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Crosslinguistic influence in early L3 acquisition: evidence from offline judgments and eye-tracking in morphosyntactic processing[1]

Influencia interlingüística en la adquisición temprana de una L3: evidencia de juicios offline y seguimiento ocular en el procesamiento morfosintáctico

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ABSTRACT

Using a combination of offline and online measures, this study explores the acquisition of *ab initio* German as a third language (L3) in sequential bilingual adults. We examine potential influences of mediating factors, such as order of acquisition of Spanish and English, structural similarity between the languages through two specific grammatical properties, and language of instruction. A group of L1-Spanish L2-English and a group of L1-English L2-Spanish speakers completed three German lessons followed by a grammaticality judgment test while their eye movements were recorded. Findings revealed a divergence between offline and online measures: grammaticality judgment test scores did not detect reliable evidence of effects of the variables, but eye-tracking data suggest that structural similarity may be associated with differences in both early and late syntactic processing. These findings highlight the complex and intricate interaction between languages during the time course of morphosyntactic processing in bilinguals who are beginning to learn an L3.

Keywords: L3 cross-linguistic influence, structural similarity, L3-German, language of instruction, eye-tracking.

RESUMEN

Mediante la combinación de medidas offline y online, este estudio explora la adquisición inicial del alemán como tercera lengua (L3) en adultos bilingües secuenciales. Se examinan posibles influencias de factores moduladores, tales como el orden de adquisición de español e inglés, la lengua de instrucción, y la similitud estructural entre las lenguas a través de dos propiedades gramaticales específicas. Un grupo de hablantes L1-español, L2-inglés y un grupo de hablantes L1-inglés, L2-español completaron tres lecciones de alemán seguidas de una prueba de juicios de gramaticalidad, mientras se registraban sus movimientos oculares. Los resultados revelaron una divergencia entre las medidas offline y online: los puntajes en la prueba de juicios de gramaticalidad no aportaron evidencia sobre los efectos de las variables, pero los datos de seguimiento ocular sugieren que la similitud estructural puede estar asociada con diferencias tanto en el procesamiento sintáctico temprano como tardío. Estos hallazgos apuntan a un patrón complejo de interacción entre los idiomas durante el curso temporal del procesamiento morfosintáctico de idiomas en bilingües que comienzan el aprendizaje de L3.

Palabras clave: influencia interlingüística en L3, similitud estructural, alemán como L3, lengua de instrucción, seguimiento ocular.

1. INTRODUCTION

Second language (L2) acquisition involves significant interaction with a learner's native language (L1) and, therefore, is not an isolated process (Foucart & Frenck-Mestre, 2012). Unlike monolinguals, bilinguals can access two linguistic systems, which can influence how they process and learn new languages. This interaction can be observed when properties from a previously acquired language are applied to a new language, which can have both positive and negative effects on L2 processing; factors such as a learner's level of proficiency in each language and the structural characteristics of the languages involved can also play a significant role (Jiang, 2018).

The acquisition of a third language (L3) introduces additional layers of complexity since L3 learners may draw on both their L1 and L2. Some studies suggest that chronological order of acquisition might favor L1 transfer (Hermas, 2010), while others emphasize the role of the L2 (Bardel & Falk, 2007, 2012; Bardel & Sánchez, 2017). Evidence also supports views such as that cross-linguistic influence may emerge from both background languages depending on specific properties (Slabakova, 2017; Westergaard et al., 2017) or that L3 learners transfer exclusively one background language based on holistically structural proximity (Rothman, 2011, 2015; Rothman et al., 2019). Indeed, current perspectives increasingly conceptualize crosslinguistic influence as a dynamic, non-exclusive process in which multiple previously acquired linguistic systems may be simultaneously activated and contribute in gradient, property-specific ways (e.g., McManus, 2021; Slabakova, 2017; Westergaard et al., 2017).

Despite extensive evidence related to the role played by prior linguistic knowledge, research on L3 acquisition at initial or *ab initio* stages becomes crucial as it can offer valuable insight into early language processing by reducing the influence of L3 knowledge. Furthermore, less emphasis has been placed on identifying how L3 processing unfolds in real time, such as that provided by eye movement recordings, which can reveal early attentional mechanisms and processing difficulties (Abbas et al., 2021; Godfroid et al., 2015).

To investigate the influence of background languages and the factors that may modulate said influence in the initial stages of L3 acquisition, this study employs both offline and online techniques to examine morphosyntactic processing during the time course of a grammaticality judgment task. We examine (a) the effect of order of acquisition by comparing bilinguals with an inverse chronological order of acquisition of L1/L2-Spanish and L1/L2-English, (b) structural similarity at both holistic and grammatical property levels, and (c) the impact of the language of instruction (LoI). This study adopts an exploratory approach to examine how these factors may differentially contribute to L3 processing across measures.

2. THEORETICAL BACKGROUND

2.1. Mediating role of background languages

There is conflicting evidence regarding which of the previously acquired languages primarily influences the processing of the L3. Some authors have proposed that

chronological order of acquisition of background languages could have a potentially influential role. The L1 has been suggested as the most influential factor due to a superior cognitive status, potentially constraining L2 morphosyntactic properties during L3 processing. For example, Hermas (2010) found evidence of L1 transfer in L1-Arabic learners of L2-French acquiring L3-English. Similar findings were observed in Hermas (2014a, 2014b) regarding null subjects and relative clauses, and Stadt et al. (2020) report patterns consistent with the mediating role of order of acquisition in initial L3-French instruction among L1-Dutch speakers, who predominantly transferred from L1-Dutch compared to L2-English. Other studies have reported that the L2 can play a prominent role, overriding the default status of the L1 due to lower levels of L1 metalinguistic knowledge (Falk et al., 2015). In this vein, the L2 Status Factor hypothesis posits that the L2 may act as a primary transfer source (Bardel & Falk, 2007, 2012; Bardel & Sánchez, 2017; Falk & Bardel, 2011). For instance, Bardel and Falk (2007) found L2 transfer in L3-Swedish and L3-Dutch learners regardless of L1-L3 structural similarities. Further support was provided by Falk and Bardel (2011), who observed L2 transfer in learners acquiring German pronouns despite structural similarities between L1 and L3.

Evidence also suggests that the preferred language of communication can contribute to L3 learning (Angelovska et al., 2020; Fallah & Jabbari, 2018). While Ghobadirad and Jabbari (2021) found that the language predominantly used for communication, whether L1 or L2, was the sole transfer source in the early stages of L3-English acquisition among Mazandarani-Persian bilinguals, Puig-Mayenco et al. (2022) observed that language dominance had a greater effect in subsequent stages of L3 acquisition, as typological proximity was more determinant in the initial stages. In this respect, if linguistic material that is more frequently used is likely to be activated due to a lower activation threshold, then the language used in instructional settings to teach the L3 in the initial stages could also constitute an additional source of influence (Nadal & Thome, 2021). Stadt et al. (2016; 2018; 2020) found a stronger L1 influence in environments with less L2 exposure, but in bilingual settings with more L2 exposure, L2 was the transfer source. Conversely, Puig-Mayenco et al. (2022) controlled for the LoI and found no significant effect. While these studies highlight the importance of the languages present in an individual's environment during L3 acquisition, the evidence remains mixed and context-dependent. Online techniques, such as eye-tracking, could provide further insight into how these factors interact during processing, since these variables have primarily been explored through offline and production tasks.

The Typological Primacy Model (Rothman, 2011, 2013, 2015; Rothman et al., 2019) argues that transfer can originate from either the L1 or the L2, regardless of the order of acquisition. In this model, transfer is holistic and can be both facilitative and non-facilitative, contrasting with claims by Flynn et al. (2004) regarding the facilitative role of all prior linguistic knowledge. Instead, transfer is determined by structural proximity between languages according to similarities at different linguistic levels (i.e., lexical, phonetic, morphological, and syntactic), specifically in the early stages of L3 acquisition when the influence of L3 knowledge is assumed to be limited (Rothman et al., 2019). In contrast, the Linguistic Proximity Model (Westergaard et al., 2017) asserts that cross-linguistic influence during L3 acquisition can stem from both L1 and

L2, since it is a selective process driven by the processing demands of the input. This perspective aligns with Slabakova's Scalpel Model (2017), which also advocates for the role of both background languages according to specific properties, describing this as a potentially hybrid process where both L1 and L2 can simultaneously influence L3 processing. Westergaard et al. (2017) documented both facilitative and non-facilitative background-language effects in a grammaticality judgment task in L3-English; specifically, they found non-facilitative effects of Norwegian in Russian-Norwegian bilingual children who were better at identifying errors than monolingual Norwegian-speaking children but less accurate compared to Russian monolinguals. Evidence from Lloyd-Smith et al. (2018) also supports the selective aspect of cross-linguistic influence as they found both L1-Italian and L2-German contributed as sources of cross-linguistic influence in L3-English among adult learners despite German being the participants' dominant language and the most similar to L3-English. Similar patterns have been reported in prior work, suggesting that bilingual experience may shape sentence interpretation across different linguistic domains (Jensen et al., 2023; Listhaug et al., 2021; Proietti Ergün, 2021). Specifically, Listhaug et al. (2021) observed effects from learners' L1 Norwegian and L2 English during the acquisition of L3 French, while Jensen et al. (2023) found that both L1 Russian and L2 Norwegian had an effect on the acquisition of L3 English. Although the Linguistic Proximity Model predicts property-by-property crosslinguistic influence at more advanced stages of acquisition, studies with very beginner L3 learners have also reported effects from both previously acquired languages. For instance, Jensen and Westergaard (2023) found that both L1 Norwegian and L2 English influenced acceptability judgments in artificial languages, and Mitrofanova et al. (2023) reported property-specific crosslinguistic effects in speakers learning an artificial language that combined Norwegian lexical features with Russian syntactic properties.

Using online and offline data, Abbas et al. (2021) demonstrated that both L1 and L2 can influence L3 processing when there is no global structural similarity among the languages (L1-Arabic, L2-Hebrew, L3-English). Their findings revealed differences in how online and offline measures capture L3 processing: eye-tracking data showed early processing effects of the L1 in longer first pass reading times in areas of L3 ungrammatical sentences reflecting L1 structures, while longer second pass reading times were found for ungrammatical sentences following the L2 syntax, suggesting explicit metalinguistic access. Grammaticality judgments, in contrast, indicated L2 transfer, especially in ungrammatical sentences reflecting L2 syntax. This study highlights differences across measures and processing stages and the fact that learners can draw on multiple sources of prior linguistic knowledge during L3 processing.

Studies on L3 morphosyntactic processing have predominantly relied on offline data (Angelovska et al., 2020; Abbas et al., 2021) collected from participants with some proficiency in the L3 (Rothman et al., 2019; Puig-Mayenco et al., 2020). While these studies offer valuable insights into the factors influencing L3 processing, they do not reflect the real-time processing of morphosyntactic structures when learners begin structuring initial L3 representations (González Alonso et al., 2020; Pereira et al., 2022). Although studies combining online and offline processing measures—such as eye-tracking and grammaticality judgment tasks—suggest that cross-linguistic influence may unfold dynamically across processing stages and measures (Abbas et al., 2021),

the focus on learners with substantial L3 knowledge does not rule out the possibility of L3 intralinguistic transfer.

2.2. Verb placement in German, English and Spanish

In a simple sentence in German, the verb is placed in the second position (V2), even when the first position is taken by a phrase that is not the subject. This is known as subject-verb inversion, a parameter that distinguishes German from other SVO (subject-verb-object) languages like English (Ehlers, 2000; Haider, 2010). As a head-initial language, complements in English follow the SVO order, so a typical sentence construction places the verb after the subject. Spanish, however, has a flexible word order, including verb and adverb sequences (Ayoun, 2005).

One of the most complex structures for beginner learners of German is the adverb-verb sequence at the beginning of an affirmative sentence (Bohnacker, 2006; von Hausen & Castillo, 2025), where the adverb is placed in the first position, followed by the verb in the second position, moving the subject to the third position, as in (1a) (Haider, 2010). Although English allows the adverb-verb sequence with frequency and manner adverbs, it is not accepted at the beginning of a sentence if it is not preceded by a subject to comply with SVO order (1b). In Spanish, the verb can occupy different positions, including the second position when the first word is an adverb; however, it requires the subject phrase, when displaced to the third position, to omit the determiner (1c) (García Menéndez, 2020).

1a *Oft kommen Katzen in dieses Restaurant*	(ADV + VERB + SUBJ)
1b **Frequently come cats to this restaurant*	(SVO)
1c *Frecuentemente llegan gatos a este restaurante*	(ADV + VERB + SUBJ)

In a simple attributive sentence in German, the word *nicht* is used for negation and must follow the verb and precede the adjective or adverb that is part of the predicate, as in (2a) (Corcoll & Corcoll, 2006). Similarly, English negation requires the word *not* immediately after the copulative verb, as in (2b), preceding the subject complement. Spanish differs from these languages; the negative marker *no* precedes the finite attributive verb, and the attribute must be placed after the verb (2c).

2a *Italienisch ist nicht schwer*	(VERB + NEGATION)
2b *Italian is not difficult*	(VERB + NEGATION)
2c **El italiano es no difícil*	(NEGATION + VERB)

In L3 acquisition studies, the processing of the V2 parameter has been argued to be influenced by the structural similarity of the languages and the input in instructional settings, highlighting a potential variation in the transfer source selection. Bardel and Falk (2007) found that L2 transfer is more likely in the initial stages of acquisition of L3-Swedish and L3-Dutch when the L2 and L3 share similar properties. In contrast, Stadt et al. (2016, 2018) observed that Dutch students learning L2-English and L3-French in a bilingual program showed more transfer errors reflecting the SVO structure, while those in a regular curriculum transferred equally from L1-Dutch and L2-English. In a related study, Stadt et al. (2020) found that in the early stages, transfer occurred

primarily from the L1, but increased L2 exposure led to more L2 transfer.

Bohnacker (2006) suggested that acquiring the V2 feature is more challenging when previously acquired languages lack this feature. In the study, L3-German *ab initio* learners with L2-English showed more difficulties in the production tasks compared to L1-Swedish learning L2-German since Swedish and German share the V2 property. Angelovska et al. (2020) found the same effect in L3-English learners with different L1 backgrounds who accepted sentences with the V2 feature more frequently, indicating a non-facilitative effect due to transfer from L2-German—the language most typologically similar to English. Although this could suggest the primary source of transfer was the structurally closest language, the influence of participants' L1 was observed in the total reading time (TRT) for sentences in L3 that matched the L1 structure. Crucially, the study combined both online and offline processing measures that enable a more detailed examination of processing as it unfolds and revealed that both L1 and L2 have the potential of simultaneous transfer during the L3 processing of verb placement.

In light of this evidence, previous research suggests that both L1 and L2 may contribute to L3 processing, potentially in different ways depending on the structure, task, and stage of processing, as demonstrated by Angelovska et al. (2020). However, since we are focusing on *ab initio* learners, whether processing patterns in the initial stages are better accounted for by holistic or property-specific approaches, or whether they reflect a combination of influences that vary across measures, remains an open question.

3. THE PRESENT STUDY

The goal of this study was to examine the morphosyntactic processing of L3-German in the initial stages of acquisition in bilingual speakers of L1/L2-Spanish and L1/L2-English and to explore whether the order of acquisition of the L1 and the L2, the typological proximity between the languages, the structural similarity between two grammatical structures, and the LoI may be associated with differences in offline judgements and eye movement patterns. To do this, we implemented instructional sessions and a sentence processing experiment that combined an untimed grammaticality judgment task (GJT) and eye-movement recordings. More specifically, we adopt an exploratory approach to answer these research questions:

1. To what extent does order of acquisition (L1-Spanish/L2-English vs. L1-English/L2-Spanish) mediate morphosyntactic processing in L3-German during the initial stages of acquisition?
2. Which previously acquired language (Spanish or English) influences the morphosyntactic processing of L3-German in the initial stages of acquisition, and is this influence determined by holistic or property-specific structural similarity?
3. Does the language employed during instruction exert an effect in the processing of L3-German?
4. To what extent do online and offline measures show comparable patterns in L3-German morphosyntactic processing?

Based on previous research (Bardel & Falk, 2007; Bardel & Sánchez, 2017; Falk & Bardel, 2011; Hermas, 2010, 2014a, 2014b) we considered the possibility that the order of acquisition of the L1 and the L2 could be associated with accuracy scores in the GJT and reading times, while also allowing for variability across measures and structures. These expectations were formulated as exploratory, and no directional predictions were made given the current debates in the literature and the constraints of the study design. Similarly, if the role of typological proximity between English and German is reflected in our data, this may be taken as an indication of sensitivity to broader structural similarity (Rothman, 2011, 2013, 2015; Rothman et al., 2019) whereas variation across the two grammatical structures would be consistent with property-specific influence from previously acquired languages (Slabakova, 2017; Westergaard et al., 2017). Given previous mixed findings in the literature with regard to the LoI no specific directional effects were predicted for this factor.

Finally, despite the scarcity of studies combining online and offline approaches, we examine whether these measures converge or diverge in capturing L3 processing (Abbas et al., 2021; Pereira et al., 2022). In particular, we consider whether eye-tracking data may reveal patterns not reflected in offline judgments, thereby providing insight into the time course of processing.

4. METHODS

The study followed an exploratory quasi-experimental design. Participants were grouped according to pre-existing language-background characteristics, specifically their order of acquisition of Spanish and English, and therefore were not randomly assigned to all between-participant conditions. The design allowed us to examine whether order of acquisition, LoI and structural similarity were associated with variation in offline judgments and eye-movement measures during the earliest stages of L3-German exposure. Given the small sample and the inclusion of interaction terms motivated by the research questions, the statistical models are interpreted as providing preliminary evidence about possible processing patterns rather than confirmatory tests of population-level effects. For this reason, non-significant results are treated as an absence of detected evidence in the present data, not as evidence that the corresponding effects are absent.

4.1. Participants

We recruited 22 sequential bilinguals, interested in learning basic L3-German, and assigned them to one of two groups based on the order of acquisition of the L1 and the L2: L1-Spanish/L2-English and L1-English/L2-Spanish, to examine potential differences associated with order of acquisition. After data cleaning and screening, the L1-Spanish/L2-English group was composed of 9 participants (8 females, 1 male; mean age = 21) who were pursuing a TESOL degree in a Chilean research university and had a B2 proficiency level in English according to the Common European Framework of Reference (CEFR). To determine their proficiency, only students in the corresponding English level course were included in the study and were given the

Oxford Quick Placement Test (Oxford University Press et al., 2001). The second group was formed by 10 participants (8 females; 2 males) whose L1 was English (mean age = 20) and were studying Spanish in a study abroad program in the same university. Their L2 proficiency level was also B2 (CEFR) and was determined by the corresponding Spanish level course they were enrolled in and the placement test DELE (Diploma of Spanish as a Foreign Language) that was administered at the beginning of the study abroad program in the same semester data collection for the present study was conducted. Data from three participants (13.6%) were excluded from the analyses due to calibration failure.

All participants answered an online adaptation of the Language Experience and Proficiency Questionnaire LEAP-Q (Marian et al., 2007), which was used to exclude participants with previous knowledge of German or any other L3. All participants signed an informed consent approved by the Ethics Review Board of the university where the study took place.

4.2. Materials and data collection procedures

4.2.1. Diagnostic test

To determine if participants had previous knowledge of the syntactic structures under examination in their L1 and L2 and to ensure comparable familiarity with these structures across languages (Rothman et al., 2019), we designed a untimed GJT in the L1 and the L2 that contained the two structures that would be later taught and tested in German: the ADV+VERB+SUBJ pattern in sentence initial position (German = Spanish ≠ English) and postverbal negation in attributive sentences (German = English ≠ Spanish). All sentences were validated by L1 speakers, and those with accuracy rates lower than 75% were replaced or modified. The tests were piloted in a group of L1-Spanish L2-English sequential bilinguals. Data and materials are available via OSF (https://osf.io/63nbf/?view_only=6de8cc72749e46f7966d72764e19af27).

The GJTs included 40 sentences organized in four pseudorandomized and counterbalanced lists (Appendix A) that contained 5 grammatical and 5 ungrammatical sentences for each target structure, and 10 grammatical and 10 ungrammatical fillers (verb 'to be' in singular and plural forms). The GJTs in English and Spanish were applied one week apart and participants were instructed to read the sentences and classify them as grammatical or ungrammatical. No significant differences were found in the diagnostic test scores between the two groups.

4.2.2. Instruction in L3-German

Two weeks after the diagnostic tests, the two groups completed three sessions of instruction in basic aspects of German syntax that included postverbal negation in attributive sentences, the ADV+VERB+SUBJ sequence in simple affirmative sentences, and the plural and singular forms of the verb 'to be' in German. We included the verb 'to be' to provide participants with basic knowledge of German that would allow them to judge different syntactic structures and could be used as distractors in the GJT.

The instructional phase was carried out over the course of two weeks. In the first week, participants completed two self-administered sessions in a computer lab (as a group under the supervision of one of the researchers), and the following week

they participated in a face-to-face session with an instructor of German. All three 40-min sessions had the same organization that followed the presentation, practice and controlled production method (Anderson, 2017) within a context (e.g., people and places; see Appendix B). We used cognates in English, Spanish and German in the instruction sessions to reduce the cognitive resources used in word meaning retrieval (Hopp, 2018). These included adverbs, nouns and adjectives that lent themselves to visual representation that facilitated instructional materials design. Explicit instruction of grammatical structures was complemented with examples using audiovisual materials and input enhancement to avoid the need to use translation (Indrarathne & Kormos, 2017; Loewen & Inceoglu, 2016). Since the participants had no previous knowledge of German, an important consideration was the LoI (Puig-Mayenco et al., 2022; Stadt et al., 2020). For this reason, we controlled possible effects by designing all the instructional materials in English and in Spanish and assigning participants to these two groups in a counterbalanced way.

The first two lessons were implemented in a free-access educational platform online, which offered different resources for the presentation and practice activities (i.e., memory games, word search, etc.). The materials were analyzed by three L1-German speakers and five EFL instructors using a rubric to check for accuracy, clarity, level of complexity, and interactivity. The lessons were piloted in a small group of bilingual learners with no prior knowledge of German to corroborate usability and completion times. Participants only needed a code to access the lessons, which allowed us to monitor task completion, provide instructions, and solve doubts during the sessions in the respective LoI. Feedback on their progress was provided for every activity.

The third lesson was conducted by an L1-Spanish, L2-German and L3-English instructor. The session included the contents of the self-administered lessons and followed the principles of task-based learning (Long, 2015). This session, taught entirely in either English or Spanish according to the respective LoI group, began with activation of the vocabulary and syntactic rules learned and proceeded to consolidation activities (i.e., word identification, scrambled sentences, error detection, among others). The instructor provided immediate and explicit feedback in the respective LoI.

4.2.3. Grammaticality judgment task

After the third lesson and within the same week, all participants completed an untimed GJT in German (Appendix A) while their eye-movements were recorded. The GJT included 48 sentences that ranged from 5 to 6 words taken from the word bank of cognates created for the training (Spinner & Gass, 2019). Out of the 48 sentences, 32 corresponded to critical items that were presented in 2 conditions according to the two possible sources of transfer (English or Spanish); 16 filler items (8 grammatical; 8 ungrammatical) were used in the GJT (Keating & Jegerski, 2015). In Table I, we present exemplar items used for each condition to operationalize structural similarity across languages and examine potential patterns of cross-linguistic influence; the interpretation of responses to the GJT is included to illustrate how participants' responses were analyzed.

Table I. *Conditions for the GJT*

	Condition 1		**Condition 2**	
	Structural similarity Spanish/German		Structural similarity English/German	
Syntactic structure	Adverb+verb+subject	Adverb+subject+verb	Verb+negation	Negation+verb
Structural similarity	German=Spanish ≠ English	*German=English ≠ Spanish	German=English ≠ Spanish	*German=Spanish ≠ English
Example	*Oft kommen Studenten in die Bibliothek.*	**Oft Touristen reisen aufs Land.*	*Der Park ist nicht lila.*	**Die Bibliothek nicht ist rot.*
Interpretation of response patterns	Grammatical > influence of Spanish	Grammatical > influence of English	Grammatical > influence of English	Grammatical > influence of Spanish
	Ungrammatical > pattern consistent with English similarity	Ungrammatical > pattern consistent with Spanish similarity	Ungrammatical > pattern consistent with Spanish similarity	Ungrammatical > pattern consistent with English similarity

The 48 sentences were validated by a group of L1-German speakers, and those with an agreement rate lower than 75% were discarded or modified. The sentences were organized in four pseudorandomized and counterbalanced lists and instructions were provided according to the corresponding LoI. The GJT was piloted in the same group of bilinguals that participated in the self-administered lessons pilot.

4.2.4. Eye-movements recording

The experiment was presented in a Tobii Eye Tracker TX-300 (sampling rate of 300 Hz, Tobii Pro LAB v1.194), using a courier 60-point font on a light gray background; all sentences were aligned to the left on the screen. Participants were positioned 65cm from the screen and used a chin rest for head stabilization. They were instructed to read the sentences at their own pace and press number 1 (yes/sí) or number 3 (no) on a numerical keyboard to judge the sentences as grammatical or ungrammatical in German, for which it is generally assumed that explicit knowledge of the language required to complete the task is used (Godfroid, 2023; Williams & Rebuschat, 2023). After instructions, four practice sentences were introduced to facilitate task familiarization.

We analyzed the eye-tracking data by first establishing two areas of interest (AoI) for each structure under examination (Table II), which correspond to the element with a syntactic violation and the word that follows to account for possible spillover effects (Abbas et al., 2021; Angelovska et al., 2020).

Table II. *AoI for each structure*

Sentence structure	AoI	Example
ADVERB + VERB + SUBJECT	Second word: VERB or SUBJECT	*Gestern **kamen** Musiker in den Park.* 'Yesterday came musicians to the park' or **Gestern **Musiker** kamen in den Park.*
	Third word: SUBJECT or VERB	*Gestern kamen **Musiker** in den Park.* 'Yesterday came musicians to the park' or **Gestern Musiker **kamen** in den Park.*
POST VERBAL NEGATION IN ATTRIBUTIVE SENTENCES	LV (Linking Verb)	*Der Park **ist** nicht lila.* 'The park is not purple' or **Der Park nicht **ist** lila.*
	Post verbal negation NICHT	*Der Park ist **nicht** lila.* 'The park is not purple' or **Der Park **nicht** ist lila.*

Eye-tracking data was collected to complement the data obtained in the GJT to gain access to processing patterns that can provide insight into how L3 learners process morphosyntactic structures in real time (Godfroid et al., 2015; Jiang, 2018; Rayner, 2009; Rayner et al., 2011). We used a combination of measures that tap into early and late processing (Conklin et al., 2018), especially considering those used for L3 processing by Abbas et al. (2021): gaze duration (GD), rereading time (RRT), and TRT (for a definition see Godfroid, 2020).

4.3. Data analysis

Data was first exported from Tobii Pro LAB v1.194 and then analyzed using the datawizard package (version 0.6.4) for descriptive analyses (Patil et al., 2022) in R (version 4.2.2, R Core Team, 2022). To examine potential effects of the L1, LoI, and structural similarity (SS: i.e., local structural similarity between the grammatical structures) on accuracy rates in the GJTs, a generalized mixed-effects model (GLMM) was used (lme4 package, v 1.1-31: Bates et al., 2015). Participants' L1, LoI and SS were set as fixed effects, while participant and item were set as random intercepts. Random slopes were also included for item interaction with L1 and LoI and for participant interaction with SS.

The relationship between these variables and L3 processing patterns (i.e., each reading measure for each AoI) was examined using GLMM for dichotomous data in five measures and linear mixed-effects models (LMM) in the remaining seven measures. RRT of the verb and the subject in sentences with the ADV+VERB+SUBJ sequence were analyzed through the binomial variable probability of skipping rereading for each AoI (Godfroid, 2020). In attributive sentences, the probability of skipping rereading the

word *nicht* and the linking verb was used instead of RRT for those two AoIs, and the probability of skipping the first reading of the linking verb was used instead of GD in this AoI.

We fitted each separate model using a maximal structure justified by the experimental design. For each dependent variable and region of interest, the initial models included L1, LoI, and SS as fixed effects, as well as their interactions. Random-effects structures were specified by-participant and by-item, initially including random slopes. Model selection followed a stepwise procedure based on likelihood ratio tests, comparing nested models using the ANOVA function in R. Specifically, random-effects structures were progressively simplified by removing slopes that led to convergence issues and did not improve the model fit (Brauer & Curtin, 2018). Post-hoc pairwise comparisons were performed on estimated marginal means using the emmeans package in R, with p-values adjusted using Holm correction.

5. RESULTS

5.1. Grammaticality judgment task

Accuracy scores for the GJT (Appendix C) showed a slight advantage for L1-Spanish (M = 0.88, SD = 0.33) over L1-English speakers (M = 0.86, SD = 0.35) and also for SS between Spanish and German (M = 0.90, SD = 0.29) in comparison to SS between English and German (M = 0.84, SD = 0.37); scores were similar across languages of instruction (English: M = 0.87, SD = 0.34; Spanish: M = 0.87, SD = 0.34). The GLMM (marginal R^2 = 0.038, conditional R^2 = 0.203; Appendix C) revealed no significant effects of learners' L1 (β = -0.16, SE = 0.47, z = -0.35, p = .726, OR = 0.85, 95% CI [0.34, 2.12]), SS with English (Verb+negation) or Spanish (Adverb+verb+subject) word order (β = 0.62, SE = 0.66, z = 0.94, p = .348, OR = 1.86, 95% CI [0.51, 6.85]), or LoI (β = -0.32, SE = 0.46, z = -0.69, p = .487, OR = 0.73, 95% CI [0.29, 1.79]). No significant interactions were found between predictors. These results indicate that no significant differences were observed across L1 backgrounds, structural similarity, or LoI in accuracy scores in the present data.

5.2. Eye-tracking measures

5.2.1. Adverb-verb-subject sequence

5.2.1.1. AOI VERB

For GD on the verb, as shown in table Table III, mean values were lower for L1-Spanish speakers than for L1-English speakers and for sentences where Spanish-German shared the same structure compared to those similar between English and German. In terms of LoI, GD was shorter in Spanish than in English. For TRT, means were lower for L1-Spanish speakers, for sentences that shared English and German word order, and for Spanish as the LoI. Results also show that the mean probability of skipping rereading the verb was lower for L1-Spanish, for English-German SS, and for Spanish as the LoI.

Table III. *Descriptive statistics for GD, TRT, and skipping rereading probability on AoI VERB*

			GD VERB			
	L1-English	**L1-Spanish**	**SS English = German(*)**	**SS Spanish = German**	**LoI English**	**LoI Spanish**
Means	208	183	257	137	199	193
SD	206	187	198	178	205	189
			TRT VERB			
	L1-English	**L1-Spanish**	**SS English = German(*)**	**SS Spanish = German**	**LoI English**	**LoI Spanish**
Means	1230	1140	1041	1336	1213	1159
SD	830	820	763	860	884	757
			Probability of skipping rereading VERB			
	L1-English	**L1-Spanish**	**SS English = German(*)**	**SS Spanish = German**	**LoI English**	**LoI Spanish**
Means	0.65	0.63	0.61	0.67	0.66	0.62
SD	0.47	0.49	0.49	0.47	0.47	0.49

The LMM fitted for GD on the AoI VERB (marginal R^2 = 0.126, conditional R^2 = 0.294) revealed a significant effect of SS (β = 5.89, SE = 1.22, t = 4.82, p < 0.001, 95% CI [3.49, 8.28]) but no significant effects of participants' L1 or LoI, and no significant interactions between factors (Table IV). This result shows that, during first-pass reading of the AoI VERB, GDs were significantly longer for sentences following the English syntactic pattern (SVO), which were ungrammatical in German (Figure 1). Considering the current sample size, a Monte Carlo simulation (500 iterations, α = .05) was conducted to evaluate the detectability of effects. The estimated statistical power to detect SS effects decreased (from 11.8% to 0.0%), suggesting that although the effect reached statistical significance in the present sample, its generalizability should be interpreted cautiously and regarded as exploratory. As for late measures, the LMM for TRT (marginal R^2 = 0.085, conditional R^2 = 0.353) and the GLMM for probability of skipping rereading on the AoI VERB (marginal R^2 = 0.024, conditional R^2 = 0.039) revealed no significant effects for L1, SS, or LoI (Table D1 and Table D2, respectively, in Appendix D).

Table IV. *LMM for GD on AoI VERB*

Gaze Duration VERB					
Fixed effects	***β***	**CI**	**SE**	**t**	***p***
(intercept)	11.086	9.09 – 13.07	1.014	10.929	<0.001***
L1	0.908	-2.7 – 4.60	1.885	0.482	0.636
LoI	0.111	-3.58 – 3.80	1.885	0.059	0.953
SS	5.886	3.49 – 8.28	1.222	4.816	0.0004***
L1:LoI	3.823	-3.57 – 11.21	3.771	1.014	0.326
L1:SS	1.607	-2.18 – 5.40	1.932	0.832	0.418
LoI:SS	1.578	-3.21 – 4.37	1.932	0.300	0.768
L1:LoI:SS	-2.300	-9.87 – 5.27	3.864	-0.595	0.560
Random effects	**Variance**		**SD**		
Participant (intercept)	11.698		3.420		
SS	1.019		1.010		
Item (intercept)	2.242		1.497		
L1	-		-		

Note. Model: lmer(sqrt(First_pass_duration)~ L1*LoI*SS + (1|item)+(SS|Participant)). Statistically significant results ($p < .05$).

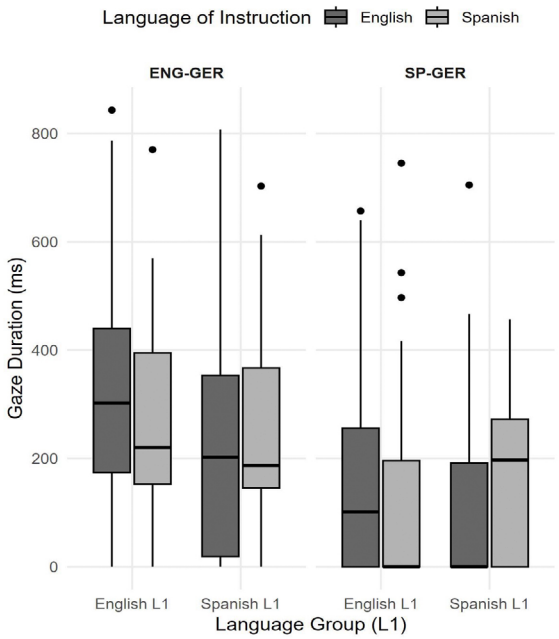

Figure 1. *GD (in milliseconds) on AoI VERB*

5.2.1.2. AOI SUBJECT

Table V shows that for GD on the subject, mean values were lower for L1-Spanish speakers, for sentences with English-German structural similarity, and for English as the LoI. For TRT, mean values were lower for L1-English speakers, for sentences with Spanish-German shared structure, and for English as the LoI. Finally, for the probability of skipping rereading the subject, means were lower for L1-Spanish speakers, for sentences with Spanish-German structural similarity, and for English as the LoI.

Table V. *Descriptive statistics for GD, TRT, and skipping rereading probability on AoI SUBJECT*

GD SUBJECT						
	L1-English	**L1-Spanish**	**SS English = German(*)**	**SS Spanish = German**	**LoI English**	**LoI Spanish**
Means	196	183	157	222	185	195
SD	217	164	170	211	171	218
TRT SUBJECT						
	L1-English	**L1-Spanish**	**SS English = German(*)**	**SS Spanish = German**	**LoI English**	**LoI Spanish**
Means	1012	1129	1169	967	1033	1106
SD	626	722	715	618	652	700
Probability of skipping rereading SUBJECT						
	L1-English	**L1-Spanish**	**SS English = German(*)**	**SS Spanish = German**	**LoI English**	**LoI Spanish**
Means	0.61	0.51	0.57	0.56	0.54	0.59
SD	0.49	0.50	0.49	0.49	0.50	0.49

The model fitted to GD on the AoI SUBJECT (marginal R^2 = 0.036, conditional R^2 = 0.191) revealed a significant effect for SS (β = -3.04, SE = 1.13, t = -2.68, p = .016, 95% CI [-5.26, -0.82]), suggesting an increase in GD on the subject in grammatical German sentences that follow a pattern shared with Spanish (Figure 2). Low marginal R^2 indicates that SS and other fixed effects accounted for only a small proportion of variance. A simulation-based analysis indicated detectability of this effect (76.8% - 99.8%), despite the limited sample size. The model did not detect reliable evidence for effects of L1, LoI, or interactions between factors (Table VI).

Although the LMM for TRT on the AoI SUBJECT (marginal R^2 = 0.098, conditional R^2 = 0.313) did not reveal an effect of L1, SS or LoI (Table VI), a significant interaction was found between participants' L1 and LoI (β = 7.72, SE = 3.46, t = 2.22, p = .041, 95% CI [0.95, 14.51]). This could indicate that L1-Spanish speakers who received instruction in Spanish showed longer TRT on the subject (Figure 3). Crucially, the simulation analysis for this model showed limited detectability of this effect (28.0% - 1.0%). The GLMM for probability of skipping rereading the AoI SUBJECT (marginal R^2 = 0.033, conditional R^2 = 0.139) did not show significant effects of any of the variables (Table D3 in Appendix D).

Table VI. *LMM for GD and TRT on AoI SUBJECT*

	GD SUBJECT					TRT SUBJECT				
Fixed effects	***β***	**CI**	**SE**	**t**	***p***	***β***	**CI**	**SE**	**t**	***p***
(intercept)	10.940	9.07 – 12.81	0.952	11.483	<0.001***	31.639	29.52 – 33.76	1.082	29.247	<0.001***
L1	-0.199	-3.72 – 3.32	1.798	-0.111	0.913	-2.530	-6.16 – 1.10	1.852	-1.366	0.191
LoI	-0.042	-3.57 – 3.48	1.798	-0.023	0.981	-1.766	-5.15 – 1.62	1.729	-1.021	0.323
SS	-3.037	-5.26 – -0.82	1.132	-2.682	0.016*	4.149	-0.06 – 8.36	2.149	1.931	0.068
L1:LoI	1.490	-5.56 – 8.54	3.595	0.415	0.684	7.729	0.95 – 14.51	3.458	2.223	0.041*
L1:SS	0.667	-3.02 – 4.35	1.879	0.355	0.722	-6.270	-13.46 – 0.92	3.671	-1.708	0.107
LoI:SS	0.911	-2.77 – 4.59	1.879	0.485	0.628	-4.279	-10.98 – 2.43	3.421	-1.251	0.230
L1:LoI:SS	1.979	-5.39 – 9.35	3.759	0.526	0.599	12.389	-1.02 – 25.80	6.843	1.811	0.090
Random effects	**Variance**		**SD**			**Variance**		**SD**		
Participant (intercept)	10.251		3.202			8.091		2.844		
SS	-		-			31.275		5.592		
Item (intercept)	1.594		1.263			6.770		2.602		
L1	-		-			7.079		2.661		

Note. GD Model: lmer(sqrt(First_pass_duration)~ L1*LoI*SS + (1|item)+(1|Participant)).
TRT Model: lmer(sqrt(Total_duration_of_fixations)~ L1*LoI*SS + (L1|item)+(SS|Participant)).
Statistically significant results ($p < .05$).

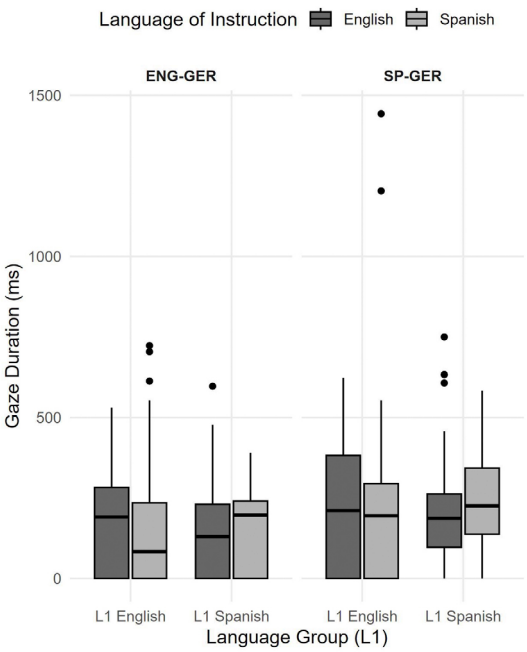

Figure 2. *GD (in milliseconds) on AoI SUBJECT*

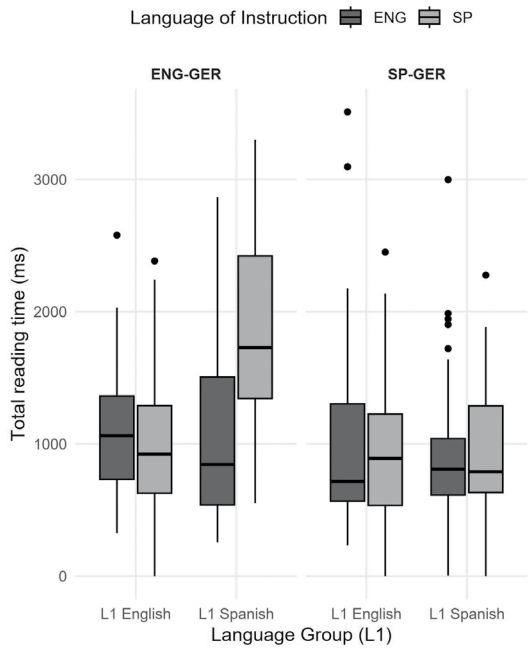

Figure 3. *TRT (in milliseconds) on AoI SUBJECT*

5.2.2. Post verbal negation

5.2.2.1. AOI NICHT

Descriptive statistics in Table VII show that for GD on the AoI NICHT mean values were higher for L1-Spanish speakers, lower in sentences where English and German shared word order, and lower in Spanish as LoI. For TRT, mean values were lower for L1-Spanish speakers, for English-German structural similarity, and for English as the LoI. The probability of skipping rereading this AOI was lower for L1-Spanish speakers, for sentences with English-German structural similarity, and for English as the LoI.

Table VII. *Descriptive statistics for GD, TRT and skipping rereading probability of AoI NICHT*

GD NICHT						
	English L1	**Spanish L1**	**SS English = German**	**SS Spanish = German(*)**	**LoI English**	**LoI Spanish**
Means	180	185	167	197	185	179
SD	153	151	138	164	157	147
TRT NICHT						
	English L1	**Spanish L1**	**SS English = German**	**SS Spanish = German(*)**	**LoI English**	**LoI Spanish**
Means	894	762	751	912	813	852
SD	665	452	547	597	544	612
Probability of skipping rereading NICHT						
	English L1	**Spanish L1**	**SS English = German**	**SS Spanish = German(*)**	**LoI English**	**LoI Spanish**
Means	0.693	0.590	0.599	0.690	0.618	0.673
SD	0.462	0.493	0.491	0.463	0.487	0.470

The model for GD on the AoI NICHT (marginal R^2 = 0.006, conditional R^2 = 0.152) revealed no significant effects of participants' L1, SS, or LoI and no significant interactions. Likewise, no significant effect was identified for any of the independent variables in the model for the probability of skipping rereading this AoI (marginal R^2 = 0.057, conditional R^2 = 0.070). Although descriptive trends suggested higher probability of skipping rereading the AoI NICHT in sentences following the Spanish word order among learners who received instruction in Spanish, this pattern did not reach statistical significance in the model (i.e., interaction between LoI and SS; β = -1.01, SE = 0.52, z = -1.95, p = .051, OR = 0.37, 95% CI [0.13, 1.00]; Table D4 in Appendix D).

Conversely, the model for TRT on this AoI (marginal R^2 = 0.064, conditional R^2 = 0.372) showed a significant effect of SS (β = -3.28, SE = 1.47, t = -2.22, p = .041, 95% CI [-6.17, -0.39]), suggesting higher processing demands for sentences matching the Spanish syntactic pattern, which is ungrammatical in German and English (Figure 4). The relatively low marginal R^2 indicates that fixed effects accounted for a small proportion of variance. A post-hoc simulation indicated the detectability of SS effect increased (69.4% - 99.0%). This result should be interpreted with caution. No significant effects of participants' L1 and LoI were found. See Table VIII for a summary of the LMM for TRT and the GLMM for the probability of skipping rereading on the AoI NICHT.

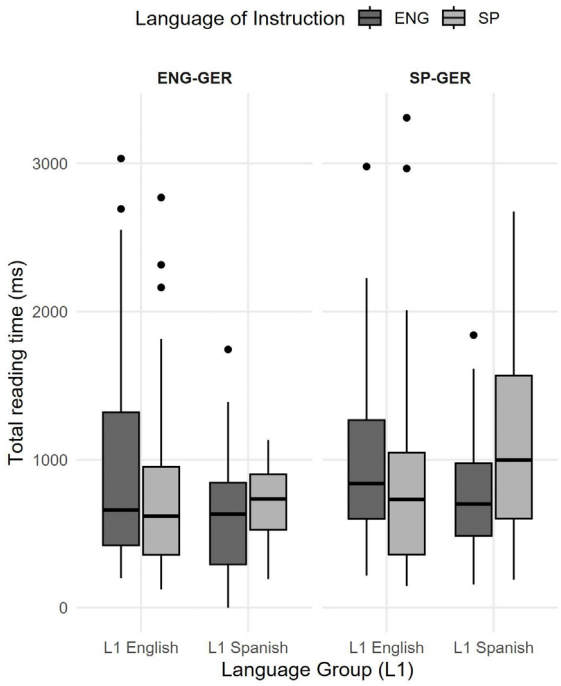

Figure 4. *TRT (in milliseconds) of AoI NICHT*

Table VIII. *LMM for TRT and GLMM for probability of skipping rereading of AoI NICHT*

	Total Reading Time NICHT					Probability of Skipping Rereading NICHT					
Fixed effects	***β***	**CI**	**SE**	**t**	***p***	***β***	**CI**	**OR**	**SE**	**z**	***p***
(intercept)	27.677	25.05 – 30.30	1.339	20.660	<0.001***	0.632	1.43 – 2.48	1.88	0.140	4.494	<0.001***
L1	1.433	-3.49 – 6.36	2.514	0.570	0.577	0.429	0.93 – 2.55	1.54	0.258	1.664	0.096
LoI	-0.325	-5.25 – 4.60	2.514	-0.130	0.898	-0.112	0.54 – 1.49	0.89	0.259	-0.434	0.664
SS	-3.278	-6.17 – -0.39	1.473	-2.224	0.041*	-0.433	0.37 – 1.12	0.65	0.280	-1.545	0.122
L1:LoI	6.624	-3.23 – 16.48	5.028	1.317	0.207	0.184	0.44 – 3.31	1.20	0.516	0.356	0.721
L1:SS	2.869	-1.63 – 7.37	2.294	1.251	0.230	0.462	0.58 – 4.37	1.56	0.516	0.896	0.370
LoI:SS	1.852	-2.64 – 6.35	2.294	0.807	0.432	-1.007	0.13 – 1.00	0.37	0.517	-1.947	0.051
L1:LoI:SS	-2.947	-11.94 – 6.04	4.581	-0.642	0.530	-0.797	0.06 – 3.40	0.45	1.032	-0.773	0.440
Random effects	**Variance**		**SD**			**Variance**			**SD**		
Participant (intercept)	23.848		4.883			0.000			0.000		
SS	8.005		2.829			-			-		
Item (intercept)	3.427		1.851			0.046			0.216		
LoI	-		-			0.001			0.039		

Note. TRT Model: lmer(sqrt(Total_duration_of_fixations)~ L1*LoI*SS + (1|item)+(SS|Participant)).
Skipping Rereading Model: glmer(skipNEG~L1*LoI*SS+(LoI|item)+(1|Participant)). Statistically significant results ($p < .05$).

5.2.2.2. AOI LV

We now turn to reporting processing patterns of the AoI LV. Table IX shows that L1-Spanish speakers had higher probabilities of skipping first reading of the linking verb. Means were also higher in sentences where English and German shared word order and among learners who completed the training using Spanish as the LoI. Mean TRT was lower for L1-Spanish participants, for Spanish-German structurally similar sentences, and for English as the LoI. Mean probability of skipping rereading this AoI was lower for L1-Spanish speakers, for Spanish-German SS, and for English as LoI.

Table IX. *Descriptive statistics for probability of skipping first reading, TRT, and skipping rereading probability of AoI LV*

Probability of skipping first reading of LV						
	English L1	**Spanish L1**	**SS English = German**	**SS Spanish = German(*)**	**LoI English**	**LoI Spanish**
Means	0.371	0.404	0.526	0.243	0.376	0.399
SD	0.485	0.492	0.500	0.430	0.486	0.491
TRT LV						
	English L1	**Spanish L1**	**SS English = German**	**SS Spanish = German(*)**	**LoI English**	**LoI Spanish**
Means	830	640	757	723	694	790
SD	510	380	489	434	437	484
Probability of skipping rereading LV						
	English L1	**Spanish L1**	**SS English = German**	**SS Spanish = German(*)**	**LoI English**	**LoI Spanish**
Means	0.723	0.681	0.829	0.574	0.662	0.748
SD	0.449	0.468	0.378	0.497	0.474	0.436

The GLMM for probability of skipping the first reading of the linking verb in the attributive sentences (marginal R^2 = 0.126, conditional R^2 = 0.265) revealed a significant effect of SS (β = 1.31, SE = 0.37, z = 3.52, p < 0.001, OR = 3.70, 95% CI [1.79, 7.67]). A simulation analysis showed high detectability of this effect (19.2% - 95.0%). This shows that participants were more likely to skip the first reading of the attributive verb in sentences that were grammatically correct in German and English but ungrammatical in Spanish (Figure 5). The model did not reveal significant effects for participants' L1 or LoI.

The LMM for TRT on the AoI LV (marginal R^2 = 0.057, conditional R^2 = 0.281) did not reveal significant main effects or interactions. While descriptive patterns show that learners who received instruction in Spanish may have exhibited longer processing times for German sentences that align with English structure, the model reveals that the interaction between LoI and SS was not significant in the present data (β = 3.49, SE = 1.90, t = 1.84, p = .067, 95% CI [-0.23, 7.23]; Table D5 in Appendix D).

Finally, the GLMM for the probability of skipping rereading the AoI LV (marginal R^2 = 0.131, conditional R^2 = 0.133) showed a significant effect of SS (β = 1.29, SE = 0.29, z = 4.37, p < .001, OR = 3.63, 95% CI [2.04, 6.48]). The results of simulation analyses indicated that the model can detect this effect despite the small sample size (17.2% - 97.6%). Results suggest a higher probability of skipping rereading the attributive verb in grammatical German sentences in which the syntax matches English syntactic patterns only (Figure 6). The model showed no significant effect of L1 or LoI (see Table X below for GLMMs for probability of skipping first reading and probability of skipping rereading the linking verb, respectively).

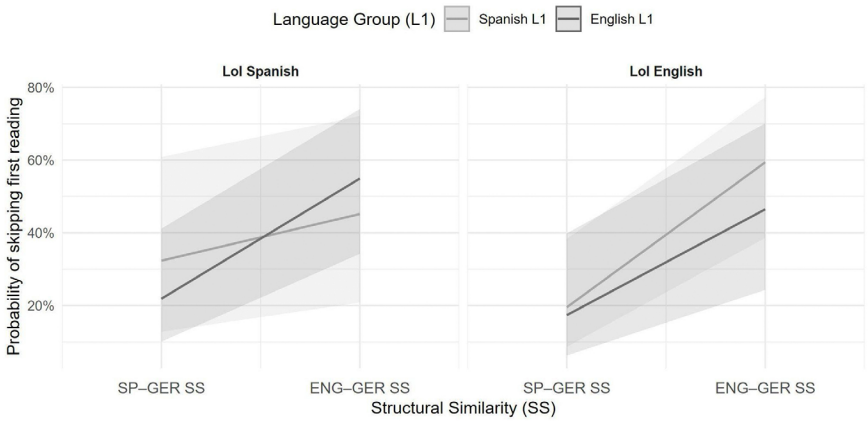

Figure 5. *Probability of skipping the first reading of AoI LV*

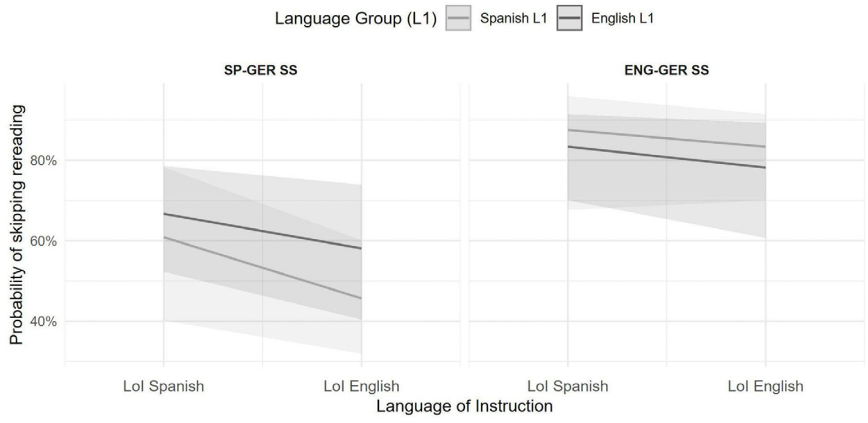

Figure 6. *Probability of skipping rereading AoI LV*

Table X. *GLMMs for probability of skipping first reading and probability of skipping rereading of AoI LV*

	Probability of Skipping First Reading LV						Probability of Skipping Rereading LV					
Fixed effects	***β***	**OR**	**CI**	**SE**	**z**	***p***	***β***	**SE**	**OR**	**CI**	**z**	***p***
(intercept)	-0.593	0.55	0.35 – 0.8	0.237	-2.494	0.012*	0.966	0.148	2.63	1.97 – 3.52	6.514	<0.001***
L1	-0.202	0.82	0.37 – 1.81	0.406	-0.498	0.618	0.019	0.291	1.02	0.58 – 1.81	0.068	0.946
LoI	-0.182	0.83	0.38 – 1.85	0.406	-0.449	0.653	-0.414	0.291	0.66	0.37 – 1.17	-1.421	0.155
SS	1.308	3.70	1.79 – 7.67	0.371	3.520	0.0004***	1.289	0.295	3.63	2.04 – 6.48	4.365	<0.001***
L1:LoI	-0.261	0.77	0.16 – 3.79	0.813	-0.321	0.748	0.124	0.583	1.13	0.36 – 3.55	0.213	0.832
L1:SS	0.274	1.32	0.44 – 3.89	0.553	0.496	0.619	-0.713	0.583	0.49	0.16 – 1.54	-1.222	0.222
LoI:SS	0.600	1.82	0.62 – 5.39	0.553	1.085	0.277	0.155	0.583	1.17	0.37 – 3.67	0.266	0.790
L1:LoI:SS	-1.304	0.27	0.03 – 2.37	1.109	-1.276	0.239	-0.248	1.166	0.78	0.08 – 7.68	-0.213	0.832
Random effects	**Variance**			**SD**			**Variance**		**SD**			
Participant (intercept)	0.387			0.622			-		-			
SS	-			-			-		-			
Item (intercept)	0.234			0.484			0.006		0.077			

Note. Skipping First Reading Model: glmer(skip~L1*LoI*SS+(1|item)+(1|Participant)).
Skipping Rereading Model: glmer(skipV_RR~L1*LoI*SS+(1|item)). Statistically significant results ($p < .05$).

6. DISCUSSION

In this study, we investigated the influence of order of acquisition of L1 and L2, structural similarity between the languages at both whole-language and structure-specific levels, as well as LoI in the initial stages of L3 acquisition. We combined grammaticality judgment and eye-tracking data in a complementary methodological approach to address a methodological gap in L3 acquisition research (Abbas et al., 2021; Angelovska et al., 2020; Rothman et al., 2019).

The GJT model did not detect reliable evidence for differences as a function of order of acquisition, structural similarity, LoI, or their interactions. Accuracy was high and descriptively similar across L1 groups, which indicates that any effect of prior language experience was not detectable in the present sample. This finding differs from previous offline evidence suggesting that the L1 or the L2 is the default source of transfer (Hermas, 2010; Hermas, 2014a, 2014b; Stadt et al., 2020; Bardel & Falk, 2007, 2012; Falk & Bardel, 2011; Bardel & Sánchez, 2017; Falk et al., 2015). Likewise, performance did not differ across LoI groups in the offline task. Our results are in line with Puig-Mayenco et al. (2022) with regards to using the L1 or the L2 to learn an L3. Concerning structural similarity, we observed no statistically significant advantage for the typologically closer language (English) in the untimed GJT. The high overall accuracy may indicate that participants were able to apply the instructed German patterns in the untimed judgment task, but the model did not provide reliable evidence that accuracy differed according to structural similarity. These findings are in line with Lloyd-Smith et al. (2018), whose results discarded the most proximal language as the unique source of crosslinguistic influence since this may arise from multiple prior representations depending on the property under consideration (Jensen et al., 2023; Listhaug et al., 2021; Slabakova, 2017; Westergaard et al., 2017). Given the limited sample size of the present study and the relatively low marginal R^2 (0.038) indicating that our fixed effects explain only a small fraction of the total variance, these findings should be interpreted with caution and validated in larger samples.

In contrast to the GJT results, the eye-tracking models detected several structural-similarity effects across processing regions and measures. These findings are consistent with sensitivity to structural similarity during real-time processing and highlight the importance of examining the time course of processing alongside end-state judgments. Under the assumption that longer reading times signal increased processing effort (Rayner, 2009; Rayner et al., 2011), reading patterns suggest that structural similarity was associated with processing differences, including increased costs in some conditions and facilitation in others.

For instance, the model for the AOI verb detected an effect of structural similarity in GD, with longer reading times for verbs in sentences resembling English SVO order but ungrammatical in German (e.g., **Gestern Politiker <u>kamen</u> zum Campus/Yesterday politicians came to the campus*). However, considering the model fit and post-hoc analyses, this effect should be interpreted cautiously since its stability beyond the present data is limited and it should not be generalized. Likewise, results show that in the ADVERB+VERB+SUBJECT sequence, increased GD on the subject was observed in sentences with the correct German and Spanish-compatible order (e.g., *Oft kommen <u>Studenten</u> in die Bibliothek/*Frequently come students to the library*). Although both

patterns could show increased processing demands at points where the German input diverged from or overlapped with previously acquired word-order patterns, they should be understood as exploratory rather than as conclusive evidence of a specific transfer source.

The findings above can be compared to those in Abbas et al. (2021) regarding early processing of areas of L3 sentences reflecting the structure of one of the previously acquired languages. In our study, structural similarity appeared to be associated with increased early processing times when participants encountered mismatching word orders resembling one of the previously acquired languages. This tendency seemed more pronounced in conditions involving conflict between competing representations, rather than uniformly regardless of grammaticality. Nonetheless, we acknowledge that, despite the structural contrasts implemented in the present mirror-image design, the observed processing patterns may also reflect the concurrent activation of representations associated with both previously acquired languages. Also, it is crucial to acknowledge that although our participants were absolute beginner learners with only a few hours of exposure to L3-German, it is not possible to rule out that increased processing times could reflect their nascent L3 knowledge recently acquired, especially considering the type of training we conducted in which participants received immediate and explicit feedback.

Crucially, what we observed in early processing measures was not consistently mirrored across all late measures associated with more conscious processing and reanalysis (Godfroid et al., 2020), which may suggest that early attentional processes are particularly sensitive to crosslinguistic activation under minimal exposure conditions. Thus, as highlighted by Rothman et al. (2019) and Puig-Mayenco et al. (2022), testing *ab initio* learners enables the observation of initial interactions between prior linguistic knowledge and the emerging L3 system.

A related pattern was observed in the higher probability of skipping the first reading and rereading of the linking verb in grammatical German sentences that followed the English syntax but were ungrammatical in Spanish (e.g., *Die Bibliothek ist nicht rot*/*The library is not red*). In contrast, the analysis showed that TRTs on *nicht* tended to increase in sentences matching Spanish word order. This may indicate more efficient processing when the structure aligns with one of the previously acquired systems, which may reflect sensitivity to the English-compatible word order and higher processing demands for structures where mismatches (i.e., reflecting Spanish syntax) are encountered. As mentioned above, these effects should be interpreted with caution given the possibility of an interaction between previously acquired languages and incipient intralinguistic knowledge of the L3, as well as other methodological factors (e.g., AoI size).

Our models did not provide clear evidence for effects of L1 or LoI. Although some descriptive trends were found, these did not reach statistical significance. For instance, participants who received L3 instruction via Spanish showed a tendency to skip rereading *nicht* more often in German sentences that align with Spanish word order but are ungrammatical in English. Similarly, significant results from our analysis that suggest an interaction between LoI and participants' L1 did not show stability

in the post-hoc simulation and therefore cannot be generalized and interpreted as evidence that instructional language modulates real-time sentence processing. For example, L1-Spanish speakers who received instruction in Spanish showed longer TRTs on the subject of German sentences. While these patterns may be compatible with the possibility that instructional language could modulate sensitivity to structural overlap, they do not provide conclusive evidence.

In summary, our analysis does not provide evidence of significant effects in offline measures and shows limited and selective patterns in online eye-tracking measures. Evidence for L1 and LoI was weak and other patterns involving LoI remained descriptive. However, significant effects of structural similarity were observed in some measures and AoI, both in early and late stages of online processing. These findings suggest a differential role of structural similarity in L3 real-time processing, consistent with accounts proposing that multiple previously acquired linguistic representations may be activated during L3 processing (Abbas et al., 2021; Lloyd-Smith et al., 2018; Slabakova, 2017; Westergaard et al., 2017), although this effect is limited to specific measures in our data.

Our findings contribute to the ongoing dialogue on multilingualism by offering exploratory evidence consistent with property-based accounts of crosslinguistic influence. A methodological strength of this study lies in its design, which addresses previous gaps by combining offline and online measures while controlling for the order of acquisition through a mirror-image design, for LoI, and for specific structural contrasts between the L1 and L2. At the same time, the findings should be interpreted within the study's methodological constraints, including the small sample size, the use of cognates, and the granularity of the AoI. Cognates may have facilitated simultaneous activation of the previously acquired languages, although they were strategically included to reduce lexical processing difficulty during the first hours of L3 exposure.

The definition of the AOIs was guided by the study's focus on structural similarity. Specifically, we selected the critical syntactic positions where German converged with or diverged from Spanish and English (i.e., the verb and subject in the adverb-verb-subject structure, and the linking verb and negation marker in attributive negation). This allowed us to examine whether participants showed processing sensitivity at the point where structural overlap or conflict became available in the sentence. However, this decision also constitutes a limitation. Single-word AOIs may not fully capture spillover effects, regressions, or broader integration processes that unfold across larger sentence regions. Similarly, although GD, rereading measures, and TRT provide useful indices of early and late processing, they offer a partial view of the full range of reading processes. Future studies should combine theoretically motivated critical-word AOIs with broader regions, spillover regions, regression-path measures, and regressions into and out of critical regions. Alternative methodological approaches, including participant-profile comparisons such as subtractive designs, may also offer complementary insights into how the linguistic repertoire influences the processing of specific properties in *ab initio* L3 acquisition.

7. CONCLUSION

The results of the study underscore the differences between online and offline measures, as the lack of detected effects in the grammaticality judgment task contrasts with the patterns observed in the eye-tracking data, which reveal the complexity of morphosyntactic processing in the initial stages of L3 acquisition. Given the limitations related to sample size and model sensitivity, these findings should be interpreted as exploratory. The strongest evidence concerns structural similarity, which was associated with processing differences across early and late measures, including increased processing effort in some conditions, particularly when learners encountered mismatches between competing linguistic representations, and facilitation in others. Evidence for LoI was limited to descriptive patterns and emerged mainly in interaction with learners' prior linguistic knowledge in online processing patterns rather than offline performance.

These findings further highlight the importance of examining the time course of processing, as online measures may capture sensitivity to crosslinguistic activation that is not reflected in offline judgments, especially under minimal exposure conditions. At the same time, they point to the importance of acknowledging the learner's background in the language classroom to understand the potential difficulties they may face and provide appropriate instruction that considers their background linguistic knowledge. Further research should explore this phenomenon from an online approach that incorporates additional techniques, including extensive instruction and more testing times. Future studies should ideally involve bigger samples, different sets of languages, and a variety of grammatical properties to gain a more robust understanding of how the three languages interact in the initial and subsequent stages of L3 acquisition.

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