The role of cross-linguistic structural priming in contact-induced language change*

Ungrammatical comparative priming in Turkish–German bilinguals

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Research investigating the psycholinguistic foundations of contact-induced grammatical language change suggests that new structures may enter a language through cross-linguistic priming in bilinguals. However, this assumes that priming effects can emerge even for structures which are ungrammatical in the target language. In the present study, we test this assumption by investigating cross-linguistic ungrammatical priming for analytic comparatives between Turkish and German. In a self-paced reading experiment, Turkish–German bilinguals read German target sentences with grammatically incorrect analytic comparatives (e.g., **mehr interessant*). These were preceded by a Turkish prime sentence which included a Turkish analytic comparative (*daha konforlu*) or an otherwise identical indicative control prime (*konforlu*). The results showed significantly faster reading times for ungrammatical German comparatives following Turkish comparative primes than following indicative primes. In an additional grammaticality-judgement task, Turkish–German bilinguals rated sentences with ungrammatical German analytic comparatives as significantly more acceptable than monolingually-raised German participants. These results suggest that cross-linguistic priming can even occur for ungrammatical structures. We conclude that cross-linguistic ungrammatical priming constitutes a candidate for a mechanism driving contact-induced language change in bilingual individuals.

Keywords: cross-linguistic priming, language change, language contact, heritage speakers

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https://doi.org/10.1075/lab.24055.jac | Published online: 5 August 2025
Linguistic Approaches to Bilingualism ISSN 1879-9264 | E-ISSN 1879-9272

1. Introduction

A fundamental question in Historical Linguistics is how new grammatical structures emerge in a language. With regard to this issue, a prominent position holds that grammatical language change is closely connected to *language contact* within bilingual individuals, who may start using grammatical structures from one of their languages in their other language as well (e.g., van Coetsem, 2000; Lucas, 2015). This suggestion establishes a connection between research on grammatical language change and the psycholinguistics of bilingualism, and assumes that members of bilingual communities, such as bilingual heritage speakers of a language, play a key role as *agents of change*, who may serve as conduit through which grammatical structures from a source language may enter a target language. The goal of the present study is to investigate the psycholinguistic foundations of this process, and to shed light on the psycholinguistic mechanisms and procedures which constitute the necessary prerequisites for grammatical language change to occur in this way.

1.1 Bilingual communities and contact-induced language change

Theoretical accounts of contact-induced language change typically assume that the mechanisms and procedures involved in intra-individual language contact differ depending on individual properties of language use. In particular, both van Coetsem (2000) and Lucas (2015) suggest that intra-individual language contact is strongly affected by *language dominance*. For instance, in bilingual individuals who are dominant in the source language and possess relatively weak proficiency in the target language, the production of target language sentences may be affected by cross-linguistic interference from the stronger source language. This may lead to the production of ungrammatical target language sentences with a grammatical structure from the source language. In contrast, for bilinguals who are dominant in the target language, and who are thus aware that a particular source language structure is impossible in the target language, intra-individual language contact may be based on different psycholinguistic mechanisms, such as cross-linguistic priming (see below).

A particular group of bilinguals who are frequently discussed with regard to their possible role in contact-induced language change are *bilingual heritage speakers* (e.g., Kupisch & Polinsky, 2022; Montrul, 2022; Baroncini et al., 2025). According to Rothman (2009), "a language qualifies as a heritage language if it is a language spoken at home or otherwise readily available to young children, and crucially this language is not a dominant language of the larger (national) society". Heritage speakers are typically unbalanced concerning their language

competence and use, usually with the heritage language as their non-dominant and the language of the larger national society as their dominant language (e.g., Montrul, 2016; Polinsky, 2018; Polinsky & Scontras, 2020). Communities of heritage speakers differ from other bilingual communities in the sense that they use each of their two languages in different communicative situations, with the heritage language typically spoken in the family and among peers and the language of the larger national society spoken in public situations, such as at work or at school. Nonetheless, there is substantial evidence for code-switching and borrowing in heritage speakers (e.g., Treffers-Daller, 1997; 2021; Treffers-Daller & Çetinoğlu, 2022). This creates ideal conditions for cross-linguistic influence within the bilingual individual, making heritage speakers particularly suitable candidates for *agents of language change*.

The present study focuses on bilingual heritage speakers of Turkish raised and living in Germany, the descendants of Turkish migrant workers who originally moved to Germany in the 1960s and 1970s. Turkish constitutes one of the most common heritage languages spoken in Germany, with the community of Turkish–German heritage speakers consisting of more than two million individuals. Turkish–German heritage language bilinguals raised in Germany are typically exposed to both German and Turkish from early childhood. While German constitutes the language of the surrounding society, heritage speakers of Turkish have extensive access to Turkish media, for instance in the form of Turkish television, social media, and Turkish-language newspapers published in Germany. In addition, Turkish is frequently used in conversations within the bilingual community.

1.2 Cross-linguistic structural priming and language change

Grammatical language change is typically assumed to consist of an *entrenchment* stage, in which restricted groups of individuals start using a new grammatical structure, and a *conventionalisation* stage, in which the new structure spreads across the linguistic community and thus consolidates itself in the language (e.g., Schmid, 2015). A key psycholinguistic effect which has been suggested to play an important role with respect to both stages is *structural priming* (e.g., Chang, 2008; Pickering & Garrod, 2017; Kootstra & Muysken, 2019). The term *structural priming* refers to the fact that, when processing or producing a sentence, speakers are influenced by structures they have processed or produced shortly before (e.g., Levelt & Kelter, 1982; Bock, 1986; and much subsequent work). As such priming effects have been shown to also occur in dialogue (e.g., Garrod & Pickering, 2007; 2013), Chang (2008) suggested that structural priming may constitute a potential mechanism for conventionalisation, with a new grammatical structure spreading across a linguistic community through structural priming.

Crucially for our purposes, a considerable number of studies have shown that structural priming can also occur across different languages. For instance, if a bilingual has just come across an L1 sentence with a passive structure and shortly afterwards produces an L2 sentence, prior exposure to the L1 passive structure may influence structural choices for this L2 sentence, and increase the chance that the speaker chooses a passive structure (e.g., Hartsuiker et al., 2004, and much subsequent work). Experimental studies investigating such *cross-linguistic priming* effects typically rely on structural alternations which exist in more than one language. A classical example is Loebell and Bock's (2003) study on cross-linguistic priming for the dative alternation between English and German. In their experiment, participants were primed with either a double-object sentence such as (1a) or an otherwise identical prepositional-object sentence such as (1b):

(1) a. The lawyer sent his client the contract.
b. The lawyer sent the contract to his client.

Immediately after listening to the prime sentence, the participants produced descriptions of pictures displaying ditransitive events. Even when prime and target were in different languages (i.e., with priming from German prime sentences to English picture descriptions, or vice versa), the results revealed a priming effect, with significantly more prepositional-object target descriptions after prime sentences such as (1b) than after (1a). Cross-linguistic structural priming has since been demonstrated for both language production (with the prime influencing structural choices during the production of a target sentence) and comprehension (with primed structures being easier to process), and for a wide variety of different structures and language pairs (e.g., Bosma et al., 2023; Desmet & Declerq, 2006; Hartsuiker & Bernolet, 2017; Hartsuiker et al., 2004; Jacob et al., 2017; Kantola & van Gompel, 2011; Loebell & Bock, 2003; Shin & Christianson, 2009; Unsworth, 2025; also see van Gompel & Arai, 2018, for a comprehensive review).

Cross-linguistic structural priming is discussed with regard to its potential relevance for a variety of issues related to cross-linguistic influence in bilinguals, such as transfer in second-language learning (e.g., Hartsuiker & Bernolet, 2017; Shin & Christianson, 2012), establishing alignment in bilingual dialogue (e.g., Costa et al., 2008), or cross-linguistic influence in translation (e.g., Jacob et al., 2021; Jacob et al., 2024; Maier et al., 2017; Maier, 2022). In the past decade, it has also repeatedly been speculated that cross-linguistic priming may constitute a potential mechanism of entrenchment in *contact-induced language change*, i.e., a possible pathway through which L1 grammatical structures may enter an L2. For instance, several studies on language contact (e.g., Barking et al., 2022; Köpke, 2004; Mayr et al., 2020) suggest that contact-induced language change is particularly likely to occur in speakers who regularly use both of their languages. In

conversations, bilinguals frequently listen to L1 input and shortly afterwards produce L2 output. This may constitute ideal conditions for cross-linguistic priming effects.[1] Another finding which makes structural priming a particularly suitable candidate for a mechanism of language change is the fact that, especially when participants are repeatedly exposed to a number of primes with the same structure, structural priming effects can be long-lasting in nature (e.g., Bock & Griffin, 2000; Hartsuiker et al., 2008; Kaschak, 2007; Kaschak et al., 2011; Kaschak et al., 2014). This has given rise to *implicit learning* accounts of structural priming, which assume that each exposure to a prime structure causes long-lasting changes to a speaker's grammatical representations (e.g., Bock & Griffin, 2000; Chang et al., 2012). Thus, if such cross-linguistic priming effects occur repeatedly over an extended period of time, the resulting *cumulative priming effects* may constitute a possible pathway which allows structures from the L1 to enter the L2.

One of the relatively few attempts to empirically investigate the possible role of cross-linguistic priming in grammatical language change is Kootstra and Şahin's (2018) seminal study on cross-linguistic structural priming for the dative alternation in Papiamento–Dutch bilinguals. Their study makes use of the fact that, while both Papiamento and Dutch allow for prepositional-object (PO) and double-object (DO) ditransitives, Papiamento is strongly biased towards the DO structure, while Dutch is relatively balanced with regard to PO versus DO use. In a dative production experiment in Papiamento, bilinguals living in the Netherlands (i.e., a situation where speakers of Papiamento are heavily exposed to Dutch) produced a significantly higher proportion of the generally rare PO structure than bilinguals living in Aruba. A subsequent cross-linguistic priming experiment with both participant groups revealed significant priming for the dative alternation between Dutch and Papiamento. The authors thus concluded that speakers of Papiamento in the Netherlands had changed their syntactic preferences due to cross-linguistic priming from Dutch.

1.3 Cross-linguistic ungrammatical priming

Kootstra and Şahin's (2018) study investigated a case of potential *quantitative* language change, i.e., a case where an already existing but initially rare syntactic structure increased in frequency of use due to language contact. However, the claim that cross-linguistic structural priming can also lead to *qualitative* language change, i.e., the emergence of new grammatical structures, is based on the addi-

1. Although cross-linguistic priming effects do not *per se* require the presence of code-switching, it is conceivable that cross-linguistic priming should be particularly strong in code-switching situations because primes and targets occur in close proximity.

tional implicit assumption that cross-linguistic priming can even occur for structures which are, at least initially, completely ungrammatical in the target language. For structural priming within a language, there is at least some evidence suggesting that ungrammatical structures can be primed. In an experiment investigating ungrammatical priming for the English dative alternation, Ivanova et al. (2012) found that speakers, when primed by ungrammatical double-object constructions with verbs which do not allow for this construction (such as *The waitress donates the monk the book.)*, occasionally produced ungrammatical target sentences of this kind. Ungrammatical priming effects occurred only when the prime was ungrammatical as well, and were also limited to cases where the verb which causes the ungrammaticality occurred in both prime and target. However, Vega Mendoza et al. (2024), in a study investigating ungrammatical ditransitive priming in second-language learners of English, found significant priming effects even when the primes were grammatical ditransitives.

The findings obtained by Ivanova and colleagues suggest that it is in principle possible to prime ungrammatical structures. For ungrammatical ditransitives, within-language priming effects were not only found in production, but also in comprehension (Ivanova et al., 2012). Note, however, that their study did not use ungrammatical structures as targets, but instead as primes, to investigate whether ungrammatical ditransitive prime sentences can prime grammatically correct ditransitive targets. Also, the double-object structure as such is fully grammatical in English. As a result, it is not entirely clear to what extent these findings can be generalized to priming of new grammatical structures which do not exist in the language. The few studies which have investigated ungrammatical priming across languages in bilinguals have obtained mixed results. Hopp and Jackson (2023) investigated cross-linguistic production priming between German and English in L1 German learners of L2 English, for English target structures which were either well-formed, dispreferred, or entirely ungrammatical. Both low-proficient adolescent and high-proficient adult L2 learners showed robust structural priming effects only for well-formed structures, but no priming (and in fact even inhibitory effects) for dispreferred or ungrammatical structures. Fernández et al. (2017) investigated cross-linguistic production priming between English and Spanish for structural alternations whose linguistic properties differed systematically between the two languages. Interestingly, the study compared groups of bilinguals living in high-contact versus low-contact environments. When primed by English structures with no direct Spanish equivalent, the participants produced significantly more innovative Spanish structures which resembled the English prime structure than after control primes. In addition, bilinguals living in high-contact environments also produced a higher overall number of such innovative Spanish target sentences irrespective of the prime than bilinguals from

low-contact environments. However, the authors point out that the total number of innovative structures in the data set was very small. Also, such innovations only occurred for some, but not all linguistic phenomena investigated in the study. Finally, two studies have investigated cross-linguistic ungrammatical priming in bilingual children. Van Dijk and Unsworth (2023), in a study investigating priming effects for adjective placement in adjective–noun constructions in French–Dutch and Spanish–Dutch bilingual children (aged between four and eight years), observed significant cross-linguistic priming effects, with children producing significantly more noun phrases with ungrammatical Dutch adjective–noun order after being primed by French and Spanish noun phrases with the same order. Similar results were obtained by Hsin et al. (2013) in a cross-linguistic priming study on adjective placement in four-to-five year-old Spanish–English bilingual children. However, because these two studies tested children, it is unclear to what extent the participants actually considered the respective adjective–noun order ungrammatical in the target language.

2. The present study

The present experiment is designed to investigate cross-linguistic ungrammatical priming between Turkish and German. Our study makes use of a systematic difference in comparative formation between the two languages. Consider German and Turkish example sentences such as (2) and (3):

(2) Jülide findet es **angenehmer**, in einem großen Haus zu wohnen.
(Jülide — finds — it — comfortable$_{\text{COMPARATIVE}}$ — in — a — large — house — to — live.)

(3) Jülide büyük bir evde oturmayı **daha konforlu** buluyor.
(Jülide — large — a — house — live — more — comfortable — finds)
'Jülide finds it more comfortable to live in a large house.'

While German comparatives such as *angenehmer* in sentence (2) are synthetic in nature, i.e., formed by attaching the suffix *–er* to the adjectival stem *angenehm*, Turkish comparatives such as *daha konforlu* in sentence (3) are instead formed analytically, by inserting the comparative marker *daha* in front of the adjective *konforlu*. Note that both the Turkish and German sentence would also be grammatical with an indicative form instead of the comparative (i.e., *angenehm* instead of *angehmer*; *konforlu* instead of *daha konforlu*).

How could cross-linguistic ungrammatical priming in Turkish–German bilinguals potentially lead to contact-induced language change for this grammat-

ical structure, i.e., cause analytic comparatives to enter the German language? Assume that a Turkish–German bilingual processes an analytic comparative while listening to a Turkish sentence, and thus activates the corresponding structural representation for analytic comparatives. Given that structural priming effects are long-lasting, the respective structural representation may remain active for an extended period of time, and may eventually influence linguistic behaviour in a subsequent German conversation, even if there is a considerable amount of time in-between the two conversations. Specifically, during formulation of a German sentence which contains a comparative, the formulation system may at least initially consider the production of an analytic comparative, because the respective structural representation for analytic comparatives has been primed. With only a single Turkish prime, it is likely that this priming effect is not strong enough for an analytic comparative to actually be produced: As the formulation system is aware that analytic comparatives are ungrammatical in German, it is likely that the production of an ungrammatical sentence is blocked by later control processes. However, in their everyday lives, Turkish–German bilinguals do not only come across a single Turkish analytic comparative, but are regularly exposed to many analytic comparatives over an extended amount of time. Given the substantial experimental evidence that exposure to more than one prime boosts structural priming, the resulting cumulative priming effects may eventually become strong enough to overcome the formulator's hesitation to produce an ungrammatical sentence. Once this process causes the production of German analytic comparatives, the new structure may subsequently consolidate itself and spread from bilinguals to other individuals through within-language priming.

In a lab-based experimental study, it is obviously not possible to directly investigate cumulative cross-linguistic priming effects caused by extensive exposure to a huge number of Turkish analytic comparatives over a lifetime. However, the cross-linguistic ungrammatical priming effect which constitutes the foundation of the process described above as such can be investigated with established experimental priming paradigms. This is the key goal of the present study.

In our experiment, participants read ungrammatical German target sentences such as (5) below, which contained grammatically incorrect German analytic comparatives (**mehr interessant*). These target sentences were preceded by either a Turkish prime sentence such as (4a), which included a Turkish analytic comparative (*daha konforlu*), or an otherwise identical Turkish control prime such as (4b), which instead contained an indicative form (*konforlu*):

(4a) Jülide büyük bir evde oturmayı **daha konforlu** buluyor. (comparative prime)
(Jülide — large — a — house — live — more — comfortable — finds)

(4b) Jülide büyük bir evde oturmayı **konforlu** buluyor. (indicative control prime)

(Jülide — large — a — house — live — comfortable — finds)
'Jülide finds it (more) comfortable to live in a large house.'

(5) *Hannah findet naturwissenschaftliche Fächer **mehr interessant** als sprachliche Fächer.
(Hannah — finds — scientific — subjects — more — interesting — than — linguistic — subjects.)
**'Hannah finds scientific subjects more interesting than linguistic subjects.'*

During processing of the Turkish comparative prime *daha konforlu*, participants should activate a representation of the analytic comparative. If this representation is language-independent in the sense that it can also be used for the processing of ungrammatical German analytic comparatives, this should lead to faster reading times for the ungrammatical comparative *mehr interessant* when primed by a Turkish comparative prime than when primed by an indicative control prime.

As explained above, in order to actually produce a German ungrammatical analytic comparative, cross-linguistic priming effects would have to be strong enough to overcome a speaker's reluctance to ungrammatical analytic comparatives. Such a reluctance to produce ungrammatical structures may lead to higher-level control processes during the production of target sentences, which may prevent the primed structure from getting produced because it is ungrammatical in the target language. This effect might be particularly severe in Turkish–German heritage speakers, given societal discussions about German proficiency in this community. Overcoming such higher-level control processes may require substantial cumulative priming effects caused by extensive and persistent exposure to a large number of Turkish analytic comparatives over an extended time period. In a typical experimental test session, even if a participant is primed successfully, priming effects may be too weak to cause the production of ungrammatical analytic comparatives. However, if cross-linguistic ungrammatical priming of this kind is in principle possible, exposure to a Turkish analytic comparative prime should cause measurable priming effects in an experimental task which does not require the participant to produce ungrammatical sentences. Thus, in order to avoid the practical problem discussed above, the present study investigates cross-linguistic ungrammatical priming in a comprehension task.

3. Experiment 1: Self-paced reading

3.1 Method

Participants

Thirty-six Turkish–German heritage language speakers (28 female, 8 male, mean age = 22.39, age range 19–27) raised and living in Southwest Germany participated in the experiment. Following Rothman's (2009) definition of heritage language speakers, the sample consisted of young adults who started learning the dominant language of the environment, i.e., German, in early childhood (mean age of German onset = 1.89, range 0–6; mean age of Turkish onset = 0.33, range 0–5). Self-ratings for their proficiency in Turkish and German revealed higher proficiency ratings for German (mean = 5.76 out of 6) than for Turkish (mean = 4.58 out of 6). Table 1 shows self-assessed proportions of language use for German, Turkish, and English in different social situations.

Table 1. Average self-assessed weekly language use in different social situations for bilingual participants in Experiment 1 (in percent)

	Turkish	German	English
with friends	40.3	55.3	4.3
with family	70.3	29.7	0.0
at work/University	6.7	79.3	14.0
in self-talk	41.3	52.7	6.0

Items

24 sets of experimental prime–target pairs were created. Each item set consisted of a German target sentence containing a grammatically incorrect German analytic comparative (e.g., *mehr interessant*) and two versions of a preceding Turkish prime sentence which contained either a Turkish analytic comparative (e.g., *daha konforlu*) or the corresponding indicative form of the same adjective (e.g., *konforlu*). With the exception of this experimental manipulation, experimental comparative prime and indicative control prime were exactly identical. The experimental items were distributed across two presentation lists according to a Latin square design, so that each list contained a total of 12 items from each of the two prime conditions. Each participant was tested on one of the two presentation lists, ensuring that a participant saw only one of the two versions of each prime–target pair. As a result, each participant encountered exactly 12 prime–tar-

get pairs from the experimental comparative condition and 12 items from the indicative control condition.

To conceal the true purpose of the experiment and avoid explicit strategies or hypotheses by the participant, we added a total of 48 filler sentence pairs. Each filler pair also consisted of a Turkish sentence followed by a German sentence. Filler sentences were of similar length as the experimental sentences and contained a variety of different syntactic structures (see the OSF repository for a full list of fillers). To avoid any regular patterns which may have caused participants to come up with hypotheses about the purpose of the study, fillers were pseudo-randomly distributed across the experiment, with a minimum of one and a maximum of three fillers between any two experimental items. To keep participants attentive and engaged throughout the self-paced reading task, 30% of all Turkish and German filler sentences were followed by a comprehension statement referring to the previous sentence, which participants had to judge as either true or false. Comprehension questions following filler sentences were randomly distributed across the experiment, so that participants always had to be prepared for the possibility that a comprehension statement may occur after any sentence. The same 48 filler sentence pairs occurred in both presentation lists.

Procedure

Participants were tested in a quiet room. Each participant was tested separately in a one-on-one test session with the experimenter. At the start of the test session, the participant received a detailed description of the procedure as well as instructions for the experimental task. After receiving the instructions, all participants were asked to give informed consent and sign the data protection agreement.

The experiment was implemented in version 3.3.12 of the *OpenSesame* experiment software (Mathôt et al., 2012) on a 13.3-inch computer screen. All sentences (i.e., all experimental Turkish primes and German targets as well as all German and Turkish filler sentences) were presented in a segment-by-segment format, with each segment consisting of either a single word or a short two-word phrase comprising a content word and a function word. The critical segments containing the analytic comparatives always consisted of two words, i.e., the adjective (e.g., *interessant*) and the preceding comparative marker (*mehr*). Participants moved from segment to segment by pressing the spacebar. All participants were instructed to read the sentences naturally at their typical individual reading speed, and that speed and accuracy were equally important for the task. To allow the participants to get used to the self-paced reading task, the experiment started with a practice session consisting of three German and three Turkish sentences.

3.2 Results

Reading times

As expected, target segments other than the critical segment containing the German analytic comparative did not show any significant priming effects (all *p*s > .1). For the analysis of the critical segment, extreme reading times of more than 10 seconds (one data point in total) were considered outliers and removed from the analysis. In addition, we also excluded reading times which were more than two standard deviations above or below the overall mean reading time for the segment were considered outliers, and were thus not included in the analysis; a total of 35 outliers (= 4.0% of all data points) were removed from the analysis due to this procedure. Mean reading times by condition for the comparative segment are shown in Figure 1.

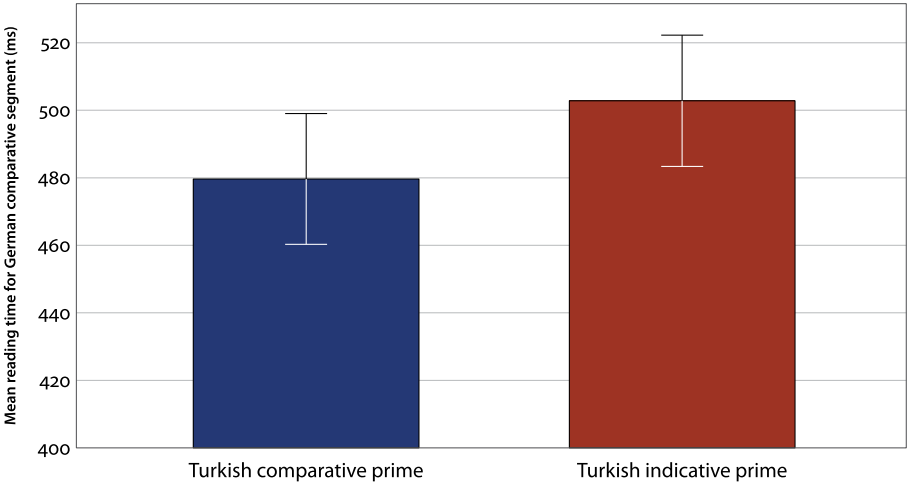

Figure 1. Mean reading times for the critical comparative segment in German target sentences by condition. Error bars reflect 95% confidence intervals

A linear-mixed effects regression model predicting log-transformed reading times for the critical segment was fit to the data. The model utilized the optimizer *Bobyqa* and contained *'prime type (comparative prime vs. indicative control prime)'* as a centered categorical predictor. Additionally, the fact that participants encounter an increasing number of ungrammatical German analytic comparatives while the experiment proceeds may cause adaptation effects, with readers gradually getting used to this particular ungrammatical construction. To control for such adaptation effects, the model included the position of the item in the experiment (henceforth referred to as *'item position'*) as an additional centered

continuous predictor. As recommended by Barr et al. (2013), the initial model contained a maximal random-effects structure, with random slopes and intercepts by participants and items for all predictors. This maximal random-effects structure was gradually simplified through a stepwise procedure (with the random effect which explained the least amount of variation in the data being removed) to determine the most complex model which reached convergence. The final model contained random intercepts for participants and items as well as a random slope for '*item position*' by participants. The results from the model analysis are shown in Table 2 below.

Table 2. Linear-mixed effects model predicting log-transformed reading times for the critical segment

	Estimate	Std. error	*df*	*t*	*p*	
(Intercept)	6.123	0.041	44.492	150.346	**<.001**	***
prime type	0.055	0.022	738.556	2.474	**.014**	*
item position	−0.015	0.004	34.411	−4.219	**<.001**	***
prime type x item position	−0.001	0.003	736.982	−0.310	.757	

Formula: *log RT comparative ~ prime type * item position + (1 + item position | participant) + (1 | item)*

The results revealed a significant main effect of '*prime type*', with faster reading times for German analytic comparatives following Turkish comparative primes than following indicative control primes. This priming effect aside, the results also showed a significant effect of '*item position*' irrespective of the prime, with faster reading times for targets which occurred later in the experiment. Both effects are illustrated in Figure 2.

To ensure that the significant main effects of '*prime type*' and '*item position*' are not specific to our particular criteria for data trimming, we repeated the model analysis with a range of different criteria for outlier exclusion (i.e., excluding all data points which are more than 2.5 SDs away from the mean, more than 3 SDs away from the mean, or fixed cut-off values based on the distribution of reading times). Both main effects remained significant in all analyses (all $ps < .05$).

Finally, for the significant effect of '*item position*' in the above analysis, it is not completely clear whether the effect is actually caused by adaptation to the ungrammatical analytic comparative, or whether the participants simply get used to the self-paced reading task while the experiment proceeds. However, if the effect of '*item position*' is caused by general adaptation to the experimental procedure, the various segments of the sentence should all show '*item position*' effects of a similar magnitude. We thus conducted additional model analyses compar-

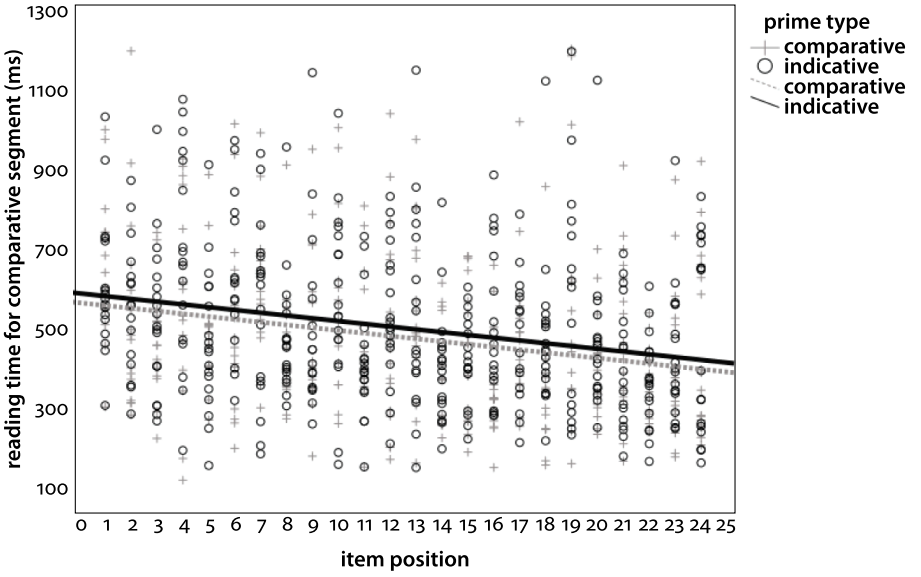

Figure 2. Reading times for the comparative segment by prime type and item position

ing the effect of '*item position*' in the comparative segment versus in the two segments immediately preceding the comparative segment. Crucially, these analyses revealed significant interactions between '*item position*' and '*segment*', with a stronger effect of '*item position*' in the comparative segment than in each of the two segments preceding it (both $ps < .05$). This indicates that, while all three segments showed a trend towards an adaptation effect (i.e., faster reading times towards the end of the experimental session), the adaptation was significantly stronger in the comparative segments than in the two preceding control segments. We thus conclude that the effect of '*item position*' in the main analysis is at least partly caused by adaptation to the analytic comparative during the experiment.

3.3 Preliminary summary and discussion

The results for the critical comparative segment in the German target sentences showed a priming effect, with significantly faster reading times after Turkish primes with analytic comparatives than after otherwise identical Turkish primes with indicative forms. This indicates that prior processing of the Turkish analytic comparative made it easier to process the grammatically incorrect German analytic comparatives in the target sentences.

Effects of the prime aside, the reading time results also showed a significant main effect of '*item position*', with reading times for the ungrammatical analytic

comparatives gradually getting faster while the experiment proceeded. This effect suggests that the participants adapted to the ungrammatical structure during the experiment.

4. Experiment 2: Grammaticality judgements

The results from Experiment 1 suggest that the processing of ungrammatical German analytic comparatives can be primed by prior exposure to Turkish analytic comparatives. However, the claim that such an ungrammatical cross-linguistic priming effect plays a role in grammatical language change is based on the additional assumption that persisting exposure to Turkish analytic comparatives over an extended period of time constitutes a form of *cumulative priming*, which leads to permanent changes with regard to the processing (and eventually also the production) of ungrammatical German analytic comparatives. As a result, Turkish–German heritage speakers who frequently use Turkish in their everyday lives should, due to frequent exposure to Turkish analytic comparatives, perceive German ungrammatical comparatives as less ungrammatical than otherwise similar monolingually-raised German speakers. We investigated this claim in Experiment 2, in which we compared grammaticality judgements for German ungrammatical analytic comparatives in Turkish–German Heritage speakers and monolingually-raised German speakers.

4.1 Method

Participants

The group of Turkish–German bilingual heritage speakers contained a total of 35 participants (28 female, 7 male; mean age = 22.94, age range = 18–30). None of these participants had participated in Experiment 1. All participants reported having acquired Turkish from birth or shortly afterwards. German was also acquired from early childhood (Mean age of German acquisition onset = 2.66, *SD* = 1.68). The German group consisted of 30 monolingually-raised young adults (25 female, 4 male, 1 other; mean age = 25.27, age range = 20–30) without any knowledge of Turkish.

Items

The 24 German target sentences with analytic comparatives from Experiment 1 were rated for grammaticality. Twenty-four German filler sentences, also taken

from the filler materials used in Experiment 1, were added to conceal the purpose of the study and to avoid explicit strategies.

Procedure

Data collection was conducted online via *SoSciSurvey*. Participants rated the grammaticality of each sentence on a seven-point Likert scale (with a rating of '7' meaning 'fully acceptable' and '1' meaning 'not acceptable at all').

4.2 Results

Mean grammaticality judgement scores for the two participant groups are shown in Figure 3.

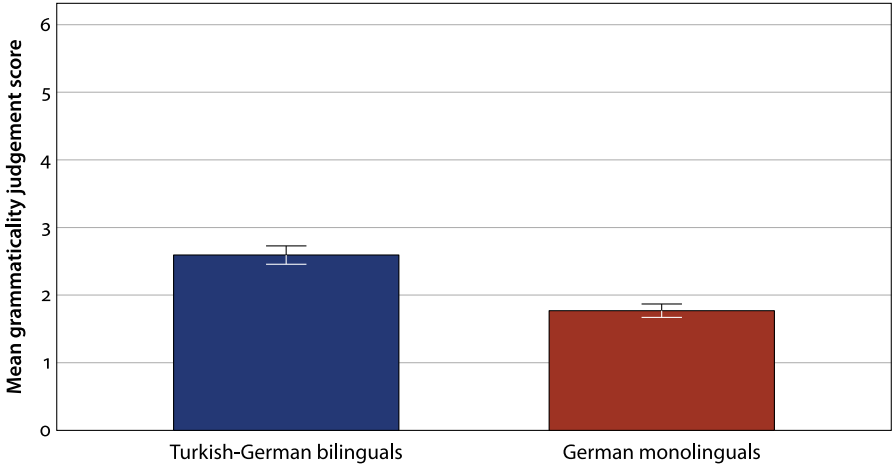

Figure 3. Mean grammaticality judgment score by participant group

For both groups, the vast majority of grammaticality judgements were situated near the lower end of the scale, suggesting that our bilingual participants were fully aware that analytic comparatives are not acceptable in German. However, as illustrated in Figure 3, bilinguals showed a tendency for slightly higher grammaticality judgements than the monolingually-raised German control group. To test this numerical trend for significance, we conducted cumulative-link mixed-effects model predicting grammaticality judgements of German analytic comparatives (see Michelotti et al., 2025, or Regulez & Montrul, 2023, for an example of such an analysis for ordinal outcome variables). The model contained *'Group (bilingual vs. monolingual)'* as a fixed effect, as well as random intercepts for participants and items. The results showed a significant effect of

'*Group*' (Estimate = −1.47, *SE* = 0.57, *z* = −2.61, *p* < .01), with higher grammaticality judgments in the bilingual than in the monolingually-raised group. Note, however, that bilinguals may also generally be less strict when judging the grammaticality of sentences in general, for instance because they encounter a wider variety of grammatical structures in their everyday lives than monolingually-raised speakers. This may lead to generally higher grammaticality judgments irrespective of any specific structure. To control for this possibility, we conducted an additional model analysis comparing the effect of '*Group*' in comparatives versus filler items. The respective cumulative-link mixed model contained '*Group (Bilingual vs. Control)*' and '*Item Type (Comparative vs. Filler)*' as fixed effects, random intercepts for participants, a by-participant random slope for '*Item Type*', and a by-item random slope for '*Group*'. Crucially, the model revealed a significant interaction between '*Group*' and '*Item Type*' (Estimate = 2.67, *SE* = 0.68, *z* = 3.90, *p* < .001), with the bilingual group showing higher grammaticality judgments than the monolingually-raised group for sentences with analytic comparatives, but no such difference (and in fact even a numerical trend in the opposite direction, with lower rather than higher grammaticality judgements in the bilingual than in the monolingual group) for filler sentences. This suggests that the effect shown in Figure 3 is specific to analytic comparatives.

5. General discussion

The main result from the self-paced reading experiment is that reading times for the critical comparative segment of the target sentence were significantly shorter when the German target sentence was preceded by a Turkish comparative prime than when the target was an indicative control prime. This suggests that the activation of the representation for analytic comparatives during processing of the Turkish prime sentence subsequently influenced the processing of the ungrammatical German analytic comparative.

With regard to the potential role of cross-linguistic priming in language change, our results are consistent with the claim that new structures may indeed enter a language through cross-linguistic ungrammatical priming (e.g., Kootstra & Muysken, 2019; Pickering & Garrod, 2017). Our finding that prior processing of Turkish analytic comparatives can influence the processing of German grammatically incorrect analytic comparatives provides support for the assumption that cross-linguistic priming can even occur for structures which are ungrammatical in the target language.

At first glance, the cross-linguistic ungrammatical priming effect in our study may appear inconsistent with the results from Hopp and Jackson (2023), who

found a cross-linguistic priming effect only for structures which are grammatical in both languages involved, but not for dispreferred or ungrammatical structures. However, recall that Hopp and Jackson investigated cross-linguistic priming in a production task, while our experiment focused on cross-linguistic ungrammatical priming in comprehension. While structural priming effects in comprehension and production are generally considered to be based on the same underlying structural representations (e.g., Pickering et al., 2013; Tooley & Bock, 2014; van Lieburg et al., 2023), ungrammatical priming effects in production can only emerge when the priming effect is strong enough to overcome a speaker's reluctance to produce sentences which are ungrammatical in the target language. As already discussed, this reluctance may be particularly severe in heritage speakers, due to societal discussions about their proficiency in the language of the larger national society. Also, heritage speakers may be especially reluctant to produce ungrammatical sentences in formal situations, such as experimental test sessions. As a result, cross-linguistic priming effects may be easier to detect in comprehension tasks, where the reluctance to produce ungrammatical sentences is irrelevant.

Nonetheless, in order for a new structure to enter a language through cross-linguistic ungrammatical priming, such priming effects necessarily have to eventually also occur in production, i.e., influence structural choices during the formulation of sentences. In other words, the priming effect has to become strong enough to overcome the reluctance to produce ungrammatical sentences. Note again, however, that, particularly in a psycholinguistic experiment based on prime-target pairs, priming effects are caused by only a very small number of primes. In everyday life, in contrast, bilinguals are repeatedly exposed to a considerable number of L1 sentences with the respective structure over years or decades. Following this rationale, repeated exposure to Turkish analytic comparatives over an extended period of time may cause cumulative priming effects, which may eventually become strong enough to overcome the reluctance to produce ungrammatical German analytic comparatives. This may also constitute an explanation for why grammatical language change typically requires extensive periods of time, with decades or even centuries before a new structure is fully established in a language. Finally, in informal conversations with other speakers from their community, heritage speakers may well be less hesitant to produce ungrammatical sentences than in a formal experimental test session.

While our results convincingly show that cross-linguistic priming can even occur for ungrammatical structures, the nature of the structural representation responsible for the ungrammatical priming effect is not entirely clear. With respect to cross-linguistic priming for grammatically correct structures, at least some theoretical accounts claim that priming effects are caused by *stored* grammatical representations which are shared between the two languages of a bilin-

gual. For instance, the *Shared Syntax* account (e.g., Bernolet et al., 2007; Hartsuiker et al., 2004; Schooenbaart et al., 2007) claims that, if a particular structure possesses similar properties in the two languages of a bilingual, the respective structure is represented as a single *combinatorial node* situated at the lemma stratum. This combinatorial node is shared between the two languages, and is thus utilized during the processing and production of sentences from both languages. While this approach indeed constitutes a viable explanation for cross-linguistic structural priming between structures which are grammatically correct (and possess similar structural properties) in both languages, the account struggles to explain the ungrammatical priming effect in our study: Turkish comparatives are analytic in nature, while German comparatives are synthetic. This fundamental difference in comparative formation should rule out the possibility to represent both structures in terms of a single, shared representation: Given that the analytic comparative does not exist in German, no stored structural representation for it should be acquired.

Note, however, that several alternative theoretical accounts of structural priming (e.g., Jacob et al., 2017; Jacob et al., 2024; Reitter et al., 2011; Scheepers, 2003; Scheepers, et al., 2011) suggest that, in addition to priming effects caused by the activation of *stored* structural representations, priming can alternatively also emerge through *computed* structural representations, for instance in the form of a hierarchical-tree representation computed on the fly during the processing of a prime sentence. In our study, the participants may have computed a structural representation of the analytic comparative during the processing of the Turkish prime. This computed representation may have subsequently influenced processing of the target. An alternative possibility is to assume that bilinguals possess a Turkish-specific stored representation for the analytic comparative, which nonetheless gets activated during the processing of the German target sentence. In research on bilingual sentence processing, there is at least some evidence that bilinguals, during the processing of an L2 sentence, may activate syntactic structures which are specific to the L1 (e.g., Hopp, 2017; Hopp & Grüter, 2023; Jacob, 2010; Rankin, 2014). Also, research on bilingual word recognition suggests that lexical access in bilinguals is language-nonselective, with lexical representations for L1 words getting activated during the processing of L2 utterances which contain form-similar words (e.g., Oppenheim et al., 2018; Thierry & Wu, 2004; 2007). Given these findings for lexical representations, it is conceivable that L1-specific structural representations may also get accessed during the processing of an L2 sentence. With regard to this issue, note that the Shared Syntax account assumes that combinatorial nodes are situated at the lemma stratum, and are connected to the lexical entries of words which can serve as the head of the respective structure. In this respect, lexical and structural representations are stored at the same level

and possess a similar format. Thus, it is possible that L1-specific structural representations are activated during the processing or production of an L2 sentence, just as L1-specific lexical representations are activated during the processing of L2 sentences with instances of code-switching or borrowing. A final possibility is that the ungrammatical priming effect is caused by the activation of an abstract comparative representation in which the particular structure of this comparative (i.e. whether it is analytic or synthetic) is not specified.

The ungrammatical priming effect aside, our results also revealed an adaptation effect for the ungrammatical German analytic comparative, with gradually faster reading times for the comparative segment towards the end of the experimental session. Additional analyses suggested that this effect at least partly reflects adaptation to the ungrammatical structure rather than to the self-paced-reading procedure. This indicates that our participants rapidly got used to the ungrammatical structure during the experiment. The adaptation effect is consistent with previous findings on the processing of novel grammatical structures in monolingual speakers (e.g., Fraundorf & Jaeger, 2016; Kaschak & Glenberg, 2004). With respect to contact-induced language change, the fact that speakers rapidly adapt to such new structures may facilitate the consolidation of a new grammatical structure in the target language, and may, for instance, make it easier for the new structure to spread throughout the linguistic community through within-language priming. In sum, while cross-linguistic ungrammatical priming may constitute a mechanism of entrenchment, within-langage adaptation may be involved in subsequent conventionalisation of the new structure.

With respect to the question of potential long-term consequences of the observed cross-linguistic ungrammatical priming, the results from Experiment 2 revealed significantly higher grammaticality judgements for ungrammatical German analytic comparatives in bilingual heritage speakers (who had not participated in Experiment 1) than monolingually-raised native speakers of German. This finding is predicted by theoretical accounts assuming a connection between cross-linguistic priming and language change, which state that frequent exposure to Turkish analytic comparatives, through cumulative priming, can have a long-term effect on a speaker's perception of German structures of the same kind. In our case, the fact that Turkish–German bilinguals frequently encounter Turkish analytic comparatives when speaking Turkish may have led to cumulative priming for this structure, eventually causing improved grammaticality ratings for German analytic comparatives. This explanation would also fit in well with the immediate priming effect observed in Experiment 1. Thus, the observed effect is at least consistent with the claim that cross-linguistic structural priming can cause grammatical language change.

Finally, it deserves to be mentioned that the particular linguistic phenomenon we utilized to investigate cross-linguistic ungrammatical priming is occasionally discussed as a candidate for a German structure which might be subject to diachronic change in the future. While analytic comparatives remain largely ungrammatical in formal written German (e.g., Bacskai-Atkari, 2018; Stolz, 2013), it has been suggested that such forms might slowly be emerging, particularly in informal and spoken German, with contact to languages with analytic comparatives (such as English, Turkish, and Arabic) mentioned as a possible source (Hahn, 2022; Roelcke, 2011). Thus, while the purpose of the present study was merely to identify a possible psycholinguistic pathway for instances of contact-induced language change, it will nonetheless be interesting to see whether this eventually turns into an actual pathway which allows analytic comparatives to emerge in German in the coming decades.

6. Conclusion

The most important result from the present study is that cross-linguistic structural priming can emerge even for structures which are ungrammatical in the target language. Our results thus provide empirical support for a key implicit assumption in theoretical accounts suggesting that cross-linguistic structural priming may potentially constitute a psycholinguistic mechanism of grammatical language change.

Funding

The research reported in this manuscript was funded by two research grants from the *Deutsche Forschungsgemeinschaft* (German Research Foundation, DFG) to Gunnar Jacob (grant number 469940249) and to Helen Engemann (grant number 469336053), as part of the DFG-funded Research Unit "*Structuring the Input for Language Processing, Acquisition, and Change (SILPAC)*" (FOR 5157, grant number 437487447).

Acknowledgments

The authors wish to thank Duygu Şafak, Christoph Schröder and the members of the *Zentrum Sprache — Variation — Mehrsprachigkeit* (University of Potsdam, Germany) for valuable help and advice.

Data availability statement

The raw data files for both experiments reported in this manuscript, as well as R script files for the respective statistical analyses and a list of all experimental materials, are available on OSF: https://osf.io/dgkez/?view_only=e1110b7492ca4835b692bbecc660a11f

CRediT statement of author contributions

Conceptualization: GJ; methodology: GJ; investigation: HI; resources: GJ and HE; software: HI; formal analysis: GJ and HI; data curation: GJ and HI; writing — original draft preparation: GJ, HI, and HE; writing — review and editing: GJ, HI, and HE; visualization, GJ and HI; supervision: GJ and HE; project administration: HI; funding acquisition: GJ and HE. All authors have read and agreed to the published version of the manuscript.

Ethics and informed consent statement

The research reported in this manuscript was conducted according to the ethics guidelines in the Declaration of Helsinki. Informed consent was obtained from all participants involved in the study.

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Publication history

Date received: 17 August 2024
Date accepted: 1 July 2025
Published online: 5 August 2025