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Learning multiple L2 syntactic structures via chat-based alignment: What is the role of learners' prior knowledge and conscious decisions?

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ABSTRACT

This study investigated whether written chat-based activities foster alignment and learning of multiple simultaneously-targeted second language (L2) syntactic structures. It further examined how these were affected by prior knowledge of the targeted structures and learners' decisions to use or avoid each structure. We tested 47 Spanish first language (L1) speakers learning L2 English. In a chat-based activity with an L1 English speaker, we examined alignment in the production of three target structures that differed in their likely familiarity for participants (genitives, passives and datives) by comparing target structure production after prime versus baseline sentences. We also compared target structure production in a post-test relative to a pre-test to assess learning (increased structure usage) and we asked participants whether they made conscious decisions to use or avoid the structures. The learners experienced chat-based alignment and learning across structures. Although prior knowledge and decisions did not significantly affect alignment and learning, more prior knowledge and choosing to use the targeted structures increased overall target structure production. Thus, chat-based activities are well-suited to support L2 grammar learning, even when they embed multiple structures. However, instructors may need to encourage learners to explicitly use the targeted structures to maximize alignment tasks' language learning outcomes.

1. Introduction

Alignment occurs when the representations of interlocutors engaged in an interaction become aligned and is thought to rely on a priming mechanism whereby interlocutors reuse each other's semantics, lexicon or syntactic structures (Branigan, Garrod, & Pickering, 2014; Pickering & Garrod, 2004). While interactionist perspectives in Second Language Acquisition (SLA) postulate that interactions foster second language (L2) learning (Gass, 2003; Gass & Mackey, 2007; Long, 1996; Pica, 1994), McDonough and Chaikitmongkol (2010) propose that this could be the case because such interactions involve linguistic alignment. Accordingly, psycholinguistic and applied linguistic research conducted with L2 learners suggests that alignment effects help learners acquire L2 syntactic knowledge (Jackson, 2018; McDonough & Mackey, 2008; McDonough & Trofimovich, 2008).

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However, alignment research with L2 learners has overlooked three key issues that are directly relevant to L2 pedagogy. First, L2 alignment studies typically target one syntactic structure at a time (but see McDonough, Trofimovich, & Neumann, 2015; Shin & Christianson, 2012). None have investigated alignment and learning effects across multiple syntactic structures *within one task*, although language learning activities may embed exposure to a variety of structures. Second, though the magnitude of alignment and resultant learning effects varies widely across structures, it remains unclear why this is the case and what the implications are for our understanding of the mechanisms of alignment and for L2 learning and teaching. Third, while most L2 alignment studies focus on oral interactions, text-based chatting is an under-studied but promising medium for L2 learning (Gilabert, Manchón, & Vasylets, 2016; though see Kim, Jung, & Skalicky, 2019; Kim, Skalicky, & Jung, 2020), that may help L2 learners with processing the target language (Ziegler, 2016). Since learning and teaching increasingly takes place online (Maican & Cocorada, 2021), and governments encourage the development of digital tools for language teaching (European Union, 2019), it is highly relevant to explore the suitability of this medium of alignment.

Thus, we assessed whether L2 learners exhibit alignment for three different syntactic structures in a written chat interaction and how this relates to L2 syntactic learning. We also examined which factors could account for between-structure differences in alignment. In this article, we use the terms "alignment" to designate both syntactic priming and its linguistic manifestation (Kim et al., 2020; Michel & Smith, 2018) and "chat" to refer specifically to written chat (also known as written Synchronous Computer-Mediated Communication (SCMC)).

1.1. L2 alignment and learning

Several psycholinguistic theories define alignment as the outcome of an implicit language learning mechanism (Chang, Dell, & Bock, 2006; Chang, Janciauskas, & Fitz, 2012; Dell & Chang, 2013; Jaeger & Snider, 2013; Malhotra, Pickering, Branigan, & Bednar, 2008; Reitter, Keller, & Moore, 2011). For example, Chang et al. (2006) postulate that alignment relies on an error- and prediction-based language learning mechanism whereby prediction error experienced during sentence processing leads to changes in the representations of that structure. These changes increase the likelihood of the structure being reused immediately (alignment) but are also persistent changes that lead to increased likelihood of the structure being used in the longer-term (learning).

There is much evidence that alignment supports L2 learning. Via alignment, L2 speakers learn to produce native-like language forms (Kim et al., 2019; McDonough & Chaikitmongkol, 2010; McDonough & De Vleeschauwer, 2012; McDonough & Mackey, 2008), or to produce a previously dispreferred or unfamiliar structure more frequently (Kim & McDonough, 2008; McDonough & Fulga, 2015; Shin & Christianson, 2012), and this learning can persist over time (e.g., Hurtado & Montrul, 2021; Jackson & Ruf, 2018; McDonough & Mackey, 2008). From a pedagogical point of view, alignment tasks seem an appropriate tool for language instructors to use to model and elicit structures which are infrequent, syntactically complex or which learners do not spontaneously produce, within meaning-focused activities and with a variety of lexical items (McDonough, 2006).

However, previous research reports varying patterns of alignment for different syntactic structures (see Jackson, 2018 for a review). In face-to-face interactions, for instance, alignment effects differ between dative structures (McDonough, 2006), datives and phrasal verbs (Shin & Christianson, 2012) and relative or adverbial clauses and passives (McDonough et al., 2015). This may have important implications for models of alignment and consequently L2 pedagogy. Though alignment is typically defined as an automatic and implicit process (e.g., Chang et al., 2006; Chang et al., 2012), Costa, Pickering, and Sorace (2008) hypothesize that the extent to which L2 learners experience automatic and implicit alignment, and therefore exhibit alignment across structures, varies according to other factors. Specifically, learners' experience with the target language determines their ability to automatically retrieve a specific linguistic representation and conscious processes may influence their choice to re-use a specific structure, or not. These predictions remain largely unexplored so far.

1.1.1. Alignment, automaticity and prior knowledge

Costa et al. (2008) predict that L2 learners should show reduced automatic alignment on structures they have experienced the least frequently and for which they have, as a result, the least prior knowledge, since their linguistic representations should be more difficult to retrieve. In line with this, there is evidence that syntactic representations of infrequent structures are less available for alignment: German learners of Spanish display small alignment effects on Spanish subjunctives (Michel & Stiefenhöfer, 2018), possibly because subjunctives are generally infrequent both in Spanish and in German. By contrast, L2 learners exhibit larger alignment with the structures that are more frequent in their first language (L1) or their L2 (Hurtado & Montrul, 2021; Jackson & Ruf, 2018). Such patterns of results contradict the predictions of implicit language learning models of alignment however. Error-based learning models state that participants should exhibit more alignment with less frequent structures as they are more likely to experience prediction error with them (Chang et al., 2006, 2012; Jaeger & Snider, 2013). In Reitter et al.'s (2011) base-level learning model, exposure to a target structure increases its base-level activation and such increases benefit infrequent structures more, triggering larger alignment for these structures. Some L2 alignment studies provide empirical support for these predictions (Kaan & Chun, 2018; McDonough & Fulga, 2015; Shin & Christianson, 2012).

Therefore, the evidence for how prior knowledge of a structure modulates within-L2 alignment is mixed, and direct within-participants comparisons of structures that vary in their likely frequency and existence in the L2 learners' L1 remain rare. Moreover, only two studies to our knowledge have directly assessed target structure knowledge using grammaticality judgement tasks, and examined how it related to syntactic alignment, but they led to conflicting results (Kim et al., 2019, 2020). Finally, it is still unclear how such knowledge relates to long-term learning from alignment, although some research suggests that alignment only translates to long-term learning if participants have some minimal initial knowledge of the target structure (Jackson & Ruf, 2018; McDonough,

2006; McDonough & Fulga, 2015).

1.1.2. Alignment and conscious processes

Costa et al. (2008) also propose that L2 learners' conscious decisions could determine whether they display alignment or not for a specific structure. Post-task questionnaires in alignment studies reveal that learners often become aware of the structures targeted in alignment activities (Grüter, Zhu, & Jackson, 2021; Jackson & Ruf, 2018; Kim et al., 2020; Michel, 2018; Michel & Stiefenhöfer, 2019). Such awareness could allow learners to deliberately choose to use or avoid producing the target structure(s) (Costa et al., 2008; Ruf, 2011).

Relatedly, there is evidence that noticing the target structure can boost alignment. Explicit manipulations to make L2 learners notice the target form increase alignment (Shin & Christianson, 2012) and one study reported that only L2 learners who detected the target form experienced immediate alignment (McDonough & Fulga, 2015). Noticing may enhance alignment because L2 learners deliberately decide to re-use the syntax of their interlocutors (e.g., Grüter et al., 2021). For instance, in post-alignment task interviews, participants report having frequently used their partner's language while composing their own sentences (Michel, 2018; Michel & O'Rourke, 2019). When interacting with a native speaker, learners could take such a decision if they are particularly interested in improving their L2 skills (Costa et al., 2008), want to seize the opportunity to practice producing the target structure or if they wish to sound like a native speaker (Ruf, 2011).

L2 learners may also decide to avoid producing a target structure they notice (Jackson & Ruf, 2018; Michel & Stiefenhöfer, 2019; Ruf, 2011). For instance, learners sometimes report producing the least syntactically complex structure or the structure requiring the least amount of effort, such as the one that is faster to type (Kim et al., 2020). L2 learners' metalinguistic knowledge about their ability to produce the target structure may also affect their decision to repeat it or not (Costa et al., 2008). Although they did not relate it to explicit avoidance decisions, Shin and Christianson (2012) observed that their learners aligned less on more syntactically complex forms. In a personal communication, one participant in our own unpublished study reported deciding to use active rather than passive sentences because they felt more confident doing so and they were worried about making "silly mistakes" when producing passives.

To sum up, there is evidence that L2 alignment may be influenced not only by speakers' prior knowledge of the prime syntactic structure, but also by deliberate decisions to use or avoid producing it. Thus, as Costa et al. (2008) predict, alignment patterns could vary across structures because, while L2 learners may experience some implicit alignment from interactions, their prior knowledge and conscious decisions could operate in different ways for different structures (e.g., depending on their complexity). Yet, the effects of these two factors on alignment behaviour and the resulting learning remain largely unexplored. By directly comparing alignment across different structures within learners, we can investigate more systematically their impact on alignment and learning.

1.2. L2 learning via alignment in chat-based interactions

Research suggests that L1 speakers manifest alignment in written chat-based contexts to a comparable extent as in oral interactions (Hartsuiker, Bernolet, Schoonbaert, Speybroeck, & Vanderelst, 2008). However, while most L2 alignment studies have examined face-to-face oral interactions, text-based chat interactions may be particularly beneficial for L2 learners (Smith, 2005), and may facilitate L2 learning via alignment. This context preserves most of the interactivity of face-to-face conversations but is also like conversing in slow motion (Beauvois, 1992): the sentences of the interlocutors remain on the screen, learners can scroll up and down the conversation and have more time to formulate their own sentences. The written modality also gives L2 learners the opportunity to rely on self-paced processing and may make the target syntactic structures particularly salient (Kim & Godfroid, 2019; Sauro, 2009). This could in turn help L2 learners understand and process the linguistic input (Gilabert et al., 2016), and notice the targeted structure (s) (Kim et al., 2020; Ziegler, 2016), which is thought to foster L2 learning (Doughty & Long, 2003; Long, 1996; Schmidt, 1990).

A recent SLA meta-analysis comparing learning outcomes between chat-based and face-to-face interactions revealed that L2 learners' productive skills benefit more from the former type of interaction (Ziegler, 2016). The few L2 alignment studies conducted in chatting environments indicate that alignment does occur in this context (Collentine & Collentine, 2013; Kim et al., 2019, 2020; Michel & Cappellini, 2019; Michel & Stiefenhöfer, 2019; Uzum, 2010) and that such alignment may be larger than in face-to-face interactions (Kim et al., 2019, 2020). Moreover, chat-based alignment tasks seem to lead to long-term learning in language production (Kim et al., 2019, 2020).

However, such studies are rare, and more research is needed to determine the conditions of alignment in this environment and its impact on long-term learning. For example, whether alignment in this context extends beyond the use of a single syntactic structure or alternation is unknown. By including a variety of structures in a chat-based interaction, we can determine whether L2 learners experience alignment effects and language learning when exposed to multiple syntactic structures simultaneously. Moreover, it is still not well understood whether learners' knowledge or conscious decisions to use a given structure influence chat-based alignment. However, if chat-based interactions indeed promote noticing of the target structures, they should provide an ideal environment to test whether alignment in L2 learners is influenced by conscious decisions. To our knowledge, Kim et al. (2020) present the only study to consider the possible effects of these factors on alignment in this context, but it did not systematically test the effect of decisions on alignment.

As well as addressing theoretical questions about models of alignment, investigating these issues is particularly relevant for L2 pedagogy. First, it allows us to assess whether it is possible to foster practice and learning of multiple structures within a single alignment task. This cross-structures comparison can also reveal which structures can best be learned via alignment activities depending on the learners' state of knowledge (Jackson, 2018). Finally, understanding the nature of alignment and how much it relies on implicit or explicit (i.e., conscious decisions) processes will allow us to understand how each type of process relates to long-term

language learning. This can help instructors identify whether giving learners explicit instructions to copy structures supports L2 learning further.

1.3. Present study

This study addressed the following research questions:

1. To what extent do learners exhibit alignment in a chat-based interaction that includes multiple syntactic structures?
2. To what extent does such alignment lead to long-term syntactic learning?
3. Are the magnitude of alignment and the resulting learning mediated by learners' prior knowledge of the target structures and their conscious decisions?

We invited Spanish L1 speakers learning English to interact with the experimenter in a chat-based alignment task. We measured alignment by comparing participants' production of the target structures following prime sentences that contained the target structures relative to syntactically-unrelated baseline prime sentences. We also assessed long-term syntactic learning, that is, whether the alignment task fostered long-term changes in L2 speakers' syntactic representations and preferences. To do so, we measured whether participants produced the targeted structures more in a post-test that immediately followed the alignment task relative to a pre-test completed before the alignment task. We examined learners' alignment and learning of three English syntactic structures: "of" genitives (e.g., "The laptop of the girl"), passives (e.g., "The surgeon is being followed by the policeman"), and double object (DO) datives (e.g., "The monk is giving the judge the apple"). We chose these target structures because participants were likely to have experienced them with varying frequency levels in their L1 and L2 and therefore, to have varying degrees of prior knowledge for each of them. We also expected participants to take different decisions regarding the use or avoidance of each of them, as described below.

1.3.1. Target structures

1.3.1.1. "of" genitives. In English, genitives can be formed in two ways: by placing the owner of the object after the object that is owned in a preposition phrase headed by "of" ("of" genitives, 1a) or by placing the owner before the object that is owned with possession marked by "'s" on the owner ("'s" genitives, 1b). Genitives in Spanish can only be formed in a preposition phrase with 'de' (of) and follow the same word order as English "of" genitives (1c). Thus, we expected L2 learners to have experienced the "of'" genitive structure more frequently and to have more prior knowledge of it than of "'s" genitives overall. It was unclear whether they would decide to use "of" genitives because they were more familiar with them or whether they would avoid "of" genitives because they were longer to type.

(1) a. The mirror of the seller.
b. The seller's mirror.
c. El espejo del vendedor.

The mirror of-the seller.

1.3.1.2. Passive sentences. English passive sentences require a subject noun phrase with a patient in sentence-initial position, followed by an auxiliary verb, a past participle and optionally, a "by-phrase" with an object noun phrase for the agent (2a). Spanish has both this structure (2c) and impersonal passives which use the pronoun *se* (2d). While passives do lead to within-L2 alignment effects (e.g., Flett, 2006), they are more syntactically complex than actives (2b) and usually highly dispreferred. Thus, we expected that L2 learners' prior knowledge would make the active form (which has the same form as the Spanish active transitive, 2e) more available than the passive form. We also expected them to be more likely to decide to avoid producing passive sentences because they would be longer to type and more difficult than active sentences.

(2) a. The adults are being followed by the kids.
b The kids are following the adults.
c Los adultos están siendo seguidos por los nińos. The adults are being followed by the kids.
d *Se* está siguiendo a los adultos. *impersonal reflexive pronoun* is following to the adults. The adults are being followed.

1.3.1.3. DO datives. English has two structures for expressing dative (transfer) events: the DO dative where the recipient is placed immediately after the verb and before the theme (3a) and the prepositional object (PO) dative in which the theme of the transfer event is expressed immediately after the verb and before the recipient which appears in a preposition phrase (3b). By contrast, Spanish only has PO datives (3c), with an optional pre-verbal dative clitic agreeing with the recipient. Thus, we expected L2 learners to have experienced PO datives more frequently overall than DO datives, making the former more likely to be the automatically-selected structure. Whilst learners may decide to use DO datives since they are shorter to type, we expected learners to be more likely to choose to avoid them as they would be less familiar and therefore less confident with them (Costa et al., 2008).

(3) a. The girl is giving the adult the bag.
b The girl is giving the bag to the adult.
c La niña (le) está dando la bolsa al adulto.

The girl (him) is giving the bag to-the adult.

1.3.2. Predictions

Overall, we expected L2 learners to experience chat-based alignment (increased use of target structures following prime sentences relative to unrelated sentences) and learning, that is, increased use of the target structures from pre-to post-test, across structures (e.g., Hurtado & Montrul, 2021; Kim et al., 2019; Kim et al., 2020). If learners experience more alignment on structures whose linguistic representations are the most available (Costa et al., 2008), they should show the most alignment on "of" genitives, followed by passives and DO datives. This is because "of" genitives are the only option for possessives in Spanish, passives exist in Spanish but are less frequent than actives and other forms like the impersonal passive, and DO datives do not exist in Spanish. For each structure, however, if learners are influenced by conscious decisions to align, as Costa et al. (2008) propose, they should experience the least alignment when choosing to avoid producing the target structure and the most when deciding to use it. On the contrary, if alignment largely relies on implicit language learning mechanisms (e.g., Chang et al., 2006; Chang et al., 2012; Reitter et al., 2011), learners should show the most alignment on structures they have the least prior knowledge of (i.e., DO datives) and show alignment regardless of their decisions. How decisions relate to learning in language production was an exploratory question.

2. Methodology

We tested our predictions in a two-part online experiment. Participants completed a picture description task to assess their baseline production of the targeted structures. Then, they interacted with an experimenter via an online chat in a joint picture-searching task designed to induce alignment. They completed a second picture-description task to measure learning and were questioned on their conscious decisions. We also measured L2 speakers' proficiency to assess whether chat-based alignment and the resulting learning would vary as a function of their L2 abilities (e.g., Sinclair, Lopez, Lucas, & Gasevic, 2018). All materials, the complete dataset, and preregistration of the analysis are available on a dedicated OSF repository (preregistration: https://osf.io/kjcvp; materials, dataset, and code of analysis: https://osf.io/9vsdj/).

2.1. Participants

We tested 47 Spanish L1 speakers (30 female), learning English as a second language. They were students recruited by contacting universities in Spain, and all received a €15 Amazon voucher as reimbursement. The study was approved by the Humanities and Social Sciences Research Ethics Committee at the University of Warwick. Informed consent was obtained prior to the test session. Participants were aged between 18 and 25 years old ($M = 19.18$) and their proficiency scores on the English LexTALE test (Lemhöfer & Broersma, 2012) ranged from 53.75 to 95 ($M = 73.20$, $SD = 10.79$). Hence, while the participants were of upper intermediate proficiency on average (LexTALE scores between 60 and 80% correspond to a B2 level), they exhibited a wide range of proficiency levels with LexTALE scores below 59% corresponding to a B1 or lower level and scores between 80 and 90% representing C1 and C2 levels (Lemhöfer & Broersma, 2012).

2.2. Materials

2.2.1. Production task

Participants completed a pre- and a post-test production task on Qualtrics which assessed whether they experienced learning.

Fig. 1. Production task stimulus. Example of a genitive trial.

Participants were instructed to describe 24 pictures per task. We created 6 target images per structure, and 6 filler images (showing intransitive events) using different verbs and different combinations of objects and characters for each test (based on stimuli from Hardy, Messenger, and Maylor (2017) and Jackson and Ruf (2018)). Each picture contained word labels for the characters, objects and verbs they depicted to aid vocabulary retrieval. For the transitive, dative and intransitive targets, participants were prompted with "what is happening in this picture?". The position of the agent characters was counterbalanced to appear an equal number of times on the right vs. left side of the pictures for the transitive and the dative events. The pictures targeting the genitive alternation contained two characters with the same object. To ensure that participants would use genitive constructions, one of the characters' objects was coloured and participants' descriptions were prompted by "which <OBJECT> is blue?" (cf. Bernolet, Hartsuiker, & Pickering, 2013, Fig. 1). In addition, we explicitly instructed participants to use the form "the _____ is blue". The order of presentation of pictures was randomized across participants.

2.2.2. Alignment task

The alignment task was embedded within a picture-searching task in which participants labelled items for their chat partner to find within a larger picture. The chat therefore involved exchanging descriptions and possible locations for the item in the larger picture and determining whether the item was in that location. We divided four "Where's Wally?" pictures into grid squares designated by combining a letter and number reference (e.g., A2, C4, …) according to their row and column in the grid. Using these four pictures, we created 72 experimental target items (24 per syntactic structure) describing either an action (for passives and DO datives) or a character and their object (for "of" genitives) depicted in one of them (Table 1). Each target item was associated with an experimental prime which contained the target structure and a baseline prime which contained an unrelated syntactic form (e.g., an intransitive form). We created 36 experimental primes (12 per structure) containing different verbs, objects and characters in order to avoid lexical overlap and 36 baseline primes (12 per structure) based on other actions and objects in the pictures. Each prime (experimental or baseline) was associated with two target sentences.

We distributed the 72 experimental trials equally between the four "Where's Wally?" pictures. Therefore, each picture was associated with 18 target sentences (6 passives, 6 "of" genitives and 6 DO datives), 9 experimental primes (3 per structure) and 9 baseline primes (all intransitive). We created two different lists with the same 72 target structures so that a given target sentence was paired with an experimental prime on one list, and with a baseline prime on the other; participants were randomly assigned to a list. This created eight picture description sets: four experimenter sets containing the prime sentences and four participant sets containing the target sentences. Each set corresponded to one of the four "Where's Wally?" pictures. The participant sets showed close-up pictures of the target items (Fig. 2). On each picture, label words for the characters, the objects and the verbs were provided to prevent problems of vocabulary retrieval and avoid code-switching or lexical overlap between the prime and target sentences. The word position was counterbalanced across items. For the genitive target sentences, the word labels corresponding to the targeted objects (e.g., "bag" in the genitive "the bag of the woman") were coloured in red to indicate to participants that the experimenter had to find the object as well as the character, and therefore that a genitive description was required. The experimenter's picture description sets provided the prime sentences corresponding to each picture to ensure correct production of the prime sentences. The order of the pictures was pseudo-randomized so that there were never two consecutive target sentences targeting the same syntactic structure. The order of prime-target pairings was the same for all participants. Additionally, all picture description sets designated a grid reference where the target item might be found (Fig. 2). To create the searching task, only 25% of these references were accurate.

2.2.3. Post-task questionnaire

We evaluated whether participants noticed the target structures and relied on conscious decisions during the alignment task in a post-task questionnaire on Qualtrics, which also probed the reasons underlying these decisions. We showed participants the name of each targeted grammatical structure, three sentences containing the structure in question and an explanation of how to build it. For each structure, we first asked participants whether they had noticed the target structure during the collaborative alignment task; possible answers were "yes", "no", "maybe". Then, we asked about participants' conscious decisions by asking them whether they deliberately tried to (1) avoid, (2) use/copy or (3) neither avoid nor use the structure during the chat. If they selected option 1 or 2, they were presented with a further open-ended question asking them why they had taken that decision.

2.2.4. Grammaticality judgment task

Participants also performed a pre- and post-alignment grammaticality judgment task. This showed good pre-alignment knowledge of each target structure (mean proportion of accurate responses: "of" genitives 83%, passives 91%, DO datives 69%) and no significant improvement in scores following the alignment task (see Shin and Christianson (2012) for similar results). To avoid unnecessary length, we do not describe or report it further in this manuscript, but details about the methods, the scoring and the analysis of this task are available on the OSF.

Table 1
Stimuli. Example of baseline prime-target and experimental prime-target combinations for each target structure.

Target structure	Baseline prime	Experimental prime	Target sentence
DO dative	The kids are running.	The woman is throwing the man the ball.	The man is showing the boy the towel.
"of" genitive	The woman is swimming.	The scarf of the girl.	The shovel of the boy.
Passive	The man is suffering.	The man is followed by the girl.	The boy is being scolded by the woman.

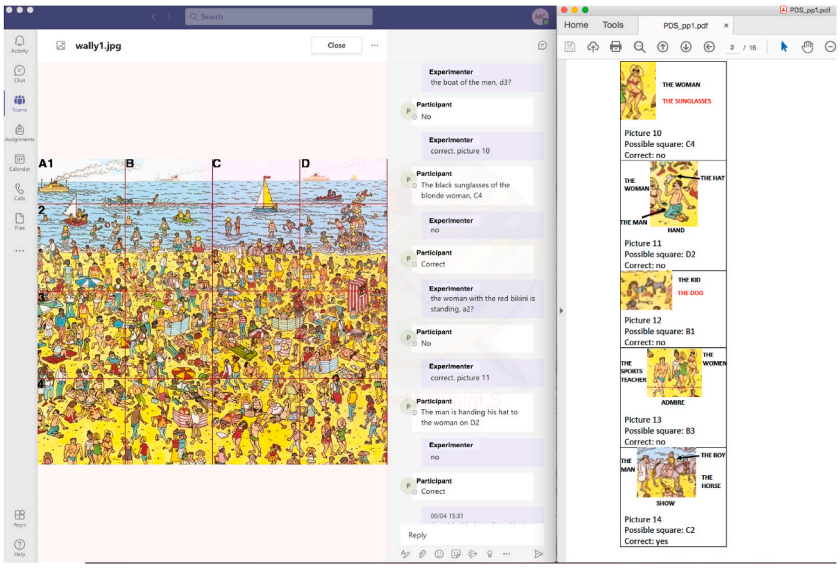

Fig. 2. Alignment task. Participant set up. a) Overall alignment. b) Alignment per structure.

2.3. Procedure

Participants were informed that the study was about how people chat in a second language. The study was split into two parts. In the first part, after signing the informed consent, participants completed a language background questionnaire, followed by the English LexTALE test and the pre-test production task.

The second part of the study was performed at least five days after the first part. Participants first completed the alignment task on Microsoft Teams (Fig. 2) which was divided into four blocks corresponding to each "Where's Wally?" picture. Each picture was saved in the Teams meeting channel. Before each block, the participant was asked to open the corresponding picture description set on their desktop and the "Where's Wally?" picture in the Teams meeting channel. The Teams conversation function, which appears as an instant messaging conversation on the side of the open picture file, was used for the chat. Participants were told that they would be interacting with an English L1 speaker. At the beginning of each prime-target trial, the experimenter wrote a description (prime sentence) in the chat as well as a grid reference. The participant indicated whether the described element was in the indicated grid square by searching in the "Where's Wally?" picture and typing their response ('yes' or 'no'). The experimenter provided feedback to the participant ('correct' or 'incorrect'). Next, the participant wrote a description of the first picture presented in their picture description set in the chat (target sentence) and cited the provided grid reference. They were instructed to use the label words to formulate their descriptions but were allowed to use additional adjectives or complements to make their descriptions more precise (e.g., "the horse of the man *with the grey t-shirt*"). The experimenter then checked whether the described picture element was in the indicated grid square and typed their response. The participant was asked to provide feedback before the next trial started. Once all target pictures had been described, participants were sent a link to reach the post-test production task and questionnaire. There was no time constraint on any of the tasks.

2.4. Scoring

2.4.1. Production and alignment tasks

Target sentences were coded for whether they were "of" or "'s" genitives, active or passive sentences, PO or DO datives, or 'other'. Complete "'s" genitives contained a possessor marked with an 's followed by the possessed object; complete "of" genitives contained a possessor placed after the possessed object with the preposition "of" between them. Complete active sentences contained a subject noun phrase with the agent produced first, followed by the verb and finally, an object noun phrase with the patient; complete passive sentences contained a subject noun phrase with a patient in first position, followed by a form of the verb "to be", a past participle and finally, a by-phrase with an agent. Complete PO datives contained a ditransitive verb followed by a noun phrase with the theme role followed by another noun phrase with the recipient/goal role introduced by the preposition "to"; complete DO datives contained a ditransitive verb followed by a noun phrase with the recipient/goal role followed by another noun phrase with the theme role.

We ignored morphological errors, such as tense or agreement errors and naming errors in which participants used an alternative noun for a character (e.g., naming a character "the judge" instead of "the teacher"). We included "'s" genitives where the apostrophe was missing ("The boys shovel"); actives where participants included the preposition "to" (e.g., "the man is chasing to another man") as we hypothesized that they reflected cross-linguistic transfer of the Spanish preposition "a" in Spanish active sentences with an animate patient (e.g., "la mamá está persiguiendo **a** la niña"). For dative and transitive sentences, we included sentences with complex noun

phrases (e.g., "the teacher kicked the clown's leg"), sentences with an added auxiliary (e.g., "the waitress does kick the jester") or with negation (e.g., "the fighter does not chase the robber") as well as sentences with inverted nouns ("The men are being watched by the kids" instead of "The kids are being watched by the men" or "The boy is showing the man the horse" instead of "The man is showing the boy the horse"), since for some target pictures it was ambiguous as to which character would be the agent of the event and either interpretation was plausible. All other responses were excluded, including actives that were not paraphrasable with a passive (e.g., with a modal auxiliary), incomplete sentences (e.g., with a missing complement) and misaligned trials. Participants produced 4602 sentences with the target structure or its alternative and 474 'other' responses; see Table 2 for a breakdown of response types by structure and experiment phase.

2.4.2. Conscious decisions

We grouped participants by their response on the conscious decision questions for each structure as Avoid, Use or No Decision. For the purpose of the analyses, the Avoid group were coded 0, the No Decision group were coded 1, and the Use group were coded 2 (see Table 3 for proportions).

3. Analysis

Since our dependent variables were binary, we analysed the data for alignment and learning effects with Generalized Logistic Mixed Models (GLMM) (Baayen, Davidson, & Bates, 2008; Jaeger, 2008). The dependent variable was coded as 0 = alternative structure (i.e., "'s" genitive, active or PO dative) and 1 = target structure (i.e., "of" genitive, passive or DO dative). Participants' LexTALE scores were centred. The factorial predictors Prime (experimental vs. baseline prime) and Section (pre-test vs. post-test) were sum contrast coded to have a mean of 0 and a range of 1 prior to analysis. We applied treatment contrast coding for the predictor Structure and defined "of" genitives as the reference level since we expected learners to be most likely to experience alignment on this structure. The contrast 'Structure 1' compared the production of passives to "of" genitives and 'Structure 2', compared datives to "of" genitives. We used multiple contrasts to compare alignment in the Avoid decision group (−0.66) to the Use (0.33) and No Decision (0.33) groups combined (Decision 1), and to compare the Use (−0.5) to No Decision (0.5) groups (Decision 2). We chose this contrast because we expected participants to show the least alignment in the Avoid group, the most in the Use group, and alignment to be more variable in the No Decision group.

For each analysis, we started with a full model including maximal by-subject and by-item random effect structures (Barr, Levy, Scheepers, & Tily, 2013) and tried to locate the best model that did not differ significantly from the full (converging) model in terms of variance explained but did differ from a null model which only included the intercept term as a predictor, as shown by ANOVA comparisons. Where models did not converge, we removed random slopes and interactions before main effects, starting with those accounting for the least variance. We report the results of the best models. All p-values for individual predictors were obtained from the model summary output.

We could not reach converging models that contained the three-way interaction of interest between Decision, Structure and Prime/Section. Therefore, we first examined alignment or learning across structures (Prime/Section x Structure x LexTALE score); we then explored the overall effect of Decision on alignment and learning (Prime/Section x Decision x LexTALE score); finally, we analysed the effect of Decision for each structure separately. We tested non-significant interactions between Prime/Section and Structure or Decision using the Bayesian information criterion (BIC) values of the models to estimate the Bayes Factor (BF) as $e^{(\text{AlternativeBIC} - \text{NullBIC})/2}$ to confirm whether our data supported the null hypothesis. We compared a model with only the main effects of the factors (Null model) to a model that contained the interaction between these factors (Alternative model; Wagenmakers, 2007). Inverse BFs <1 favour the null hypothesis and values > 1 favour the alternative hypothesis (Jarosz & Wiley, 2014; Raftery, 1995).

Table 2
Overview of response frequencies in the alignment task. Frequency of target responses by structure and experiment phase.

		Response		
Structure	Phase (prime)	Target	Alternative	Other
DO dative	Pre-test	16	245	21
	Baseline prime	56	433	75
	Experimental prime	88	413	63
	Post-test	34	240	8
"of" genitive	Pre-test	31	221	30
	Baseline prime	180	291	93
	Experimental prime	226	283	55
	Post-test	53	205	24
Passive	Pre-test	29	239	14
	Baseline prime	49	485	30
	Experimental prime	65	465	34
	Post-test	36	245	1

Table 3
Conscious decisions. Number (percentage) of participants selecting each decision per structure.

		"of" genitives	Passives	DO datives
Decisions	Avoid	14 (29.8%)	7 (14.9%)	7 (14.9%)
	Neither	11 (23.4%)	24 (51.1%)	29 (61.7%)
	Use	21 (44.7%)[a]	16 (34%)	11 (23.4%)

[a] One participant did not provide an answer regarding their decision for "of" genitives. Their data was removed from the analyses that included Decision as a factor.

4. Results

4.1. Alignment effects

We first explored to what extent the learners would exhibit alignment in a chat-based interaction that included multiple syntactic structures. The best model for alignment across structures revealed a significant main effect of Prime (Table 4): Participants produced more target sentences after experimental primes ($M = 0.25$, $SD = 0.43$) than after baseline primes ($M = 0.19$, $SD = 0.39$), with an overall alignment effect of 6% (Cohen's $d = 0.37$, $SE = 0.01$, Fig. 3a). The contrasts Structure 1 and Structure 2 were both significant: irrespective of the prime, participants produced significantly more "of" genitives (M = 0.41, SD = 0.49) than passives ($M = 0.11$, $SD = 0.31$) and DO datives ($M = 0.15$, $SD = 0.35$). Note that the main effect of LexTALE scores was not significant and the best fitting model did not include any interaction with Prime: Proficiency did not relate to target structure production, nor alignment. There was also no interaction between Prime and Structure (inverse BF < 1, Fig. 3b): alignment did not vary by structure.

We then examined whether the magnitude of alignment was affected by learners' prior knowledge of the target structures and their conscious decisions. The best model for the effect of Decision on alignment showed significant main effects of Prime, Decision 1 and Decision 2. Participants in the No Decision and Use groups combined produced significantly more target structures ($M = 0.25$, $SD = 0.43$) than those in the Avoid group ($M = 0.13$, $SD = 0.32$). They also produced significantly more target structures in the Use ($M = 0.32$, $SD = 0.47$) than in the No Decision group ($M = 0.19$, $SD = 0.39$). There was no significant interaction between Prime and Decision (inverse BF < 1, Fig. 4a). When split by structure, there was a significant effect of Decision 1 for "of" genitives, $\beta = 3.90$ ($SE = 1.53$), $Z = 2.8$, $p < .025$ (with Bonferroni correction applied). Participants in the Avoid group produced fewer "of" genitives ($M = 0.19$, $SD = 0.40$) than the No Decision and Use groups combined ($M = 0.53$, $SD = 0.50$). Decision did not significantly predict alignment or target structure production for DO datives and passives (Fig. 4b).

4.2. Learning effects

In this part of the analysis, we examined to what extent the observed alignment led to learning (i.e., whether they produced the target structures more in the post-than in the pre-test). The best model for learning across structures revealed significant main effects of Section, Structure 1 and Structure 2 (Table 5). Participants produced more target sentences in the post-test ($M = 0.15$, $SD = 0.36$) than in the pre-test ($M = 0.10$, $SD = 0.30$), with an overall learning effect of 5% (Cohen's $d = 0.33$, $SE = 0.03$, Fig. 5a), indicating that they experienced significant learning across all three structures. Moreover, participants produced more "of" genitives ($M = 0.16$, $SD = 0.37$) than passives ($M = 0.12$, $SD = 0.32$) and DO datives ($M = 0.09$, $SD = 0.29$; Fig. 5b). Note that the best fitting model did not include a main effect of or any interaction between LexTALE scores and Section indicating that proficiency did not affect learning, and there was no significant interaction between Section and Structure (inverse BF < 1) which reveals that learning did not vary significantly across the three structures.

We then examined whether the magnitude of learning was affected by learners' prior knowledge of the target structures and their conscious decisions. The best model examining the effect of Decision on learning showed main effects of Section and Decision 2

Table 4
Alignment. Summaries of the best models for alignment. *The best model for alignment across structure included the main effects Prime, Structure and LexTALE and by-subject and by-item random intercepts. The best model for alignment per decision included the main effects of Prime and Decision and by-subject and by-item random intercepts.*

Fixed effects	Estimate	Standard Error	z-value	*p*-value
Alignment across structures				
Intercept	−1.62	1.28	−1.26	.21
Prime	.41	0.11	3.81	**<.001**
Structure 1	−2.20	.19	−11.71	**<.001**
Structure 2	−1.86	.18	−10.27	**<.001**
LexTALE	0	.02	−0.04	.99
Alignment per decision				
Intercept	−2.06	.24	−8.51	**<.001**
Prime	.48	.11	4.52	**<.001**
Decision 1	1.61	.19	8.32	**<.001**
Decision 2	−0.30	.15	−1.97	**.049**

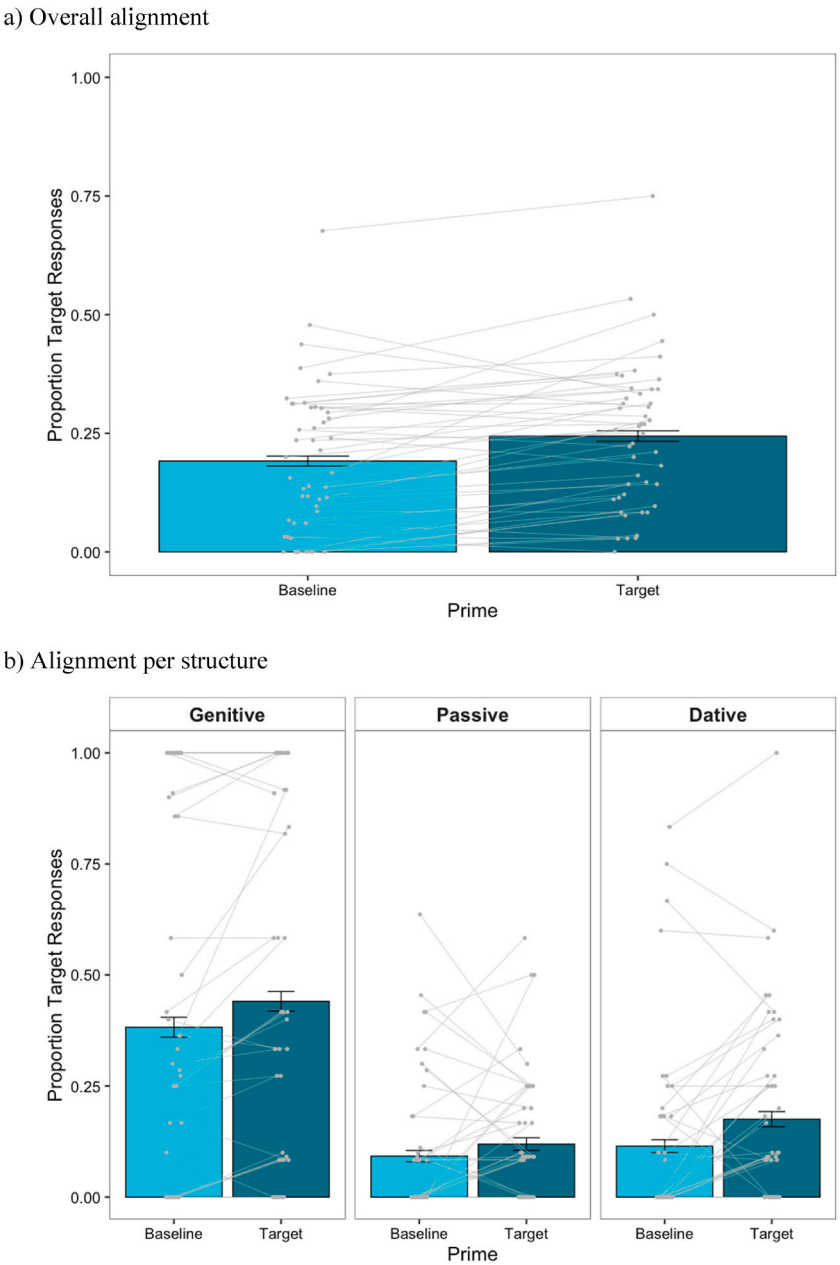

Fig. 3. Target responses in the alignment task. Mean proportion of target responses by Prime (and Structure) in the alignment phase. Error bars indicate the standard error of the mean, grey dots individual data points and grey lines individual priming effects. a) Overall alignment. b) Alignment per structure.

(Fig. 6a). Participants in the Use group produced significantly more target structures ($M = 0.19$, $SD = 0.39$) than the No Decision group ($M = 0.08$, $SD = 0.27$). There was no significant interaction between Section and Decision (inverse BF < 1). When split by structure, there was no effect of Decision on learning for any structure (Fig. 6b).

5. Discussion

This study investigated whether L2 speakers exhibit chat-based alignment for multiple simultaneously-targeted structure and whether such alignment would lead to long-term syntactic learning (Research Questions 1 and 2). We also explored if such alignment and learning were influenced by learners' prior knowledge of the structures and their conscious decisions to use or avoid these structures (Research Question 3). As expected, L2 learners experienced chat-based alignment and learning in a task that included multiple structures. However, while prior knowledge and conscious decisions did influence target structure production, they did not

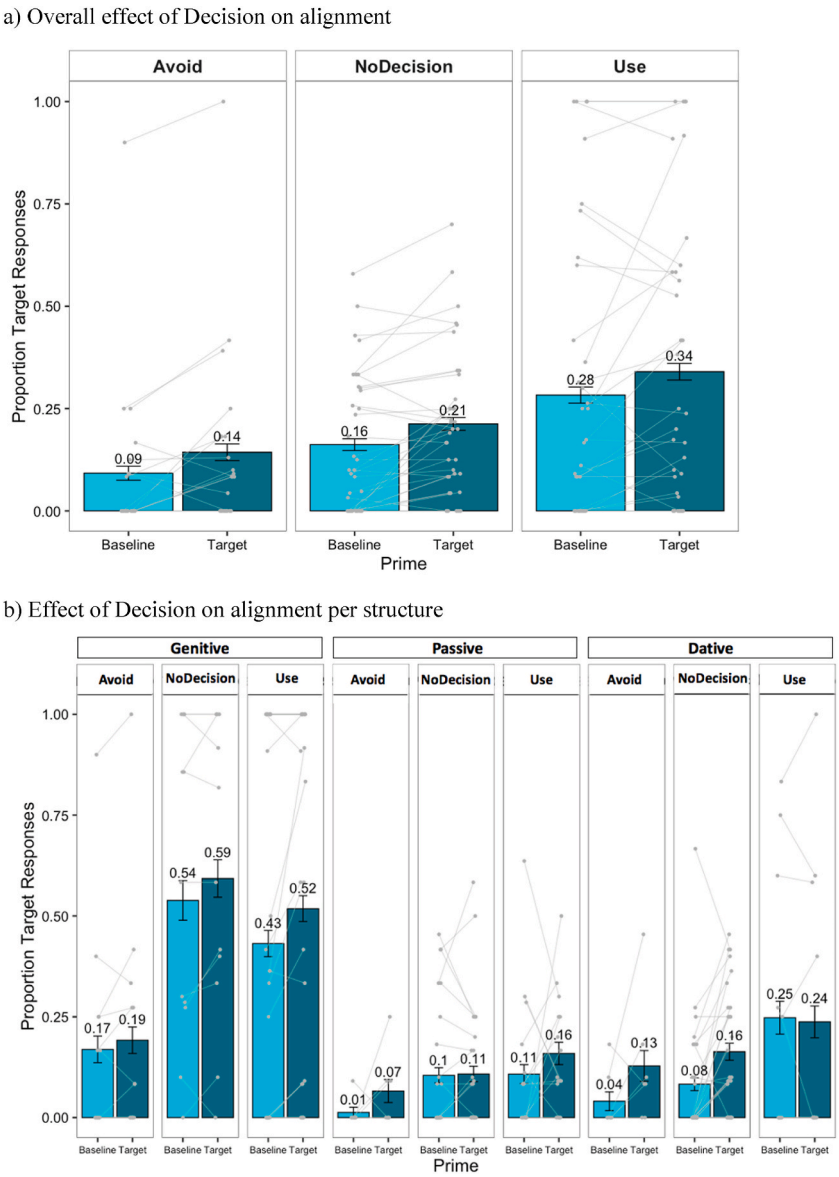

Fig. 4. Effect of Decision in the alignment task. Mean proportion of target responses by Prime, Decision (and Structure) in the alignment phase. Error bars indicate the standard error of the mean, grey dots individual data points and grey lines individual priming effects. a) Overall affect of Decision on alignment. b) Effect of Decision on alignment per structure.

Table 5
Learning. Summaries of the best models for learning. *The best model for learning included the main effects of Section and Structure and by-subject and by-item random intercepts. The best model for learning per decision included the main effects of Section and Decision and by-subject and by-item random intercepts.*

Fixed effects	Estimate	Standard Error	z-value	*p*-value
Learning across structures				
Intercept	−2.34	.19	−12.62	**<.001**
Section	.52	.17	3	**<.005**
Structure 1	−.50	.20	−2.46	**<.05**
Structure 2	−.79	.21	−3.70	**<.001**
Learning per decision				
Intercept	−2.38	.18	−12.96	**<.001**
Section	.61	.19	3.28	**<.005**
Decision 1	.39	.24	1.66	.10
Decision 2	−1	.22	−4.48	**<.001**

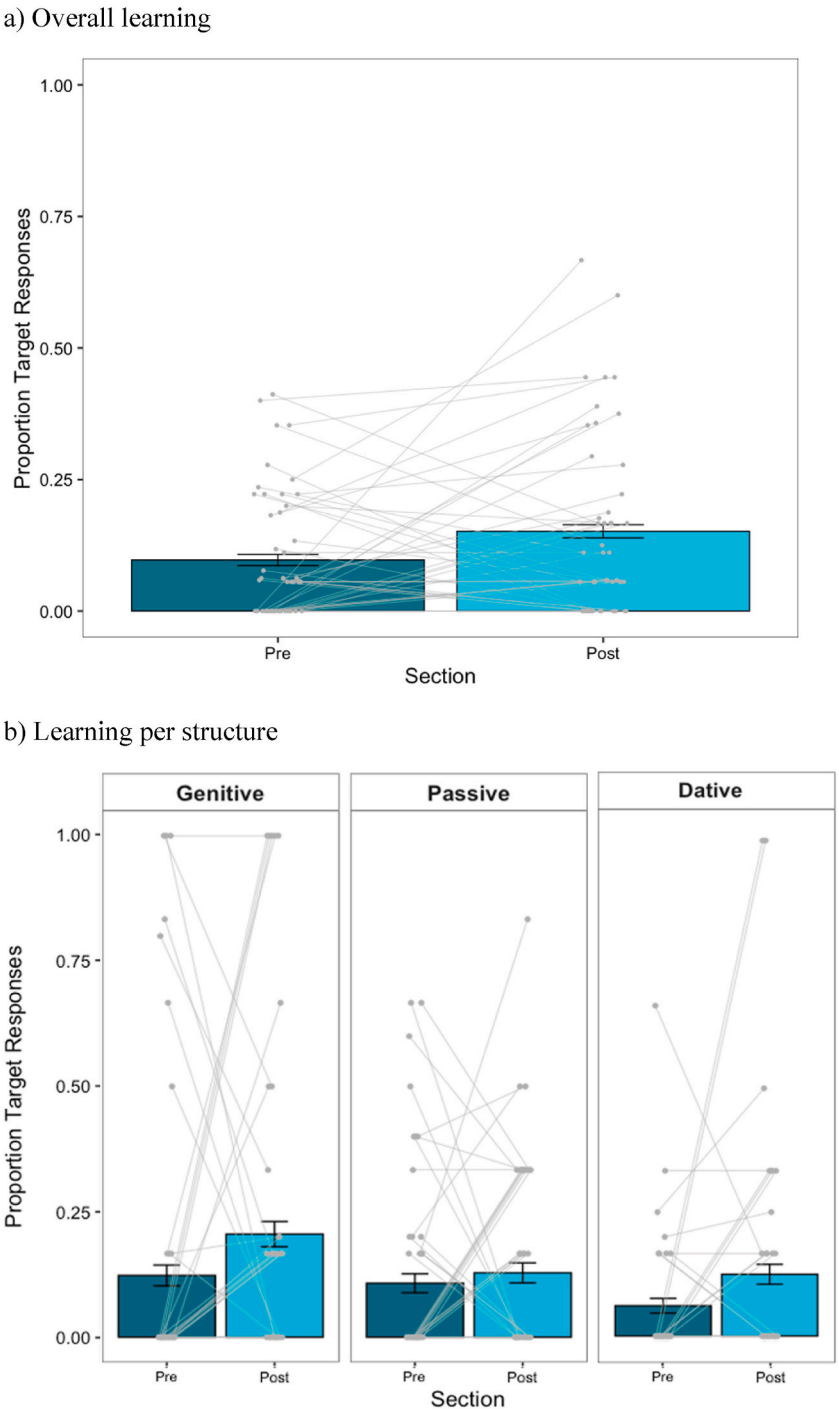

Fig. 5. Target responses in the pre- and post-tests. Mean proportion of target responses by Section (and Structure) in the pre- and post-tests. Error bars indicate the standard error of the mean, grey dots individual data points and grey lines individual priming effects. a) Overall learning. b) Learning per structure.

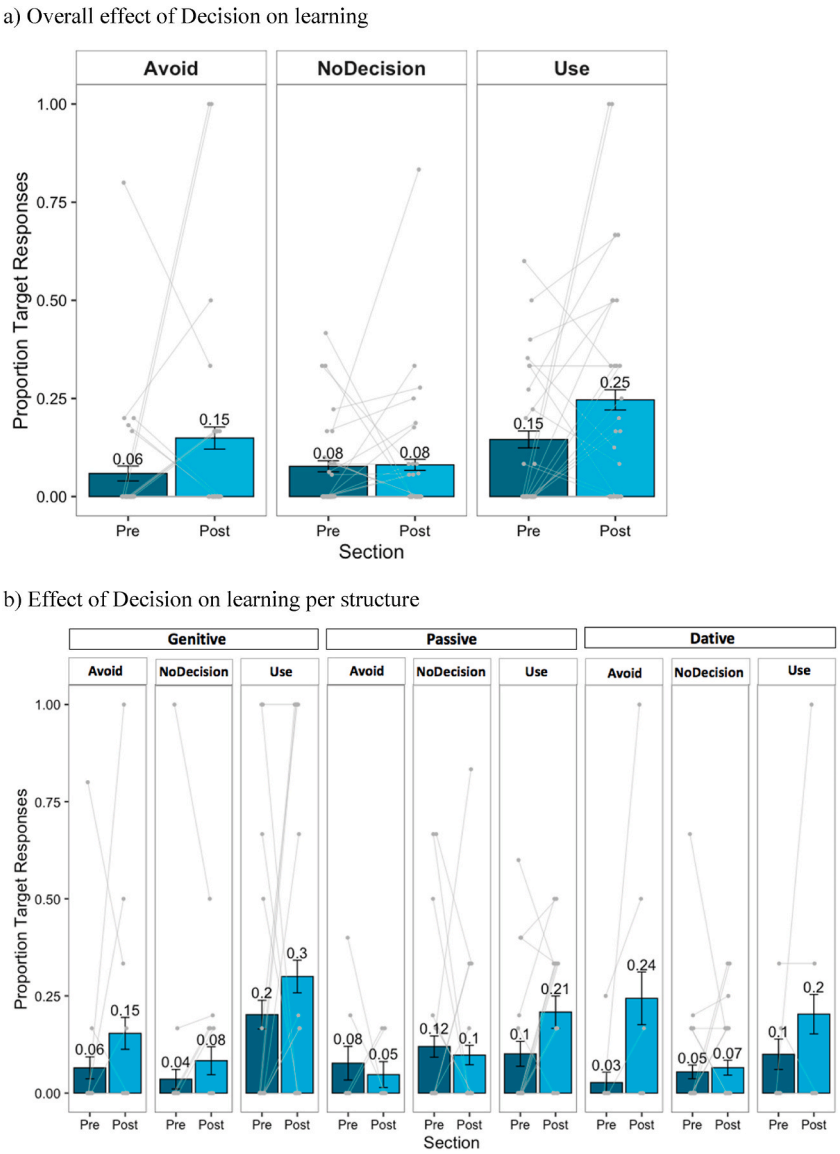

Fig. 6. Effect of Decision on learning. Mean proportion of target responses by Section, Decision (and Structure) in the pre- and post-tests. Error bars indicate the standard error of the mean, grey dots individual data points and grey lines individual priming effects. a) Overall effect of Decision on learning. b) Effect of Decision on learning per structure.

significantly affect alignment and learning. We review the implications of these findings for models of alignment and for L2 learning and teaching.

5.1. Chat-based alignment and learning

In line with previous research, L2 learners showed chat-based alignment: they produced target structures more frequently following experimental primes than baseline primes (e.g., Kim et al., 2019; Kim et al., 2020). Moreover, the effect of this immediate chat-based alignment was long-lasting: learners produced more target structures in the post-test than in the pre-test as in previous chat-based (Kim et al., 2019, 2020) and oral alignment studies (e.g., Hurtado & Montrul, 2021; Jackson and Ruf, 2018). This implies that the alignment activity fostered long-term changes in the learners' syntactic representations that led to increased use of the target structures. This could suggest that the structures became more accessible or easier to retrieve. Previous research similarly shows significant within-L2 alignment for genitives (Bernolet et al., 2013), passives (e.g., Flett, 2006) and datives (e.g., Shin & Christianson, 2012), and L2 long-term learning for passives (e.g., Bernolet, Collina, & Hartsuiker, 2016) and datives (e.g., Shin & Christianson, 2012) in oral tasks. Importantly, in this study, alignment and learning occurred even when multiple target structures were embedded in the same activity. The absence of any relationship with participants' English proficiency, as measured by the LexTALE scores, suggests that the task

fostered alignment and learning for L2 learners across proficiency levels. This stands in contrast with previous research showing that alignment is more likely to occur with higher L2 abilities (e.g., Sinclair et al., 2018). However, given that our participants were of upper intermediate proficiency overall (see Section 2.1), this result could indicate that the structures we targeted were too easy for proficiency to play a role in this population.

Participants showed only small (approximately 5%) increases in their production of the target structures on experimental relative to baseline trials but this measurement may actually mask larger effects of alignment. Inspection of the graphs suggests that pre-test usage of the target structures was generally lower (accounting for 10% pre-test responses on average) than on baseline trials (on average 19% responses were target structures versus 24% on prime trials) in the alignment phase. This suggests that once exposed to primes, participants' use of target structures increased across all trials, not just prime trials. We ran an additional exploratory analysis which compared production of the target structures in the pre-test and in the alignment phase across prime conditions. This showed that L2 learners were significantly more likely to produce target structures during the alignment task than in the pre-test ($p < .001$). Thus, our study adds evidence that chat-based interactions with multiple structures are an appropriate medium to implement L2 grammar learning activities: alignment via chat-based exposure supports increased and lasting target structure production.

One route to learning may be that interacting in a chatting environment makes target structures particularly salient (Kim et al., 2019; Kim & Godfroid, 2019; Sauro, 2009). This may help learners notice target structures, which is thought to facilitate L2 learning (Doughty & Long, 2003; Long, 1996; Schmidt, 1990). In fact, 42 learners reported noticing the "of" genitives, 42 noticed passives and 37 noticed DO datives during the alignment activities. Text-based chatting thus appears an ideal tool for L2 teaching as it fosters noticing of target structures in meaningful language input, even without explicit instructions. Such noticing may support learners' explicit memories of the prime sentence form used to formulate their own sentences (Kim et al., 2019, 2020). Since learners also experienced long-term learning effects, it suggests that explicit memory processes may contribute to long-term learning via alignment (see discussion of Jackson & Ruf, 2018) or that such learning benefits from implicit as well as explicit learning processes (Kim et al., 2020). However, further research is required to examine the exact nature of the relationship between explicit memory processes and long-term language learning.

5.2. Variation across structures

5.2.1. Prior knowledge

While we expected L2 learners to show the most alignment on "of" genitives, followed by passives and DO datives, the alignment and learning effects were equivalent across structures, regardless of learners' prior knowledge of them. However, the learners did produce significantly more "of" genitives than passives and DO datives in the alignment task which provides partial support for Costa et al. (2008)'s predictions. By contrast, our findings are not consistent with the inverse frequency effect predicted by theories defining alignment as an implicit language learning mechanism (e.g., Chang et al., 2006; Chang et al., 2012), according to which participants should show more alignment and learning with less familiar structures. Participants' higher prior knowledge of "of" genitives because of the similarity with Spanish may have made them more available for production (see Kim et al., 2020 for similar results). In other words, the L2 speakers in this study rather manifested L2 frequency effects, that is, increased production of the structures they have experienced the most frequently (see e.g., Hurtado & Montrul, 2021), and these results imply that alignment activities may be less well-suited to promote production of structures participants are less familiar with. To clarify this for the pedagogical perspective, it would be interesting to assess whether increasing the number of experimental primes for such structures or working with them in isolation would increase their production and resulting learning further.

5.2.2. Conscious decisions

While most L2 learners noticed the target structures in the present study, they did not necessarily choose to use them, as anticipated (see Jackson & Ruf, 2018 for a similar observation). Rather, more prior knowledge of the target structure seems to be associated with an increased likeliness to choose to use the target structure (Table 3): learners most often reported choosing to use "of" genitives, presumably because these are easy to produce for Spanish speakers as suggested by their open answers to the post-task questionnaire (e.g., "[I used it] because it is very simple"). However, the most often-selected decision for passives and DO datives, which Spanish speakers would have less prior knowledge of, was "Neither". Nonetheless, learners reported choosing to *use* DO datives and passives more often than to *avoid* them. In line with this, a few participants explained that they decided to use a structure because their interlocutor had or because they had seen it in the task (see Michel & O'Rourke, 2019 for similar findings). Thus, the modelling of structures provided by alignment tasks appears to be a good way to motivate learners to produce structures.

Overall, the absence of a significant interaction between alignment and participants' conscious decisions reveals that, regardless of their decision, the L2 speakers showed the same magnitude of alignment and thus experienced to some extent automatic and implicit alignment that was insensitive to more top-down processes and strategies (see Ivanova, Horton, Swets, Kleinman, & Ferreira, 2020 and Weatherholtz, Campbell-Kibler, & Jaeger, 2014 for discussions of the relationship between top-down strategies and alignment). However, we did find indirect support for Costa et al.'s (2008) predictions regarding the effect of learners' decisions. Decisions did affect target structure production. Across structures, learners in the Use group were more likely to produce target structures in the alignment task than in the No Decision and the Avoid groups. Within structures, learners in the No Decision and Use groups produced significantly more "of" genitives than those in the Avoid group, and the results for both DO datives and passives followed the same numerical trend though it did not reach significance: learners in the Use group produced more target structures (DO: $M = 0.24$, $SD = 0.43$; passives: $M = 0.13$, $SD = 0.34$) as did those in the No Decision group (DO: $M = 0.12$, $SD = 0.33$; passives: $M = 0.11$, $SD = 0.31$) than those in the Avoid group (DO: $M = 0.09$, $SD = 0.28$; passives: $M = 0.04$, $SD = 0.19$ respectively). Given that splitting the data by

decision group reduced sample sizes, understanding how exactly conscious decisions affect alignment and learning for various structures will require further research. Inevitably, choosing to avoid a target structure led to reduced production in spite of exposure to prime structures. This indicates that the effect of prime sentences on subsequent sentence production may not be purely implicit but may also depend on learners' decisions (Costa et al., 2008). Whether deciding to use the target structure led to more learning remains unclear. Learners of the Use group produced significantly more target structures than those in the No Decision group but only when we looked at the data of the pre- and post-tests together. However, this may reflect the lack of a relationship between *immediate* alignment and decisions.

Further inspection of the participants' open answers to the questions asking why they consciously chose to use or avoid the targeted structures revealed that they often decided to re-use their interlocutor's syntax in order to have "a wide range of sentence responses", not to be "repetitive" (as in Ruf, 2011), in order to sound more "professional", more or less "formal", or because it "[was] a structure [they] had learnt in school". By contrast, the participants avoided using a structure if they thought that the structure was grammatically incorrect ("I thought the structure was wrong"), or, as above, due to education ("I tried to avoid using this grammatical form because I have been taught that it is better to use the possessive form") or if they considered it a challenging form to produce (e.g., "the passive form is very difficult for me", "I did not know how to use it [the passive form] well" or "because I felt more comfortable using a different structure") as predicted by Costa et al. (2008; see Kim et al., 2020 for similar findings). The latter findings suggest that it might be necessary for teachers to provide learners with instructions regarding more difficult structures before an alignment task to promote further production and practicing of such structures.

5.2.3. Pedagogical implications

This study demonstrates that chat-based online interactions are well-suited to eliciting targeted structures from L2 speakers and to supporting L2 learning via alignment tasks (e.g., Kim et al., 2019; Kim et al., 2020). This is particularly relevant for language teachers who may have to resort more and more to online L2 teaching (Maican & Cocorada, 2021; European Union, 2019). That a single alignment activity fosters increased use of multiple simultaneously-targeted structures indicates that participating in conversations which contain a multitude of structures in the L2 may successfully support learning of multiple structures too. This study also shows that chat-based alignment tasks are an appropriate tool to foster noticing of target structures. This may be because such tasks represent a form of input flooding (see Indrarathne & Kormos, 2017 for a review), a technique which consists in increasing the frequency of a target construction in the input to make it more salient. From a pedagogical point of view, L2 teachers may therefore use such activities as a starting point to implement inductive pedagogical approaches, where learners are invited to discover grammatical rules by themselves in the language input (Hedge, 2008). Finally, taken together, though the alignment task most often led L2 speakers to choose to use the targeted structures, language teachers may need to explicitly ask learners to use less familiar structures (and not to avoid them) or provide instructions about them, in order to increase their production rate in alignment tasks. More research is however needed to determine whether such explicit instructions would also be beneficial for long-term learning.

6. Conclusion

This study shows that written chat-based collaborative alignment activities support practice and learning of L2 syntactic structures even when multiple structures are presented simultaneously. We also found that L2 learners' production, and potentially learning, was influenced by their conscious decisions to use or avoid the targeted structures. Overall, although alignment is typically defined as an implicit process (e.g., Pickering & Garrod, 2004), the results suggest that both explicit and implicit processes may underlie alignment and the resulting learning for L2 learners in this context. These findings have important implications for instructors when considering how to adopt alignment tasks for language teaching.

CRediT authorship contribution statement

Marion Coumel: Conceptualization, Methodology, Investigation, Data curation, Validation, Formal analysis, Writing – original draft, Visualization. **Ema Ushioda:** Conceptualization, Methodology, Writing – review & editing, Supervision, Funding acquisition. **Katherine Messenger:** Conceptualization, Methodology, Writing – review & editing, Supervision, Project administration, Funding acquisition.

Declaration of competing interest

None.

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