subject or object question in German (in cases where there is no overt case marking information). The results showed an influence from the L1 for the L2 German speakers in the US and in Germany, but no effect vice versa and no modulation by length of immersion in the L1 groups. Both L2 groups displayed differences in their interpretative biases between present-tense and perfect-tense questions. Grüter and Hopp take their findings as evidence for an important role of order of acquisition and explain the divergent findings from previous studies through frequency differences. In comparison, the structures that elicited group differences in Dussias and Sagarra (2007) and Kasparian and Steinhauer (2017) were infrequent and syntactically complex. Hence, additional factors that influence whether L1 processing undergoes attrition may be the frequency of a construction in the L1 and the syntactic complexity of the construction under investigation.

Another study that did not find evidence for effects of attrition is Chamorro et al. (2016b). In an eye-tracking during reading study, the authors found no differences in the processing of the presence/absence of differential object marking in Spanish when comparing the same group of L1 speakers of Spanish as in Chamorro et al. (2016a) described above, that is, short-term and long-term expats, as well as re-exposed long-term expats. All groups were equally sensitive to the differential object marking violations (i.e., when the preposition *a* preceded an inanimate direct object and when it did not precede an animate direct object). The authors speculate that L1 attrition further depends on the linguistic domain or interface between domains.

In sum, the findings from the reviewed studies show that effects of attrition, when observed, tend to be subtle and are probably not permanent (Chamorro et al., 2016a). Moreover, studies that have combined online and offline measures show that processing but not knowledge representations can be affected (Chamorro et al., 2016a; Kasparian & Steinhauer, 2016), which highlights the importance of online measures for the investigation of L1 attrition. Chamorro et al. (2016a, 2016b) mention the possibility that phenomena at the syntax-pragmatics interface are more susceptible to attrition than phenomena at the syntax-semantics interface (e.g., differential object marking). However, current research, especially on processing, is limited. Furthermore, Grüter and Hopp (2021) mention as potential factors the frequency of a construction in the L1 and syntactic complexity. L1 attrition may also be promoted by competition between the L1 and L2 in case of cross-linguistic differences (Steinhauer & Kasparian, 2020). In the next section, we focus on the property under investigation in the present study, morphological case marking on noun phrases (NPs), and its mapping to grammatical and semantic roles.

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Morphological case marking

The present study investigates the exploitation of case marking for incremental argument interpretation in German. German discriminates between four cases that are marked on pre-nominal articles: nominative (NOM), accusative (ACC), dative (DAT), and genitive (GEN). The first three cases will be of relevance for our investigation. As it has been argued that L1 attrition may proceed as a reverse acquisition process (e.g., Jordens et al., 1989), we briefly outline the acquisition of case before describing the importance of case for the processing of sentences in German and the processing of case in bi-/multilinguals more generally.

In L1 acquisition, German-speaking children have been shown to first produce NPs without morphological marking, before they proceed to a stage where they produce both NPs and pronouns with the default NOM case. When they start to produce DAT and ACC, frequent errors consist of ACC use in DAT contexts (Clahsen, 1984). An experimental investigation on the production of case markers in monolingual and sequential bilingual children found that even monolingual German-speaking children between the ages of 2;4 and 5;0 had an error rate of almost 50% for the structural dative (Schönenberger et al., 2012), that is, when DAT marks the indirect object, as in example (1). In contrast, performance for ACC to mark the direct object was much better.

(1)	*Ich*	*gebe*	*der*	*Maus*	*den*	*Ball.*
	I	give	the-DAT	mouse	the-ACC	ball.

Under the assumption that L1 attrition proceeds in reverse acquisition order, one may assume later acquired cases, such as DAT, to be more prone to attrition than NOM and ACC (see section 'Predictions').

In her work on German Jews who migrated to the US at different stages during the Nazi regime, Schmid (2002) found incorrect uses of case for all four German cases in her interview data, although the error rate was very low. Case errors mostly occurred in the group of immigrants who left Germany after the pogrom on November 9th, 1938, and who were presumably most traumatized. For this group, there was a slight tendency towards an overuse of NOM and ACC. The following observations for Heritage German seem to support an increased susceptibility to change for case morphology and differences between cases, here across generations though: Yager et al., (2015) report a reduction in morphological case, especially loss of DAT marking. Boas (2009) observed a trend towards a two-case system, including NOM and ACC, while Yager et al., (2015) attested the development of new structures replacing case marking, such as differential object marking. However, note that none of the above studies investigated the comprehension of case. The present study contributes to filling this gap by testing comprehension in first-generation expats.

Because of morphological case marking, German allows for a relatively free word order. The processing of German sentences with varying word orders has been extensively studied, including ERP and visual-world eye-tracking experiments (e.g., Bornkessel et al., 2002; Dröge et al., 2016; Hopp, 2015; Kamide et al., 2003;

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Matzke et al., 2002; Özge et al., 2022; Rösler et al., 1998; Schipke et al., 2012; Schlenter & Felser, 2021; Schlesewsky et al., 2003). In sentence (2b) from a study by Hopp (2015, p. 287), ACC marking on NP1 indicates that it is the object and patient and that the subject/agent is yet to come. Eye-tracking studies show that L1 speakers use this early morphosyntactic cue to anticipate a plausible agent (e.g., Kamide et al., 2003; Hopp, 2015; Özge et al., 2022).

(2) a. *Der* *Wolf* *tötet* *gleich* *den* *Hirsch*
The-NOM wolf kills soon the-ACC deer
"The wolf will soon kill the deer."

b. *Den* *Wolf* *tötet* *gleich* *der* *Jäger*
The-ACC wolf kills soon the-NOM hunter
"The hunter will soon kill the wolf."

Moreover, Schlenter and Felser (2021) showed that German speakers also exploit DAT and ACC marking on the first object following a ditransitive verb to predict the semantic role of the final argument.

In Schlenter and Westergaard (2024), we investigated German L1 speakers' exploitation of case marking while processing transitive and ditransitive sentences, similar to the ones tested by Hopp (2015) and Schlenter and Felser (2021). In a picture-selection task with concurrent eye-movement recording, participants were presented with two scenes, one showing the target event (e.g., prince defeating dragon) and one showing the same event with role reversal (e.g., dragon defeating prince). Critically, unlike in the previous studies, the described actions were fully reversible (e.g., the prince/dragon defeats the dragon/prince), and animacy and world knowledge provided no additional cues to argument interpretation. Moreover, we controlled for the perceptual salience of case by including as many nouns with the simple marking of ACC case (e.g., *den Vampir* "the-ACC vampire") in object-initial position as nouns with the double marking of ACC (e.g., *den Prinz-en* "the-ACC prince-ACC").[3] For the ditransitive sentences, we systematically varied the order of masculine and feminine NP after the verb, as shown in example (3). By doing so, we also manipulated the perceptibility of the case cue: While the difference between DAT and ACC for masculine nouns corresponds to the subtle difference between *dem* and *den,* for feminine nouns it is *der* and *die*. Note that all ditransitive sentences started with the subject/agent, so the nominative could be ruled out at the time the first postverbal argument was encountered. Moreover, as participants were presented with visual scenes, the event characters' gender provided an additional cue (Bürsgens et al., 2021).

(3) *Der Krankenpfleger bringt* . . . — "The nurse brings . . ."

a. *dem* *Patienten* *morgens* *die* *Ärztin*
the-DAT patient in the morning the-ACC doctor
"In the morning, the nurse brings the doctor to the patient."

b. *den* *Patienten* *morgens* *der* *Ärztin*
the-ACC patient in the morning the-DAT doctor
"In the morning, the nurse brings the patient to the doctor."

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c. *der* *Ärztin* *morgens* *den* *Patienten*
the-DAT doctor in the morning the-ACC patient
"In the morning, the nurse brings the patient to the doctor."

d. *die* *Ärztin* *morgens* *dem* *Patienten*
the-ACC doctor in the morning the-DAT patient
"In the morning, the nurse brings the doctor to the patient."

In short, the eye-tracking data showed that German L1 speakers used the first case cue that enabled them to interpret the unfolding sentence to preferentially fixate the target scene for both transitive and ditransitive structures, but also that the immediate exploitation of case depended on the perceptibility of the case cue. This was most clearly seen for the ditransitive sentences. When the first postverbal argument was a masculine NP and marked as ACC (i.e. *den*), see (3b), no clear preference emerged prior to the final argument, unlike for the other conditions (see Figures S.1 and S.2 in the Supplementary Materials). Moreover, we obtained more incorrect responses and longer response times for this condition relative to others. In the present study, we use a similar experimental design and a subset of the materials from this study to test bi-/multilingual speakers' processing of morphological case.

While research on adult L1 processing, as exemplified for German above, has shown a reliance on case for incremental argument interpretation, its use in bi-/multilingual speakers has been shown to vary. Some studies report differences between L1 and L2 processing for the predictive use of case (Frenck-Mestre et al., 2019; Hopp, 2015; Mitsugi & MacWhinney, 2016; Mitsugi, 2017; but see Schlenter & Felser, 2021). Cross-linguistic differences between the L2 and the learners' L1 are one possible explanation as to why L1 and L2 processing may differ. For example, for transitive sentences in German such as (2) above, Hopp (2015) found that English L1 speakers predicted a plausible patient (*deer*) irrespective of word order. Unlike the German L1 group, the L2 group relied more on the linear word order and lexical-semantic information provided by the verb, which leads to an incorrect sentence interpretation for the object-verb-subject (OVS) order, at least temporarily. Unlike in German, there is no morphological case on full NPs in English, where word order is a strong cue to argument interpretation (e.g., MacWhinney et al., 1984). Evidence for L1 influence has most clearly been shown by Frenck-Mestre et al., (2019), who contrasted the processing of case in Korean in two learner groups, one with Kazakh and one with French as L1. The processing pattern of the Kazakh L1 group more closely aligned with the pattern of the Korean L1 (control) group than that of the French L1 group. Unlike Korean and Kazakh, French does not mark case on full NPs and has a less flexible word order than both Korean and Kazakh. The L2 processing results reported here may be explained by cross-linguistic differences in cue weighting along the lines of the Competition Model; see e.g., Meir et al., (2024), who do so for the processing of case marking in Russian-Hebrew bilingual children. Critically, effects of attrition may also be explained by the Competition Model, with L1 maintenance being affected by cue availability and reliability in the different languages of a bi-/multilingual (MacWhinney, 2019).

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The processing of case morphology has further been shown to vary among heritage speakers, that is, bilingual speakers who acquire a language at home that does not correspond to the societal language. Using a similar design as Hopp (2015), Karaca et al., (2023) showed that adult heritage speakers of Turkish in the Netherlands predicted an upcoming argument for verb-medial but not for verb-final sentences, while a control group in Turkey did so for both. The heritage speakers seemed to require additive cues, that is, case and verb semantics. While the present study was under way, Grüter and Roos (2024) conducted a visual-world eye-tracking study with Japanese L1 speakers in the US. The study also tested the predictive use of case, here to predict a ditransitive structure (or not). The results revealed that the length of residence influenced looks to a potential theme argument, with long-term expats ($\geq$ 10 years abroad) showing no predictive use of DAT case.

To conclude this section, L1 speakers of case-marking languages have been shown to exploit case cues to anticipate the semantic role of an upcoming argument. In contrast, the predictive use of case in adult L2 and heritage language processing seems more limited. There is indication that L1 speakers who have lived abroad for a long period of time also show a limited use of case in real-time processing. For L2 processing, there is indication of cross-linguistic influence. L2 speakers whose L1 marks case seem to show positive cross-linguistic influence, while the absence of case (and flexible word order) seems to hinder the processing of a case-marking language. Altogether, the reviewed studies suggest that the recognition of case (and subsequent syntax-semantic mapping) is easily affected in bi-/multilingual processing and thus provides an ideal testing ground for the present investigation of L1 attrition.

Argument order in English and Norwegian in comparison to German

Since our study includes multilingual speakers with German as L1 who moved to Norway in adulthood and who speak Norwegian and English as L2, in this section, we describe how arguments can be ordered in English and Norwegian, the two most relevant L2s in our study. As mentioned above, effects of attrition may be caused by cross-linguistic differences. One notable difference between the languages of our multilinguals is the presence of morphological case. Unlike German, both English and Norwegian only discriminate between subject and object case in the pronominal system. Moreover, as suggested by Grüter and Hopp (2021), the frequency of a construction may also influence whether bi-/multilinguals experience attrition. What all languages of our multilinguals have in common is that the predominant surface word order in main clauses is SVO. However, the languages differ in terms of word order alternates and their frequencies.

Although OVS is a viable option in German, object-initial orders are rather infrequent (Bader & Häussler, 2010) and, even when ACC case is unambiguously marked, have been associated with processing costs (e.g., Bornkessel et al., 2002; Schipke et al., 2012). In Norwegian, OVS is not ungrammatical, but highly constrained by referent animacy and definiteness (Øvrelid, 2004). Because of the lack of case marking, a sentence such as (4b) is structurally ambiguous in Norwegian.[4] Also in English, it is possible to topicalize the object, but then it will be followed by the subject, not the verb.

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(4) a. *Dragen* *beseirer* *prinsen.*
dragon-DEF defeat prince-DEF
"The dragon defeats the prince."
b. *Prinsen* *beseirer* *dragen.*
prince-DEF defeat dragon-DEF
"The prince, the dragon defeats."

As was shown in example (3), both orders of IO/recipient and DO/theme are possible word orders in a German double-object construction. The order IO-DO is overall more frequent, but not necessarily so when both objects are animate (Häussler & Bader, 2012). However, an acceptability judgment task conducted by Schlenter and Westergaard (2024) with the stimulus sentences used in the present study showed that German speakers still preferred the order IO-DO over DO-IO when all referents in the sentence were animate. In English (5a) and Norwegian (6a), there is only one order in a double-object construction, which is the order IO-DO (i.e. recipient first). Alternatively, speakers of English and Norwegian can use a prepositional object (PO) construction (5b/6b), in which the recipient appears sentence-finally following a preposition (which is also possible in German). This is commonly known as the dative alternation.

(5) a. The nurse brings the doctor the patient.
b. The nurse brings the patient to the doctor.

(6) a. *Sykepleieren* *bringer* *legen* *pasienten*
Nurse-DEF bring doctor-DEF patient-DEF
"The nurse brings the patient to the doctor."
b. *Sykepleieren* *bringer* *pasienten* *til* *legen*
Nurse-DEF bring patient-DEF to doctor-DEF
"The nurse brings the patient to the doctor."

Without any further cues (e.g., animacy), it is only towards the end of the sentence—when listeners encounter the preposition—that they know for sure who is the recipient and who is the theme. The verb may provide some indication of which structure will follow. In German, on the other hand, the verb is not a strong cue. Whether English uses a double-object or a PO construction is strongly verb-dependent (e.g., Şafak & Hopp, 2023), though not entirely (e.g., Bresnan et al., 2007). The PO construction has been said to be less frequent than the double-object construction in American English (e.g., Jaeger & Snider, 2013; but see Flett et al., 2013, for contrary claims for British English). For Norwegian, PO has been said to be the default structure (Anderssen et al., 2014).

The present study

The present study investigates the use of morphological case for argument interpretation in German by native speakers who have permanently moved abroad after they had fully acquired their L1. All speakers were tested in the same place in the Arctic region of Norway, which is home to many researchers and students from

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all over the world. At the time of testing, all participants included in the present study were regularly exposed to English and/or Norwegian, that is, to languages that lack morphological case marking on NPs. Since we lack an additional group of German L1 speakers in a country where the societal language has morphological case on NPs, any conclusions regarding cross-linguistic influence must remain tentative. Our study primarily addresses the questions of whether and how long-term shortage of exposure to German and the bi-/multilingual experience affect L1 sentence processing. Since we slightly changed the experimental design from a previous study with German L1 speakers in Germany (Schlenter & Westergaard, 2024) to the present one, a new control group was tested, using the same design that was employed to test the German L1 speakers in Norway.

Predictions

Transitive sentences

For the home country group, we expect to find a preference for the target over the competitor scene prior to NP2 onset. We may find that the preference develops earlier for the prototypical order SVO as compared to OVS, due to a general preference to interpret the NP1 as subject/agent. If reduced exposure to the L1 and corresponding increased exposure to one's L2(s) negatively affect L1 processing, then we expect our expat group to differ from the home country group. Concretely, we expect a difference in the time course of target scene identification for OVS, that is, when linear order and case marking information are in conflict. According to Grüter and Hopp (2021), infrequent and syntactically more complex structures may be more susceptible to attrition than frequent structures, and OVS is a non-prototypical and infrequent order in German (possible but highly constrained and ambiguous in Norwegian, no option in English). In order to immediately assign semantic roles to the arguments of the verb for OVS, listeners must use ACC marking on NP1. If case becomes a less reliable cue, then the expats should show no, a weaker, or a delayed effect of prediction for OVS relative to the home country group. That is, due to the low frequency of OVS and/or changes in cue strength, we expect a difference between groups for OVS. In contrast, we expect to find an effect of prediction for the SVO order for both groups alike.

In addition to effects of group in the eye-tracking data, we may also find differences in the behavioral data, that is, better performance and faster response times for OVS in the home country group relative to the expat group. In both groups, we expect to find longer response times for OVS relative to SVO and, potentially, lower accuracy, in line with our previous study (Schlenter & Westergaard, 2024).

Ditransitive sentences

For the home country group, we expect to find a preference for the target over the competitor scene prior to the onset of the second object, as they should use case, DAT and ACC, on the first postverbal object for incremental argument interpretation. Based on previous results for a smaller subset of ditransitives (Schlenter & Westergaard, 2024), we expect to find no differences between IO-DO

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and DO-IO when the first postverbal argument is a feminine NP and DAT and ACC are marked by *der* and *die,* respectively. For the expat group, several outcomes are possible: First, the expats may develop a stronger expectation for the "default" order IO-DO (recipient > theme), which is overall more frequent and more preferred in comparison to DO-IO in a German double-object construction (e.g., Häussler & Bader, 2012; Schlenter & Westergaard, 2024). If so, they should show an earlier increase in target fixations for the order IO-DO as compared to DO-IO. Moreover, there should be a difference between groups, at least for the DO-IO order. Alternatively, the expats may adhere to the frequency pattern of their L2s English and Norwegian, where the PO construction and thus the order DO-IO is more commonly used (e.g., Anderssen et al., 2014; Bresnan et al., 2007). We return to this possibility in more detail in the discussion section. Second, the expat group may wait for the final argument before committing to a sentence interpretation, as, in both English and Norwegian, it only becomes clear toward the end of the sentence which object is the recipient and which is the theme. In German, DAT and ACC signal whether the first postverbal argument corresponds to the recipient or theme, but if case becomes a less reliable cue for the expats, they may assign less weight to it. Following the regression hypothesis (Jordens et al., 1989), this might be particularly true for DAT case. If so, the expat group should show no or a reduced preference for the target scene prior to the second object as compared to the home country group, for both DAT and ACC or for DAT only. That is, there should be a difference between groups, either for both orders or for IO-DO.

As regards end-of-sentence responses and response times, participants in both groups (or only the control group) may be faster and more accurate for the more prototypical order IO-DO than for DO-IO. Less sensitivity to case in the expat as compared to the home country group may result in an effect of group or interaction with group for response times and, potentially, accuracy.

Methods

The materials, data, and scripts of this study are openly available on the Open Science Framework (OSF) under https://osf.io/j42p5/. Prior to data collection, we pre-registered this study (for the expat group only) on OSF under https://osf.io/m2sfj. Any changes are described in the following.

Participants

Expat group: A total of 37 expats participated in the study. Out of these, three participants had to be excluded, one because of a reported language disorder, one because of the regular use of other case-marking languages, and one who was not born in a German-speaking country and spent the initial years of life abroad. One participant was excluded because of problems with the eye-movement recording. The 33 remaining participants were all born in Germany, Austria, or Switzerland, and German was their only language during the first years of life (mean age: 40 years, range: 25–63 years; 22 female, 11 male). For 27 participants, English was the first L2; other first L2s were Russian (2), Latin (2), Spanish (1), and French (1). The mean age of acquisition (AoA) of the first L2 was 9 years (range: 3–13).[5] Throughout life, all participants learned several languages, of which Norwegian

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Table 1. Participant information

	Expat group		Home country group	
Exposure to ...	Mean (in %)	Range, SD (in %)	Mean (in %)	Range, SD (in %)
German	**24.5**	3–70, 14	**76.5**	50–95, 11
English	28.5	3–75, 21	17.8	3–40, 9.9
Norwegian	44.6	5–90, 21.5	5.7	0–30, 6.7
Other languages	2.4	0–16, 4		

was the third (10), fourth (12), fifth (10), or the seventh additional language (1). Except for two expats who arrived 8 and 11 months before testing in Norway, all had been living there for more than a year, 17 even for ten or more years (max. 21 years). Twenty-four participants had also lived in other (non-German-speaking) countries than Norway for more than three months. Except for two participants, all had been abroad for longer periods of time only after childhood.[6] At the time of testing, all of them reported use and exposure to German, English, and Norwegian; other languages comprised maximally 16%.

Home country group: A total of 37 German speakers were tested at the XLinC Lab Cologne. The data of one participant was accidentally overwritten. One participant was excluded because s/he seemed inattentive.[7] The 35 remaining participants were all born in Germany and German was their only language during the first years of life (mean age: 24 years, range: 19–37 years; 29 female, 5 male, 1 diverse). For 34 participants, English was the L2; for one person, it was French. The mean AoA of the first L2 was 7 years (range: 3–11). Twelve participants in the home country group reported to have lived abroad for more than three months, e.g., during an exchange. Importantly, all resided in Germany at the time of testing.

In Table 1, we present an overview of current language exposure per group, as reported in a background questionnaire, where participants had to indicate how often they are exposed to each of their languages in present-day life, adding up to 100%.

Design & Materials

Our materials comprise a transitive and a ditransitive set, which function as fillers for each other. The materials are taken from a previous study of the authors. Each set has 24 items that are distributed across two lists with a Latin Square design, so each participant encounters an item only in one of the two conditions (48 sentences in total). That is, each participant listens to 12 transitive sentences with SVO and 12 with OVS order, as well as to 12 ditransitive sentences with IO-DO and 12 with DO-IO order. Since there was no indication that the order of NPs affected sentence processing and interpretation, but perceptual salience of case marking might do so, we decided against the fully counterbalanced design of the previous study. Instead, we use one fixed order of NPs. For the ditransitive sentences, this is the order with a feminine NP following the verb, meaning that the difference between DAT and ACC corresponds to the difference between *der* and *die*. For the transitive sentences,

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		Critical window		TARGET	COMPETITOR
SVO	*Der Gitarrist* The-NOM guitarist	*schlägt plötzlich* hits suddenly	*den Sänger* the-ACC singer		
OVS	*Den Gitarristen* The-ACC guitarist-ACC		*der Sänger* the-NOM singer		
Der Sekretär bringt … The-NOM secretary brings …					
IO-DO	*der* the-DAT	*Ministerin eilig* minister quickly	den General the-ACC general		
DO-IO	*die* the-ACC		dem General the-DAT general		

Figure 1. Example of an item for the transitive (top) and the ditransitive set (bottom). The critical window for the eye-tracking analyses is shaded in blue. The rightmost columns show the respective target and competitor scenes.

we increased the number of OVS sentences with double marking of ACC, so that two-thirds of OVS sentences marked ACC on the article as well as the noun.

The sentences were spoken by a female native speaker of German with an average speech rate of 4.32 syllables per second. The critical window for a prediction effect, as indicated by the shadings in Figure 1, is cross-spliced, so it is identical between conditions. Note that the recordings are the same as in the previous study, with the only difference being that only a subset is used in the present one. The critical window for the transitive set includes the verb and adverb segment with a mean length of 962 milliseconds (msec). The critical window for the ditransitive set includes the noun of the first object (here always feminine) plus the adverb (mean length 1111 msec).

All our sentences include animate subjects and objects. Thus, animacy provides no additional cue towards the semantic role of an argument. For the transitive set, we used 12 transitive verbs that could be easily depicted and that clearly identified one event character as agent and another as patient, such as *besiegen* ("defeat") or *ziehen* ("pull"). Each verb appears twice, each time with different characters. For the ditransitive set, we used the same six verbs four times (*bringen* "bring," *holen* "take/fetch," *überlassen* "leave to," *übergeben* "give/surrender," *zeigen* "show," and *empfehlen* "recommend"), as there is a limited number of ditransitive verbs that sound natural with two animate objects. As determined by Şafak (2022) and Chen et al. (2023), five of these verbs have a non-alternating (*recommend*) or alternating PO-bias (*bring, give, take, leave*), and one has an alternating double-object-bias (*show*) in English. We lack information for the Norwegian translation equivalents. As in the transitive set, every time a verb is repeated, it appears together with a new character combination. Event characters are either human beings, fictional characters, or animals, and should be easy to identify because of their stereotypical features (e.g., a crown for the prince).

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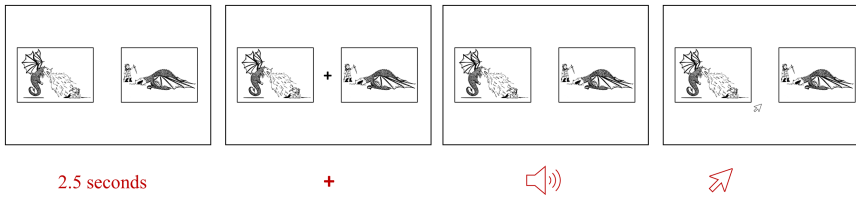

Figure 2. Procedure in the eye-tracking experiment.

The sentences appear together with two scenes, one showing the target event and another the same event with role reversal, as illustrated in Figure 1.[8] For the transitive set, the role of agent and patient is reversed. For the ditransitive set, the role of recipient and theme is reversed, while the agent remains the same. There is a total of 96 scenes. The position of target and competitor scenes, left or right, is counterbalanced.

Procedure

At the beginning of each experimental session, we obtained informed written consent from the participants. By means of an ocular dominance test, the experimenter determined the participant's dominant eye for the eye-movement recording. After completion of the eye-tracking experiment, the participants filled in a background questionnaire. The experimental session ended with a short debriefing and lasted altogether about 45 minutes (expats) or 30 minutes (home country group). Participants in Norway received a 200-NOK gift card. Participants in Germany received 6 EUR or course credit for their participation.

In Norway, we used an EyeLink Portable Duo without a chin rest. Participants were seated in front of the display laptop (15.6″ Full HD, 1920 x 1080 resolution, 144 Hz) to which the camera was attached. The procedure was the same as for the group in Germany, except that after the questionnaire, the expats continued with a mouse-tracking experiment, which included the same materials as the eye-tracking experiment, but which we have chosen not to report on in this article.[9] For the eye-tracking experiment in Germany, we used an EyeLink 1000 Plus with the monitor positioned on a flexible arm with the camera and illuminator mounted beneath. Participants were seated in front of the monitor (17″ LCD, 1280 x 1024 resolution, 60 Hz) without a chin rest. Instructions on the screen told participants to click on the scene that was described by the sentence. The camera setup included a 5-point calibration and validation, and if calibration/validation was successful, the experimenter started the recording (500 Hz sampling rate). Figure 2 shows an example trial. First, participants were given a preview of the two scenes for a duration of 2.5 seconds. Then, a fixation cross appeared, which the participants had to fixate on for 500 consecutive msec. If they did not fixate on the cross, the experiment went back to the camera setup, and the aborted trial would be resumed. As soon as participants accurately fixated on the cross, it disappeared, and the audio was played. A trial ended when the participant selected one of the scenes via mouse click. By clicking on a start button, participants proceeded to the next trial. Trials appeared in a pseudo-randomized order with no more than two items with the same argument order being presented in succession. Each recording started with four practice trials.

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Table 2. Target scene selection per group and argument order

Transitive set				
Group	Order	Total correct	% correct	Range, SD (in %)
Expat group	SVO	389/396	98	83–100, 4
Expat group	OVS	383/396	97	75–100, 6.2
Home country group	SVO	407/420	97	83–100, 4.5
Home country group	OVS	409/420	97	75–100, 6
Ditransitive set				
Group	Order	Total correct	% correct	Range, SD (in %)
Expat group	IO-DO	362/396	91	58–100, 9.2
Expat group	DO-IO	317/396	80	33–100, 16
Home country group	IO-DO	393/420	94	75–100, 7.9
Home country group	DO-IO	341/420	81	50–100, 12.8

Results

Accuracy

First, we analyzed whether participants' accuracy, that is, the selection of the target (coded as 1) versus the competitor scene (coded as 0), was influenced by argument order and group. In our pre-registration, we set an error rate of > 20% for SVO as an exclusion criterion, as this would indicate that participants did not pay attention or did not understand the task. None of the participants had more than two incorrect responses for the SVO order. The participants' accuracy for the transitive set was almost at ceiling, while the accuracy for the ditransitive set was considerably more variable, as shown in Table 2.[10]

The statistical analyses were conducted in R (R Core Team, 2024, version 4.4.2), with the packages *lmerTest* (Kuznetsova et al., 2017, version 3.1–3) and *lme4* (Bates et al., 2015, version 1.1–35.3). We fitted generalized linear mixed-effects regression (*glmer*) models to predict accuracy with argument order and group for each set. Argument order was treatment-coded with the prototypical order as the reference level, that is, SVO for the transitive set and IO-DO for the ditransitive set. Deviation coding was applied to the factor group (Home country group: 0.5, Expat group: –0.5). We started with the maximal random-effects structure justified by the design (Barr, 2013). If the maximal model failed to converge, we removed random slopes for the fixed effects and reported the output of the model with the lower value for the Akaike information criterion.

Transitive set

The best-fitting converging model for the transitive set included only random intercepts for subject and item. The model's intercept is at 4.33 on the logit scale ($SE = 0.4$, $z = 10.95$, $p < 0.001$) and shows above-chance performance for SVO order. The effect of argument order is non-significant (*Est.* = –0.24, $SE = 0.32$,

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Table 3. Likelihood of target scene selection for the ditransitive set

Fixed effects	Est. [95% CI]	*SE*	*z*	*p*
(Intercept)	3.23 [2.61, 3.85]	0.31	10.27	<.001
argument_orderDO-IO	−0.98 [−1.94, −0.01]	0.49	−1.98	0.05
group	0.34 [−0.37, 1.06]	0.37	0.94	0.35
argument_orderDO-IO:group	−0.24 [−0.95, 0.47]	0.36	−0.67	0.51

$z = -0.74$, $p = 0.46$) as is the effect of group (*Est.* = −0.6, $SE = 0.53$, $z = -1.14$, $p = 0.25$) and interaction effect (*Est.* = 0.84, $SE = 0.64$, $z = 1.30$, $p = 0.19$). Thus, participants across groups were equally likely to select the target scene for OVS as for SVO.

Ditransitive set

The best-fitting converging model for the ditransitive set included random intercepts for subject and item and argument order as by-item slope. The output of the model is shown in Table 3. The model's intercept shows above-chance performance for the IO-DO order across groups and a significant difference between orders, as indicated by the effect of argument order. No other effects become significant.

The results for the ditransitive set show that participants across groups were less accurate in selecting the target scene for DO-IO order than for the more prototypical IO-DO order.

Response times

Response times (RTs) were measured from the offset of the case cue that should enable identification of the target scene. For the transitive set, this is the offset of NP1, and for the ditransitive set, the offset of the article of the first object. Only RTs for correctly answered trials are included in the analyses. We excluded one participant from the expat group from the RT analyses because s/he had to use the non-preferred hand for medical reasons. There were no RTs below 200 msec, which would not reflect successful processing of the linguistic information. For the statistical analysis, RTs were log-transformed to approach a normal distribution. The same coding scheme and model selection criteria as for the accuracy data were used.

Transitive set

A linear mixed-effects model for the transitive set that included random intercepts for subject and item as well as argument order as by-item slope revealed a significant effect of argument order (*Est.* = 0.08, $SE = 0.02$, $t = 4.42$, $p < 0.001$), indicating that participants across groups were slower in responding to OVS relative to SVO. There was a significant effect of group (*Est.* = 0.13, $SE = 0.07$, $t = 2.01$, $p = 0.05$) due to an overall tendency of faster response times in the expat relative to the home country group. The interaction effect was not significant (*Est.* = 0.01, $SE = 0.03$,

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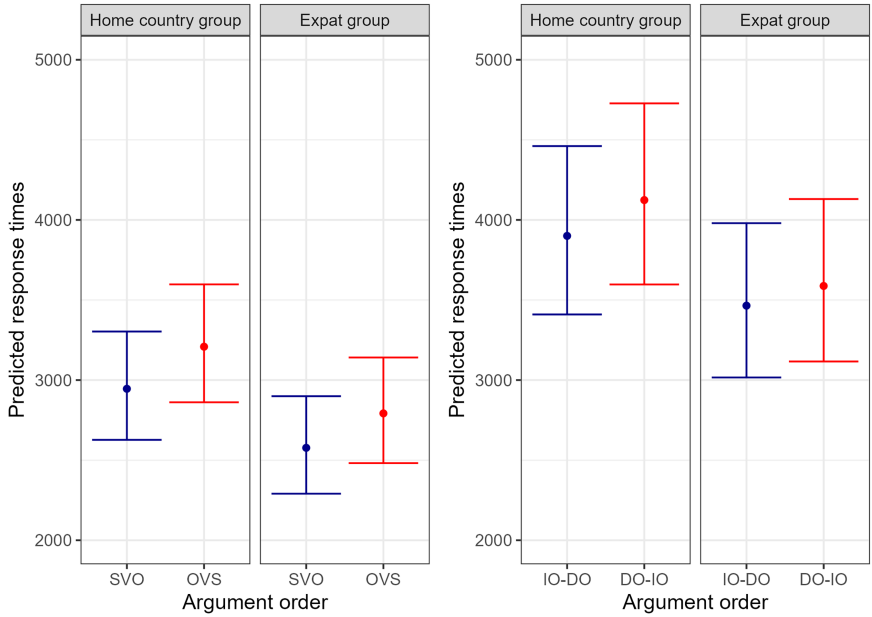

Figure 3. Predicted response times and 95% confidence intervals for the two argument orders in the transitive set (left panels) and the ditransitive set (right panels) depending on group. Orders that are more prototypical in German are shown in blue and non- or less prototypical orders in red.

$t = 0.19$, $p = 0.85$). In the left panels of Figure 3, we show the back-transformed values and 95% confidence intervals as predicted by the model.

Ditransitive set

A linear mixed-effects model for the ditransitive set that included random intercepts for subject and item as well as argument order as by-item slope showed a marginally significant effect of argument order (*Est.* $= 0.05$, *SE* $= 0.02$, $t = 1.94$, $p = 0.07$) with longer response times after DO-IO than IO-DO. There was no significant effect of group (*Est.* $= 0.12$, *SE* $= 0.08$, $t = 1.47$, $p = 0.14$) and no significant interaction effect (*Est.* $= 0.02$, *SE* $= 0.04$, $t = 0.57$, $p = 0.57$); see the right panels in Figure 3 for the predicted response times and 95% confidence intervals.

Eye movements

First, we loaded the eye-tracking data into DataViewer (SR Research) and exported the sample report for the down-sampled (50 Hz) data. Then, we loaded the sample report into R and excluded all rows with blinks and saccades. Next, we visualized the data. The time course graphs from sentence onset for all trials and all regions of interest, also including background looks, are found in Figures S.3–S.4 in the Supplementary Materials. Visual inspection suggests that participants in the home country were more likely than the expat group to fixate on the background/center of the screen throughout the trial. For the eye-tracking analyses, we focused on fixations on the target and competitor scenes. Moreover, as for the RT analyses

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before, we chose as a time window the earliest point when listeners could identify the target scene based on case marking information up to the point when critical information is encountered. This corresponds to the NP2 for the transitive sentences and the second object for the ditransitive sentences. We excluded all trials where participants selected the competitor scene. The rationale for this was that we were interested in knowing when listeners exploit case marking to identify the target scene, that is, prior to or after the critical information (but see below).

Originally, we set out to analyze the eye-tracking data by means of divergence point analyses (Stone et al., 2020) in order to determine whether a sustained target-over-competitor preference emerges prior to the critical information and whether there are differences between argument orders and groups. However, due to the distribution of the data with multiple clusters of divergence points, primarily in the home country group, and the following difficulty in determining unique confidence intervals, we followed a reviewer's suggestion and tested for differences between argument orders and groups by means of cluster-based permutation analyses (CPA) as described by Ito and Knoeferle (2023). For each 20-msec time bin within the critical time window for a set, we tested for significant effects of argument order and group as well as their interaction using permutation tests based on generalized linear mixed-effects models with by-subject and by-item random intercepts.[11] The test statistics for all time bins within a cluster were summed to generate the sum-statistics for that cluster. We employed 1000 permutations. Note that this way we can test for (i) significant differences between argument orders and (ii) significant differences between groups for an argument order, but the results do not provide us with the onset of an effect or show when looks to target and competitor significantly differ.

Transitive set

The length of the critical time window for the transitive set was 1160 msec, corresponding to the average length of the verb and adverb segment plus 200 msec to account for eye-movement latency (i.e., 58 time bins). A CPA conducted to test for effects of argument order and group, as well as their interaction, detected no significant clusters. The proportion of target scene fixations for each group and argument order condition is shown in Figure 4.

Ditransitive set

The length of the critical time window for the ditransitive set was 1320 msec, corresponding to the average length of the noun of object1 and adverb segment plus 200 msec to account for eye-movement latency (i.e., 66 time bins). A CPA conducted to test for effects of argument order and group, as well as their interaction, revealed a significant effect of argument order across groups. In the expat group, there were two significant clusters, one between 800 and 840 msec (*cluster-mass*: 18.2, $p = 0.007$) and one between 900 and 960 msec (*cluster-mass*: 21.4, $p = 0.004$), indicating a higher likelihood of target fixations for DO-IO than for IO-DO. This is shown by the black bars in Figure 5. In the home country group, there is one significant cluster between 1200 and 1300 msec (*cluster-mass*: 33.8, $p = 0.001$), indicating a higher likelihood of target fixations for IO-DO than for DO-IO, shown by the gray bar in Figure 5. In addition, the CPA revealed a

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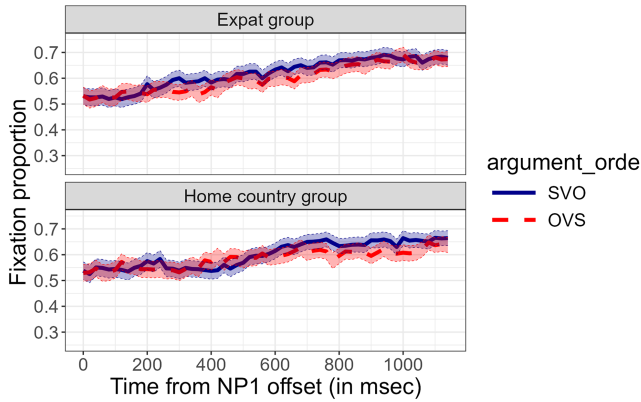

Figure 4. Fixations to the target during the critical time window in the transitive set for the expat group (top) and the home country group (bottom).

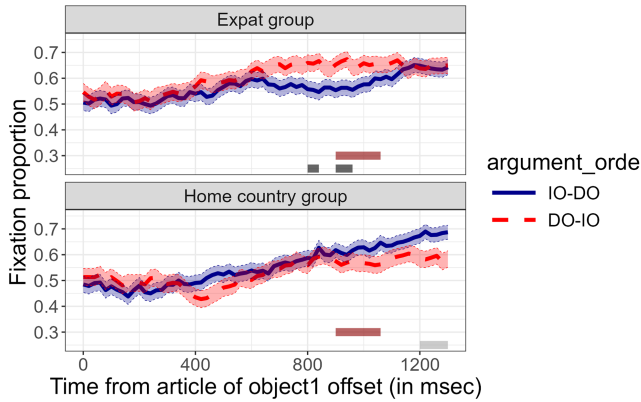

Figure 5. Fixations to the target during the critical time window in the ditransitive set for the expat group (top) and the home country group (bottom). The vertical bars at the bottom indicate significant clusters.

significant interaction between argument order and group. The interaction effect was significant for a cluster between 900 and 1060 msec (*cluster-mass*: 46, $p = 0.001$) and is illustrated by the red bar in Figure 5.

Following up on this, we explored the effect of group per argument order. As shown in Figure 6, there was a significant effect of group for the order DO-IO but not for IO-DO. For DO-IO, two significant clusters were detected, one between 380 and 540 msec (*cluster-mass*: 66.3, $p = 0.001$) and one between 580 and 700 msec (*cluster-mass*: 39.8, $p = 0.001$), indicating a higher likelihood of target fixations for the expat than for the home country group.

Discussion

We set out to answer the question of whether German L1 speakers in Norway experience subtle attrition in their ability to exploit case marking in transitive and

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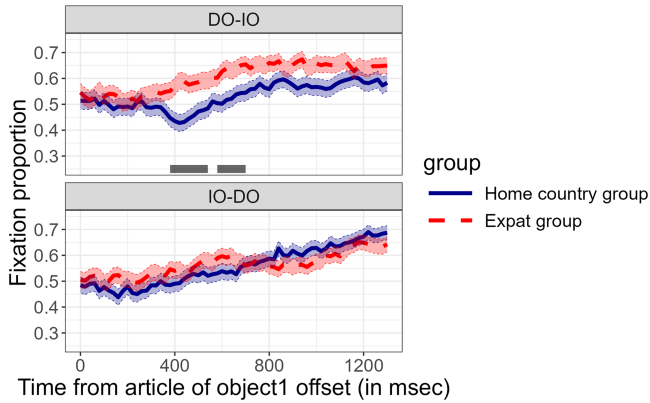

Figure 6. Fixations to the target during the critical time window in the ditransitive set for the order DO-IO (top) and the order IO-DO (bottom). The vertical bars at the bottom indicate significant clusters.

ditransitive sentences to identify the target in a picture selection task, before the critical information is provided. To this end, we compared a group of expats in Norway with a group of L1 speakers in Germany. In the following, we discuss the accuracy, response time, and eye-movement results for the transitive and ditransitive sets and how they confirm or disconfirm our predictions. We also discuss how the results inform our understanding of effects of attrition in L1 processing.

Transitive set

For the set of transitive sentences, we found that both groups were equally likely to select the target scene, and there was no significant difference between argument orders. We had hypothesized that participants may score lower for OVS than for SVO based on our previous study (Schlenter & Westergaard, 2024), where we found an effect of argument order in the eye-tracking experiment but not in a subsequent mouse-tracking experiment with a similar set of stimuli. Across groups, participants were slower in selecting the target scene for the order OVS relative to SVO, in line with our prediction based on the results from our previous study (Schlenter & Westergaard, 2024) and further replicating previous research that showed processing costs for object-initial sentences in German (e.g., Bornkessel et al., 2002; Schipke et al., 2012). Surprisingly, we found a difference between groups for response times due to the expat group being overall faster in selecting the target scene than the home country group. We can only speculate that this was a result of group differences in terms of motivation. Most of the expats were researchers themselves, who wanted to support our research and who were keen on performing as fast and accurately as possible.

As regards the real-time processing of case in the transitive set, we had hypothesized that the expat group would differ from the home country group in the time course of target scene identification for OVS. If so, the presently used cluster-based permutation analysis should have detected significant cluster(s) with a lower

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likelihood of target scene fixations for the expat as compared to the home country group for OVS. However, no significant clusters were detected. Thus, we conclude that both groups were equally sensitive to ACC marking on NP1. In the present study, we found no difference between SVO and OVS, unlike in our previous study (Schlenter & Westergaard, 2024). We attribute this to slight changes in the design and materials. For example, we increased the number of OVS sentences with double marking of ACC case to increase its perceptual salience in the present study.

To conclude, we found no indication of effects of attrition for the comprehension of transitive sentences following the non-prototypical order OVS in comparison to SVO and, critically, also no effects of attrition for the real-time processing of ACC case on the NP1 in OVS sentences.

Ditransitive set

We investigated participants' use of DAT and ACC case on the first object following a ditransitive verb. Here, DAT and ACC case indicate whether the first object corresponds to the indirect object/recipient or direct object/theme, and thus also which semantic role will follow. In German, the order IO-DO has been shown to be more frequent overall and, as indicated by the results from an acceptability judgment task in Schlenter and Westergaard (2024), to be preferred over DO-IO even when both objects are animate. Therefore, we had hypothesized that participants may be faster in selecting the target scene for IO-DO and, probably, also more accurate than for DO-IO. In the present study, we exclusively focused on ditransitive sentences with a feminine NP as first postverbal argument, so DAT and ACC were marked by *der* and *die,* respectively. We found a significant effect of argument order for accuracy and a marginal effect for response times, with slightly lower accuracy and longer response times for DO-IO as compared to IO-DO. This aligns with the finding that DO-IO is less prototypical than IO-DO in German, and we explain the difference from our previous study with the changes in the experimental design. Critical for the present investigation, we found no differences between the expat and the home country groups for accuracy and response times. Both groups scored better for IO-DO than for DO-IO, and both groups needed less time to select the target scene for IO-DO than for DO-IO. With this in mind, we turn to the processing results.

While we had found no significant difference between DAT *der* and ACC *die* in terms of fixations on the target as compared to the competitor scene in our previous study (Schlenter & Westergaard, 2024; see Figure S.1 in the Supplementary Materials), the home country group in the present study showed a difference between the two argument orders towards the end of the analysis window. This was reflected by a significant cluster between 1200 and 1300 msec, indicating a higher likelihood of target fixations for IO-DO than for DO-IO. This finding aligns with the behavioral data, as it shows a preference for interpreting a first postverbal argument as the indirect object/recipient. As for the behavioral data, we explain the difference from our previous study with the changes in the experimental design. Previously, ACC *die* was more prominent compared to *der*, *dem*, and *den*, which might have facilitated the processing of DO-IO there.

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As regards our predictions for the expat group, we had entertained several options. A first hypothesis was that the expats would develop a stronger expectation for the 'default' order IO-DO due to its higher frequency in their L1 German. This prediction was clearly disconfirmed by our findings. A cluster-based permutation analysis revealed two significant clusters, one between 800 and 840 msec and one between 900 and 960 msec, which indicated a higher likelihood of target fixations for DO-IO than for IO-DO. While the differences between argument orders within groups did not result in a group effect for the order IO-DO, there was a significant group effect for the order DO-IO. As reflected by two significant clusters, one between 380 and 540 msec and one between 580 and 700 msec, the expat group was more likely to fixate the target scene than the home country group. In other words, the expats as a group were (temporarily) more likely to fixate the target scene for the in German less prototypical order DO-IO.

What could be the reason for this difference between groups for the DO-IO order? As mentioned in the prediction section, the expats may adhere to the frequency pattern of their L2s English and Norwegian, where the PO construction and thus the order DO-IO is more commonly used than in German (e.g., Anderssen et al., 2014; Bresnan et al., 2007). Thus, they may have a less strong expectation that the first object following the ditransitive verb is the indirect object/recipient than the home country group, and, as a consequence, they are more likely to immediately exploit ACC marking on the first object. Moreover, they may even have developed a stronger expectation that the first object following the ditransitive verb is the direct object/theme, which would explain the significant difference between DO-IO and IO-DO within the expat group. In the outlook below, we provide an explanation as to why that might be and how this could be tested in future research.

Another hypothesis we proposed was that the expat group may wait for the final argument before committing to a sentence interpretation, as their reliance on case as a cue to argument interpretation might have changed due to the bi-/multilingual experience. Against our predictions and in line with the results for OVS, this hypothesis was not confirmed. We did not find a group difference for the IO-DO order and even a higher likelihood of target fixations in the expat than the home country group for the DO-IO order in two clusters. Based on the hypothesis that attrition may follow the reverse order of acquisition, we moreover noted the possibility that the processing of DAT could be more prone to attrition than the processing of ACC. Indeed, we did find a significant difference between IO-DO and DO-IO prior to the second object in the eye-movement data of the expat group, indicating a reduced likelihood of target looks after DAT as compared to ACC. However, given the absence of a between-group difference for IO-DO, the evidence for a reduced use of DAT marking in the expat group is limited.

To summarize, the behavioral data showed better performance for IO-DO than for DO-IO in both groups alike. In contrast, the eye-movement results suggest a processing advantage for DO-IO in the expat group. If we follow the recommendations given by Steinhauer and Kasparian (2020, pp. 186–187), who advise researchers not to downplay unexpected differences, the processing advantage for DO-IO in the expat group may be taken as an effect of attrition.

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Implications for L1 attrition research

We found that expats had no more difficulties identifying the target scene for OVS and DO-IO than speakers in the home country, that is, for structures that are overall less frequent in German (relative to SVO and (S-)IO-DO). Hence, we found no indication that structures that are less frequent in the L1 are more likely to undergo attrition, as was suggested by Grüter and Hopp (2021), at least not in general. Our results suggest that structures that are more likely to alternate, such as ditransitive structures, could also be more likely affected by attrition (see outlook). At the same time, the results indicate that the expats used ACC marking in a similar way as the home country group. Thus, there is no indication that ACC marking had become a less reliable cue due to the bi-/multilingual experience. The results are less clear for DAT marking, which has been shown to be particularly susceptible to language change (Boas, 2009; Yager et al., 2015); see also Grüter and Roos (2024) for DAT marking in Japanese. However, the absence of a between-group difference for IO-DO does not allow strong conclusions in this regard. Instead, we found an unexpected difference between groups for the order DO-IO with a higher likelihood of looks to target for the expat as compared to the home country group. This difference was restricted to processing and did not affect final responses and response times. Without the eye-movement data, this difference would have been left undetected, which again highlights the importance of online studies for L1 attrition research. The processing results also raise the question of the utility of prediction (e.g., Ryskin & Nieuwland, 2023). The current findings suggest that the processing advantage for DO-IO in the expat group did not facilitate their final sentence comprehension.

Limitations of the present study and outlook

This study is not without limitations. Many participants in the expat group were older than the participants in the home country group, meaning that age is a potential confound in our study. Since age can have positive (e.g., vocabulary size) as well as negative effects (e.g., decreases in memory and processing speed) on language processing (Fernandez et al., 2025), we cannot rule out that the observed differences were to some extent the result of age differences. Ideally, future research should include two or more groups that are matched for age. Moreover, our expats were mostly people with a high level of education and high motivation. Our home country group, on the other hand, included mostly undergraduate students who participated in exchange for monetary compensation.

Next to the group differences, another limitation of our study concerns the stimuli for the ditransitive set. A reviewer noted that the article *der* prototypically maps onto masculine referents while the article *die* always refers to feminine referents, at least in the singular. Thus, the frequent use of *der* in the nominative for masculine nouns might have provided a competing gender cue. As we presented participants with two scenes that both included all three referents, we cannot tell whether expats were considering a male referent when listening to *der*. Further note that we exclusively tested one instance of DAT (i.e., fem. *der*). Future research may want to test a broader range of constructions.

More research is called for that also tests speakers in the comprehension/production of the other actively used language(s). This way, one could better assess

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individual preferences for certain argument orders. Above, we speculated that (some) speakers in the expat group could have developed a less strong expectation towards the order IO-DO in German due to their bi-/multilingual experience. This could be due to the frequency of constructions in the L2(s) but also due to the individual use of constructions. As our participants were non-native speakers of English/Norwegian, it is conceivable that they show a different use of constructions than L1 speakers of these languages. Differences in the distributional use of constructions have been shown for bilinguals (vs. monolinguals). For example, in a structural priming study with the verbs *give*, *show*, and *sell*, Wolleb et al. (2018) found that English-Norwegian bilingual children produced fewer double-object constructions overall than monolingual Norwegian children (20% vs. 43%). Thus, bilinguals produced more PO, corresponding to the construction proposed to be the least complex one for Norwegian (Anderssen et al., 2014). Schönenberger et al. (2012) made a similar observation for successive bilingual children in German. Unlike monolingual children, they often inserted a preposition to mark indirect objects. Thus, future research may want to assess speakers' production preferences in their different languages to examine whether they can account for patterns in real-time comprehension. Moreover, online measures could be combined with offline measures. In an additional acceptability judgment task, one could assess how bi-/multilingual speakers rate different argument orders in double-object constructions as well as PO constructions and how this is affected by the country of residence. Based on the findings from the present study, we may tentatively conclude that argument orders that can easily alternate, such as the dative construction, are also easily subject to change in individuals' linguistic experience, and with that also to attrition.

Finally, as we tested a group of German expats in Norway, they were regularly exposed to Norwegian and English. Since we lack a participant group in a country whose societal language marks case morphologically, we do not know whether the subtle changes in the processing of ditransitive sentences that we observed are independent of the L2(s) or not. To test for cross-linguistic influence, an additional group of expats should be included, for example, German L1 speakers in Iceland, where they are exposed to a language that also has morphological case marking, with DAT used for indirect objects and ACC for direct objects.

Conclusion

When we compared the real-time processing of different argument orders between a group of German L1 speakers in Germany and in Norway, we found no difference for subject- and object-initial transitive sentences, neither within nor between groups. We thus conclude that both groups capitalized on case marking on the first noun phrase in transitive sentences. However, we found subtle within- and between-group differences for the processing of alternating argument orders in ditransitive sentences. Despite a similar performance for picture selection, the expats were more likely to fixate on the target scene than the home country group prior to the final argument when the order of arguments followed the less prototypical order DO-IO. Thus, the expats showed a similar use of accusative marking on the first object following the ditransitive verb as the home country group, and also displayed a processing

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advantage. We argued that this could be the result of their bi-/multilingual experience that may have influenced their expectations towards argument order in the L1.

Supplementary material. To view supplementary material for this article, please visit https://doi.org/10.1017/S0142716425100295

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Competing interests. The authors report there are no competing interests to declare.

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Replication package. The materials, data, and scripts of this study are openly available on the Open Science Framework (OSF) under https://osf.io/j42p5/. Prior to data collection, we pre-registered this study (for the expat group only) on OSF under https://osf.io/m2sfj.

Notes

1 Similarly, Bergmann et al. (2015) compared German L1 speakers in Germany to German L1 speakers residing in the US and Canada on the processing of verb and gender agreement violations. However, despite subtle between-group differences, they interpreted their results as evidence for the stability of the L1 system. Steinhauer and Kasparian (2020) call this interpretation into question, as the expat group showed an additional N400 after a verb violation in German that was absent in the control group.
2 The group of bi/multilinguals in this study was quite heterogeneous. The authors report a mean age of acquisition of 1.3 (range: 0–7 years). Thus, some participants had another language than Japanese as their L1.
3 In addition to the marking of ACC on the pre-nominal article, so-called weak masculine nouns mark ACC via a suffix on the noun.
4 Unlike in German and English, in Norwegian only indefinite articles and demonstratives appear pre-nominally, and [+definite] is expressed through a post-nominal suffix.
5 Deviating from our selection criteria in the pre-registration, we included three German L1 speakers who learned a second language (English or Spanish) before the age of 6 years.
6 One returned and attended school in a German-speaking country, the other participant received schooling in German abroad.
7 The participant had only three correct responses for the OVS order. Even though our selection criteria were based on the performance for SVO, this performance stands in stark contrast to the rest of the group. Moreover, the participant kept fixating the center of the screen after the fixation cross disappeared, so we lack eye-gaze data for the prediction window from this participant.
8 A similar forced choice eye-tracking design has been used in previous studies on the predictive use of case marking in Korean (Frenck-Mestre et al., 2019) and Japanese (Mitsugi, 2017). Recent findings from Minor et al. (2025) show that bilingual children had a higher sensitivity towards case cues when they were presented with event scenes than when presented with images of individual referents.
9 The interested reader can find the results in the OSF repository. They are not reported here because of several problems that arise from repeated exposure to the materials. Furthermore, eye-tracking provides us with more fine-grained temporal information than mouse-tracking.
10 There were eight participants with 58% or lower accuracy for the DO-IO order, three from the home country and five from the expat group. Except for two, all had at least 83% correct responses for the IO-DO order. One expat had an accuracy of 58% for IO-DO and 50% for DO-IO. One participant in the

home country group had 75% for IO-DO and 50% for DO-IO. As only correctly answered trials enter the response time and eye-movement analyses, these participants contribute fewer trials than the other participants there.

11 Aine Ito kindly shared with us a script for a CPA that allows the inclusion of an interaction.

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