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Address for correspondence:
Antje Muntendam, PO Box 3061540, Tallahassee, FL 32306-1540, USA
E-mail: amuntendam@fsu.edu

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The role of stress position in bilingual auditory word recognition: Cognate processing in Turkish and Dutch

Antje Muntendam[a,b], Remy van Rijswijk[b], Giulio Severijnen[c] and Ton Dijkstra[c,b]

[a]Florida State University, Tallahassee, Florida, USA; [b]Centre for Language Studies, Radboud University, Nijmegen, The Netherlands and [c]Donders Centre for Cognition, Radboud University, Nijmegen, The Netherlands

Abstract

We examined the effect of word stress position on bilingual auditory cognate processing. Turkish–Dutch early bilinguals who are dominant in their L2 (Dutch) performed an auditory lexical decision task in Turkish or Dutch. While Dutch has variable word stress, with a tendency for penultimate stress, stress in Turkish is mostly predictable and usually falls on the ultimate syllable. Our tasks included two-syllable cognates with penultimate stress in both languages, ultimate stress in both languages, or ultimate stress in Turkish and penultimate stress in Dutch. Some cognate facilitation effects arose in Dutch, while inhibition was found in Turkish. Cognates with ultimate stress were processed faster than cognates with penultimate stress, in both languages. This shows that in Turkish–Dutch early bilinguals, cognate processing depends on Turkish stress position, although Dutch is dominant. Together, the findings support the view that cognates have separate, though linked representations.

Introduction

A comparison of the vocabularies of European languages reveals that there are thousands of translation equivalents with orthographic or phonological form overlap in various language combinations (Schepens, Dijkstra & Grootjen, 2012; Schepens, Dijkstra, Grootjen & Van Heuven, 2013). Examples of such cognates are *tomato - tomaat* in English and Dutch (Dijkstra, Grainger & Van Heuven, 1999), and *gitar - gitaar* ('guitar') in Turkish and Dutch.

Research has shown that when a bilingual processes a cognate in one language, its equivalent in the other language is co-activated, which often results in faster word recognition relative to other words, especially in the L2. This is known as the cognate facilitation effect (Dijkstra, Miwa, Brummelhuis, Sappelli & Baayen, 2010; Midgley, Holcomb & Grainger, 2011; Peeters, Dijkstra & Grainger, 2013; Van Hell & Dijkstra, 2002; Voga & Grainger, 2007).

Surprisingly, almost all cognate studies concern word recognition in the visual rather than the auditory domain. However, there are at least two interesting aspects of auditory cognate processing. First, sub-phonemic differences are only present in auditorily presented cognates. For instance, the word *camera* is an English–Dutch cognate, but the first "a" is pronounced /æ/ in English and /a/ in Dutch. Importantly, the language-specific sounds of a cognate might reduce or even prevent co-activation of the cognate member from the other language. This raises the question whether cognate effects occur in auditory word recognition. Second, cognate members may be similar in phonological form and meaning, but different in their allocation of word stress. Of relevance for this study is that in Turkish, word stress lies quite predictably on the ultimate syllable. Words that do not have ultimate stress are exceptions and are mostly loanwords and foreign proper names (Inkelas & Orgun, 2003). In contrast, Dutch is a free-stress language, with a tendency for stress on the first syllable in two-syllabic words (i.e., penultimate stress; Van Donselaar, Koster & Cutler, 2005). For Turkish–Dutch cognates, the language difference leads to differences in word stress. For instance, in Turkish, *dokTOR* ('doctor') bears ultimate stress, while its Dutch equivalent *DOKter* has penultimate stress. The present study addresses the consequences of such incongruencies for cognate processing.

Our study is innovative from a third perspective. Most previous studies have focused on late bilinguals, who are dominant in their L1 (Van Hell & Tanner, 2012). However, our study considers Turkish–Dutch early bilinguals from the second generation of Turkish immigrants who arrived in the Netherlands in the 1960s. Bilinguals who speak their immigrant language as an L1 and the majority language of the society as an L2 are also referred to as HERITAGE SPEAKERS (Benmamoun, Montrul & Polinsky, 2013). Heritage speakers are different from late bilinguals, because the L2 is often their dominant language. Although language maintenance of Turkish is high in the Netherlands, second- and third-generation heritage speakers of Turkish report Dutch as their dominant language (Doğruöz & Backus, 2007; Extra, Yağmur & Van der

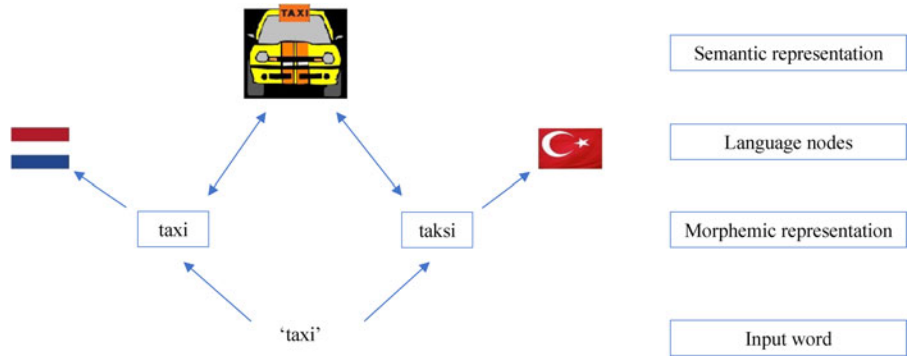

Fig. 1. The representation of the Turkish-Dutch cognate 'taxi': two similar, but non-identical morphemic representations that are linked to a (largely) shared semantic representation.

Avoird, 2004). Previous research on late bilinguals has revealed that the dominant L1 is more influential than the weaker L2 during word processing (Blumenfeld & Marian, 2005, 2007), but we know relatively little about how heritage speakers process words. Particularly, because the decreasing use of the L1 in heritage speakers generally leads to slower word recognition in that language (Köpke & Schmid, 2004; Montrul & Foote, 2014; Schmid & Köpke, 2009), the question arises whether this language is still activated and influential while heritage speakers hear words in their dominant L2. Our study addresses this question by comparing auditory cognate processing in our heritage speakers' L1 and L2.

To set the stage for our study, we first consider how cognate effects might depend on modality (visual or auditory). Subsequently, we review studies on the processing of word stress, and we formulate our research questions and hypotheses.

Bilingual visual versus auditory word recognition

Although cognates are translation equivalents with form overlap, they differ in the degrees of their semantic, orthographic, and phonological overlap (Dijkstra et al., 1999). Dijkstra et al. (2010) have demonstrated that even when cognates are presented visually, their phonological form in both languages is activated and affects item identification. It has been suggested (Dijkstra et al., 2010; Van Assche, Drieghe, Duyck, Welvaert & Hartsuiker, 2011) that the more phonologically similar a cognate across two languages is, the faster its recognition is (but see Dijkstra et al., 1999 for a different finding).

Most studies have focused on the visual domain (Dijkstra et al., 2010; Midgley et al., 2011; Peeters et al., 2013; Van Hell & Dijkstra, 2002; Voga & Grainger, 2007). These studies indicate that cognate representations in both languages are activated even in the context of only one language, and thus that lexical access is thoroughly language-nonselective. Dijkstra et al. (2010; see also Voga & Grainger, 2007) have proposed that the representation of cognates in the lexicon consists of two similar but non-identical morphemic representations that are linked to a (nearly) shared semantic representation (Figure 1).

This proposal has been supported by several studies (see Dijkstra, 2009) and it appears to hold even for orthographically identical cognates (Mulder, Schreuder & Dijkstra, 2012; Peeters et al., 2013).

An interesting and rather unexplored issue is whether the same kind of representation can be assumed to underlie the auditory processing of cognates. The different properties of the visual and auditory modalities might lead to differences in representation and processing. When the words from the different languages of the bilingual are represented in one and the same script, language-specific item properties only become visible in terms of sublexical orthotactic characteristics (Van Kesteren, Dijkstra & De Smedt, 2012). However, in the auditory domain the differences between languages are more salient, not only due to phonotactic properties but also to sub-phonemic cues that are language-specific. For instance, English and Dutch have phonemes and allophones that do not occur in the other language (e.g., /æ/ in English and /r/ in Dutch). Bilingual listeners might use these cues to efficiently retrieve words: by realizing almost immediately to which language the word belongs, they could restrict lexical access to this language. However, available evidence indicates that they do not do so. Even when there are small sub-phonemic differences between the languages, the two languages are co-activated, resulting in, for instance, cross-linguistic competition effects in interlingual cohort members (Marian & Spivey, 2003; Spivey & Marian, 1999; Weber & Cutler, 2004) and interlingual homophones (Lagrou, Hartsuiker & Duyck, 2011; Schulpen, Dijkstra, Schriefers & Hasper, 2003). For instance, Spivey and Marian (1999) observed that Russian–English bilinguals looked more at the between-language distractor item of a MARKER when they received the Russian (L1) instruction "Poloji *marku* nije krestika" or even its English (L2) equivalent "Put the stamp below the cross" than at a control item with an unrelated name. Furthermore, in two cross-modal priming experiments, Schulpen et al. (2003) found that a visual lexical decision on the English target word LEAF was faster both when it was preceded by the auditory English item LEAF /li:f/ and by the Dutch item LIEF /lif/ (meaning 'nice'), relative to an unrelated item like BIKE /baɪk/. This effect appeared despite sub-phonemic differences in the between-language item pairs.

Remarkably, few auditory lexical decision studies have considered this issue for cognates. One exception is Blumenfeld and Marian (2005, 2007), who showed that the auditory presentation of cognates led to co-activation of the other language in late German–English bilinguals. They observed an auditory cognate facilitation effect, which suggests that the type of cognate representation proposed for visual processing might also be valid for the auditory modality. Specifically, two phonological form representations would be linked to a largely shared semantic representation. During processing, the two form representations would be co-activated, resulting in resonance between codes and thus faster auditory word recognition than in non-cognates. The present study investigates whether a cognate facilitation effect arises in auditory word recognition by Turkish–Dutch bilinguals. Specifically, we examine the role of word stress position in the recognition of cognates.

Auditory processing of word stress

Little is known about the role of word stress position in the auditory recognition of cognates. Previous studies on auditory processing of word stress were concerned with cross-linguistic differences in word stress perception in non-cognates (Domahs, Genc, Knaus, Wiese & Kabak, 2013; Domahs, Wiese, Bornkessel-Schlesewsky & Schlesewsky, 2008; Dupoux, Peperkamp & Sebastián-Gallés, 2001; Peperkamp, Vendelin & Dupoux, 2010). These studies indicate that perception of word stress largely depends on whether the language concerned is a free-stress or fixed-stress language (Cutler, 2005; Van Donselaar et al., 2005). Free-stress languages such as English and Dutch have different syllable positions for word stress, depending on factors such as syllable weight and morphology. In fixed-stress languages, however, stress always falls on the same syllable. For instance, in French and Turkish the final syllable is stressed (with some exceptions). The assumption is that in free-stress languages stress is stored with the lexical representation, whereas in fixed-stress languages this is not required, given its predictability (Domahs et al., 2013; Gussenhoven & Jacobs, 2011; Peperkamp et al., 2010). This is supported by the finding that speakers of a fixed-stress language are not able to perceive differences in stress position in non-words. That is, they are said to be "stress deaf" (Dupoux et al., 2001; Peperkamp et al., 2010).

Speakers of free-stress languages tend to use word stress information to solve the competition between activated candidates during word processing (Cutler & Van Donselaar, 2001; Reinisch, Jesse & McQueen, 2010; Sulpizio & McQueen, 2012; Van Donselaar et al., 2005). Furthermore, studies on Dutch have shown a bias for initial stress, not only due to the statistical distribution in Dutch, but also due to use of signal information (Reinisch et al., 2010). That is, presence of stress on the first syllable leads to disambiguation in an early stage, because as soon as listeners perceive stress on the first syllable, all candidates with non-initial stress are attenuated. Absence of stress on the first syllable, however, does not automatically lead to the conclusion that the other syllable is stressed, because alternative scenarios are possible, such as word stress reduction by the speaker, or disturbed perception by the hearer. This explanation holds in particular for experiments in which words are presented in isolation, because there is no previous context to compare prominence of the first syllable to (Van Heuven & Menert, 1996). In other words, presence of initial stress leads to faster constraining of candidates than the absence of initial stress, as in the latter case more competitors remain activated.

Research on bilinguals has shown that late L2 learners (Dupoux, Sebastián-Gallés, Navarrete & Peperkamp, 2008; Lin, Wang, Idsardi & Xu, 2014) and some simultaneous bilinguals (Dupoux, Peperkamp & Sebastián-Gallés, 2010) show stress deafness compared to monolinguals if their L1 lacks contrastive stress. Interestingly, Dupoux et al. (2010) found an effect of language dominance (defined by early language exposure) in their study on simultaneous French–Spanish bilinguals: only the French-Dominant bilinguals in their study showed stress deafness in Spanish. Conversely, Boll-Avetisyan, Bhatara, Unger, Nazzi, and Höhle (2020) did not find speech rhythm deafness in their study on early French–German bilinguals.

The present study

The differences in stress assignment in Turkish and Dutch make it possible to manipulate stress position for cognates. The cognates in the present study either had penultimate stress in the two languages (Turkish *TEnis* versus Dutch *TEnnis,* 'tennis'), ultimate stress in the two languages (Turkish *giTAR* versus Dutch *giTAAR,* 'guitar'), or ultimate stress in Turkish and penultimate stress in Dutch (Turkish *dokTOR* versus Dutch *DOKter*, 'doctor'). We did not include a condition with items with penultimate stress in Turkish and ultimate stress in Dutch: words with penultimate stress in Turkish are exceptions, and the Dutch equivalents generally have penultimate stress as well.

We investigated the effect of word stress position in both L1 and L2 to clarify how stress assignment relates to lexical retrieval. Heritage speakers of Turkish performed an auditory lexical decision task in one of their languages. The following questions were addressed. First, is there evidence for a processing difference between cognates and non-cognates in bilingual auditory word recognition in Turkish and Dutch? Second, what is the effect of stress position in the two languages on the bilingual processing of cognates? Third, do similar effects occur while processing in the weaker L1 Turkish and in the dominant L2 Dutch?

Regarding the first question, we expected cognates to be processed faster than non-cognates in the L2 (Dutch), based on findings in the visual modality (Dijkstra et al., 2010). In the L1, a cognate effect is usually absent. However, it has been suggested that a cognate facilitation effect can arise in the L1 when the L2 is strong enough (Van Hell & Dijkstra, 2002). Because both Turkish and Dutch are relatively well established in our participants, a cognate facilitation effect might be expected for the L1 Turkish. Interestingly, however, given that the dominant language of our participants is the L2, the cognate effect might be stronger for L1 than for L2 (Blumenfeld & Marian, 2005, 2007).

Regarding the second question, we expected stress position to affect auditory cognate recognition. To allow segmentally similar words to differ in stress position, we assumed the existence of separate representations for the two cognate readings (as proposed by Peeters et al., 2013). We predicted a larger cognate facilitation effect in the stress congruent conditions (with penultimate stress in both languages, or ultimate stress in both languages) than in the incongruent condition (with ultimate stress in Turkish and penultimate stress in Dutch) for L2 target words. This prediction is based on the assumption that there is more overlap between cognates that are congruent in stress position. However, based on Dupoux et al.'s (2010) findings for simultaneous French–Spanish bilinguals, we might expect that our participants are "stress deaf", as their L1 is Turkish. If that is the case, no differences between the congruent and incongruent conditions might arise.

As for the third question, we expected that in the L1 Turkish lexical decision task, penultimate stress in both cognates would lead to a reduced cognate facilitation effect, because in this condition word stress in Turkish is lexical and not predictable. This situation is more similar to Dutch and might therefore lead to relatively more competition from the L2. In comparison, in the L2 Dutch lexical decision task, we predicted that ultimate stress in both cognates would lead to a larger cognate facilitation effect than in the other conditions: although Dutch has the tendency to stress the first syllable of words, when both cognates have ultimate stress, the Dutch cognates have a Turkish-like stress pattern and will therefore be recognized faster. These hypotheses were tested in two experiments with Turkish–Dutch bilinguals: a Turkish (L1) lexical decision task and a Dutch (L2) lexical decision task.

Experiment 1: Turkish (L1) lexical decision task

Method

Participants

The participants in the Turkish lexical decision experiment were 19 Turkish–Dutch bilinguals (13 female; mean age: 21.3 years, range 18–26 years), all second-generation heritage speakers of Turkish in the Netherlands. Two other participants were discarded because they had less than 70% correct responses in the lexical decision task.

Participants first completed a background questionnaire (NetQ Internet Surveys, 2002) online, including questions on their age of acquisition of Turkish and Dutch, language dominance, frequency and domains of language use, knowledge of other languages, educational level, and family background. Participants were born in the Netherlands, and their parents were born in Turkey. All participants acquired Turkish as a first language at home; some learned Turkish and Dutch simultaneously at home, while others learned Turkish at home and Dutch at (pre)school. All participants had at least finished secondary school. Most participants considered Dutch to be their dominant language.

In the questionnaire, participants were asked to indicate their proficiency in speaking, listening, writing, reading, and pronunciation in Dutch and Turkish (Table S1). The proficiency ratings were relatively high for both languages, but paired t-tests revealed significantly higher proficiency ratings for Dutch than Turkish for speaking ($t(18) = 2.48$, $p = .023$), writing ($t(18) = 3.14$, $p = .006$), reading ($t(18) = 4.14$, $p < .001$), and pronunciation ($t(18) = 2.48$, $p = .007$).

At the end of the session, participants completed the Boston Naming Test (BNT) (Kaplan, Goodglass, Weintraub, Segal & Van Loon-Vervoorn, 2001) in Dutch and Turkish, which measured the participants' proficiency in both languages. The order of the languages was counterbalanced among participants. Participants scored significantly higher on the Dutch BNT than on the Turkish BNT ($t(17) = 10.40$, $p < .001$) (Table S2).

Together, the findings from the questionnaire, the proficiency ratings, and the BNT show that the participants' first language is Turkish, but that their dominant language is Dutch. Participants with a high proficiency in French were excluded from the study, because the materials contained words that occurred in French but had different stress patterns in French and Turkish.

Stimulus materials

The materials for the Turkish lexical decision task consisted of two-syllable items in three stress conditions. The first condition (ULT-ULT) contained cognates with ultimate stress in both languages, e.g., Turkish *giTAR* and Dutch *giTAAR* 'guitar'. The second condition (PEN-PEN) comprised cognates with penultimate stress in both languages, e.g., Turkish *TEnis* and Dutch *TEnnis* 'tennis'. Finally, the third condition (ULT-PEN) comprised cognates with ultimate stress in Turkish but penultimate stress in Dutch, e.g., Turkish *tüNEL* and Dutch *TUnnel* 'tunnel'. The abbreviations indicate stress position in Turkish, followed by stress position in Dutch. Thus, items in ULT-PEN have ultimate stress in Turkish and penultimate stress in Dutch. There were 30 Turkish–Dutch cognates, 30 Turkish non-cognates, and 60 pronounceable pseudo words per condition. Each task contained 360 items in total (Tables S17 and S18). There was also a practice set with 4 cognates, 5 non-cognates, and 9 pseudo words.

The cognates were selected from Turkish–Dutch dictionaries (Kiriş, 2006, 2009). The selection criteria included word frequency, phonological similarity, and semantic similarity. The participants had some proficiency in English in addition to Dutch and Turkish: specifically, 12 participants reported knowledge of English with a mean self-reported proficiency of 3.35 on a scale from 1 ('not good at all') to 5 ('very good'). Therefore, cognates with incongruent stress patterns in Dutch and English were excluded. The pseudo words were strings of sounds that were not existing words in Turkish but that followed the phonotactics of Turkish. These pseudo words had ultimate or penultimate stress, like the cognates and non-cognates. All pseudo words were checked by native speakers of Turkish.

The cognates and non-cognates in the different conditions were matched for word frequency. Turkish word frequencies were calculated using Dave's (2012) corpus. The SUBTLEX-NL database (Keuleers, Brysbaert & New, 2010) was used to get an estimation of word frequencies of the Dutch reading of cognates. Dutch word frequencies were used, because not all cognates appeared in Dave's (2012) corpus. In addition, the duration and the number of phonemes of the cognates, non-cognates, and pseudo words were calculated (Table S3). There were no significant differences for word frequency and duration, based on independent t-tests. However, there were some significant differences for the number of phonemes (Table S3).

Finally, all items were recorded with a 23-year old bilingual Turkish–Dutch female, who was born in the Netherlands and speaks a variety of Turkish that is spoken in the Netherlands and that is similar to that of our participants. The recordings were made in a soundproof booth at 32-bits and 44 kHz.

Further assessment of the Turkish test items through ratings

Because heritage speakers are exposed to and use their two languages in different domains and for different purposes, word frequencies for this population might differ from those obtained from databases. Therefore, after the lexical decision task, our participants assessed the frequency of the items included in the study. In addition, they rated the semantic similarity and phonological similarity of the Turkish and Dutch items. The order of the ratings was varied among participants.

In the subjective frequency rating task, participants indicated how often they used (reading, writing, speaking, hearing) the word shown on a scale from 1 ('absolutely never') to 7 ('very often'). Participants were also asked to write down words that were unfamiliar to them. For each language, two lists were created with 45 cognates and 45 non-cognates each. The words were presented in a (pseudo-)random order, which was different for each participant.

In the semantic similarity rating task, a Dutch and a Turkish word appeared on a computer screen. Participants indicated how similar the two words were in meaning on a scale from 1 ('no similarity at all') to 7 ('perfect similarity'). The word pairs consisted of low similarity word pairs (e.g., Dutch *leegte* 'emptiness' and Turkish *yağmur* 'rain'), middle similarity word pairs (e.g., Dutch *honing* 'honey' and Turkish *arı* 'bee') and cognate pairs. To ensure that participants only paid attention to the meaning of the words, two pairs of words that had the same meaning but were phonologically different were included, e.g., Dutch *aardbei* and Turkish *çilek* 'strawberry'. Two lists were created with 45 cognate pairs, 15 middle similarity word pairs and 15 low similarity word pairs each. The lists were randomized and each participant received a different list.

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Table 1. Accuracy rates for the items in the three stress conditions in Experiment 1 (Turkish lexical decision).

	Cognates			Non-cognates			Pseudo words		
	PEN-PEN	ULT-PEN	ULT-ULT	PEN-PEN	ULT-PEN	ULT-ULT	PEN-PEN	ULT-PEN	ULT-ULT
Incorrect responses	163	98	118	167	102	83	92	111	114
Missing values	23	20	11	8	8	10	24	34	37
Correct responses	444	512	501	455	520	537	1144	1115	1109
Total	630	630	630	630	630	630	1260	1260	1260
% accurate	70.48	81.27	79.52	72.22	82.54	85.24	90.79	88.49	88.02

Note: Missing values are reaction times below 500 ms and reaction times higher than 2000 ms.

In the phonological similarity rating task, participants indicated how similar two words that were presented auditorily were with respect to pronunciation, with 1 ('no similarity at all') and 7 ('perfect similarity'). The word pairs consisted of low similarity word pairs (e.g., Dutch *brommer* 'moped' and Turkish *omuz* 'shoulder'), middle similarity word pairs (e.g., Dutch *heelal* 'universe' and Turkish *hilal* 'new moon'), and cognate pairs. In addition, two pairs of words that were phonologically similar but semantically different in the two languages (e.g., Dutch *tabak* 'tobacco' and Turkish *tabak* 'plate') were added to check that the participants only paid attention to phonology. Again, two lists were created with 45 cognate pairs, 15 middle similarity word pairs, and 15 high similarity word pairs each. The lists were randomized and each participant received a unique list.

Independent t-tests showed significantly higher ratings for the cognates in ULT-PEN (i.e., with ultimate stress in Turkish and penultimate stress in Dutch) than for those in PEN-PEN ($p = .048$) (Table S4). Moreover, for ULT-ULT, the non-cognates received significantly higher ratings than the cognates ($p = .006$). There were no other significant differences ($p > .05$). Because there was a discrepancy between frequency ratings based on the corpora and the subjective frequency ratings, subjective frequency was added as a factor in our regression model (see Results). The mean frequency of each item was used in the model as each participant rated only half of the items. Regarding semantic and phonological similarity, all cognates were rated as highly similar. There were no significant differences between stress conditions (p's $> .05$) (Table S4).

Procedure

Participants first received instructions about the study and gave their informed consent. The lexical decision task instructions were presented on the screen in Turkish. Participants indicated whether a sequence of sounds was an existing word in Turkish by pressing a button as quickly as possible (left = 'no', right = 'yes'). A fixation point appeared on the screen for 200 ms, followed by a beep for 190 ms. The stimulus appeared 400 ms after the beep, and the participants had to react within 3000 ms. Response times (RTs) were measured from the onset of the syllable. The intertrial interval was set at 1500 ms. The experiment was divided in 4 blocks, with 90 trials per block. The stimuli were pseudo-randomized and each participant received a different list. The main task was preceded by a practice session. In total, the task lasted approximately 25 minutes.

Results

First, RTs lower than 500 ms and higher than 2000 ms (2.31% of the data) and incorrect responses (13.86% of data) were removed.

Table 2. Reaction times (means and standard deviations, in milliseconds) for Experiment 1 (Turkish lexical decision).

	PEN-PEN	ULT-PEN	ULT-ULT
Cognates	1059 (192)	1009 (203)	1003 (182)
Non-cognates	1016 (193)	1004 (183)	991 (193)
Difference	43	5	12

Accuracy rates per condition are given in Table 1 (see Tables S5 and S6 for our mixed-model analyses). Subsequently, data from two participants were discarded, because they had less than 70% correct responses. Furthermore, two cognates from PEN-PEN and one non-cognate from ULT-PEN were excluded because they had few responses. Finally, RTs deviating more than 2.5 standard deviations from the mean were discarded. The RT analysis is based on 2,574 data points (see Table 2 for mean RTs and Standard Deviations).

The RT data were analyzed by mixed-effects regression modeling with the lmerTest package (Kuznetsova, Brockhoff & Christensen, 2014) in R (R Core Team, 2014). To take out contributions of duration and subjective frequency from the cognates, we created a new factor 'residual Cognate Status' (Cognate-r) in R. This new variable Cognate-r was strongly correlated with the original variable Cognate Status ($r = .960$).

Given that the two conditions with ultimate stress in Turkish (ULT-PEN and ULT-ULT) did not differ significantly, a factor Ultimate Stress in Turkish (1 = 'yes', 0 = 'no') combining these conditions was created. This factor thus contrasted all items that had ultimate stress in Turkish (and either penultimate or ultimate stress in Dutch) with those that had penultimate stress in Turkish (and penultimate stress in Dutch). This factor explained the data better than the variable Stress Condition, as determined by AIC and the *anova* function in R.

The initial model had Cognate-r as fixed effect and Subject and Item as random effects. Other factors (Subjective Frequency, Duration, Ultimate Stress in Turkish, and proficiency measures) were added one by one. Subjective Frequency was added because the results of the subjective frequency rating task showed differences between stress conditions, and Duration was added for consistency between the models for Experiments 1 and 2. Both Subjective Frequency and Duration were mean-centered in R. Ultimate Stress in Turkish was added to assess the effect of stress position. The proficiency measures were included as a higher proficiency could result in faster RTs. We checked for interactions and used the AIC and loglikelihood measures of the model fit, and the *anova* function in R to select the best fitting

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model. In the finally chosen mixed-effects model, the fixed effects were Cognate-r, Ultimate Stress in Turkish, Subjective Frequency, Duration and Self-rated proficiency for Listening in Turkish (Table S7). Included random effects were Subject and Item. Other factors did not lead to an improved fit of the model.

The model did not show an effect of Cognate-r, which could be due to the large standard deviations (Table 2). However, there was a significant effect of Ultimate Stress in Turkish (β = -36.39, SE = 12.40, t = -2.94, p = .004). That is, words with penultimate stress in Turkish (PEN-PEN) were processed slower than words with ultimate stress in Turkish (ULT-PEN and ULT-ULT). Interestingly, penultimate stress is the atypical stress pattern for words in Turkish. The interaction between Cognate-r and Ultimate Stress was not significant.

The model further yielded significant effects of Subjective Frequency (β = -32.12, SE = 4.48, t = -7.16, p < .001) and Duration (β = 0.43, SE = 0.06, t = 6.75, p < .001): items with a lower subjective frequency and a longer duration led to longer RTs. Finally, there was a significant effect of Self-rated proficiency for Listening in Turkish (β = -114.33, SE = 32.15, t = -3.56, p = .002). That is, participants with a lower proficiency rating for listening in Turkish had longer RTs.

To further analyze cognate effects in the three stress conditions, we ran mixed-effects regression analyses for each condition separately (Table S8). We used the same procedure as in the main analysis to select the model with the best fit. Cognate-r only had a marginally significant effect in PEN-PEN (β = 46.64, SE = 25.27, t = 1.85, p = .071), with slower responses to cognates than to non-cognates. In this condition, there was also a significant interaction between Cognate-r and Subjective Frequency (β = 46.11, SE = 20.77, t = 2.22, p = .03). There were significant effects of Subjective Frequency and Duration in all conditions.

In all, an effect of Ultimate Stress showed that items with atypical stress in Turkish (items in PEN-PEN) were processed slower than items with typical stress (items in ULT-PEN and ULT-ULT). As Table 2 shows, RTs were longer for cognates than for non-cognates in all three stress conditions. This effect was nominally larger for items in PEN-PEN than for those in ULT-PEN and ULT-ULT. However, the separate analyses for the three stress conditions showed only a marginally significant cognate effect in PEN-PEN and non-significant effects in the other two conditions.

Discussion Experiment 1 (Turkish lexical decision)

In a Turkish lexical decision task, we collected RT and accuracy data for cognates and non-cognates with three different positions for word stress. Because the accuracy data patterns were generally in line with those for RTs, we will focus on the latter. First, we expected a cognate facilitation effect to arise, because Dutch was the participants' dominant language. However, no such cognate effect was observed. In fact, cognates were processed (non-significantly) slower than non-cognates in all conditions.

Second, relative to non-cognates, cognates with congruent stress positions in Turkish and Dutch were predicted to show a larger RT effect than cognates with incongruent stress positions, because there is more cross-linguistic overlap for cognates that are congruent in stress position. However, although there was a trend towards cognate inhibition in PEN-PEN, stress congruence did not significantly affect the size of the cognate effect.

One might therefore consider if the Turkish–Dutch bilinguals in our study were "stress deaf" (like the simultaneous French–Spanish bilinguals in Dupoux et al., 2010). However, this does not appear to be the case, because when the two conditions with ultimate stress in Turkish were combined, these had significantly faster RTs than PEN-PEN. We note that word stress in Turkish is usually positioned on the ultimate syllable. Our participants seemed thus to be similar to the French–German bilinguals in Boll-Avetisyan et al. (2020), who did not show speech rhythm deafness. We would like to point out, however, that our study did not include a comparison group and that it was not designed to study "stress deafness", which is studied in for instance lexical decision tasks with words and non-words that only differ in stress position (Dupoux et al., 2008; Dupoux et al., 2010).

Third, we hypothesized that penultimate stress in the two readings of a cognate would lead to a reduced cognate facilitation effect. The similarity of stress in Turkish and Dutch in PEN-PEN might induce more competition between the languages, especially because it arises early in processing. Although we observed a (non-significant but 43 ms) inhibition effect rather than a reduced facilitation effect, this hypothesis could be considered to be supported by the data. Such a competition effect did not arise in ULT-PEN.

In all, the observed RT patterns can be interpreted as follows. First, the absence of strong cognate effects is in line with the view that Turkish is our participants' L1, because in studies with late bilinguals cognate null-effects have often been reported in the L1 (Van Hell & Dijkstra, 2002). In fact, cognate facilitation effects standardly arise in the L2 of late adult bilinguals. Second, in line with this, the stress position in Turkish underlays the pattern of results across stress conditions, rather than stress congruence or incongruence between Turkish and Dutch.

To confirm and extend these results, in Experiment 2 we conducted a DUTCH lexical decision task with comparable Turkish–Dutch bilinguals with Dutch–Turkish cognates and Dutch non-cognates in the same three word-stress conditions. Assuming that Turkish functions like an L1, we expect cognate facilitation effects to arise when the L2 (Dutch) is the target language. Furthermore, if Turkish determines the word stress effects, we again expect similar RT patterns in ULT-ULT and ULT-PEN, but a different pattern in PEN-PEN. More specifically, the first two conditions are expected to yield cognate facilitation effects, whereas the third one should show reduced cognate facilitation or even cognate inhibition effects, due to the presumed competition between the Dutch L2 target words and their Turkish L1 counterparts.

Experiment 2: Dutch (L2) lexical decision task

Method

Participants

Participants in this Dutch lexical decision experiment were 20 Turkish–Dutch bilinguals (15 female; mean age: 21.9 years, range 19–26 years), who did not participate in the Turkish experiment. Participants were highly similar to those in the Turkish study and reported a relatively high level of proficiency in both languages (Table S9). Paired t-tests revealed significantly higher proficiency ratings for Dutch than Turkish for speaking ($t(19)$ = 3.27, p = .004), listening ($t(19)$ = 2.35, p = .030), writing ($t(19)$ = 3.32, p = .004), reading ($t(19)$ = 3.56, p = .002), and pronunciation ($t(19)$ = 3.11, p = .006). Moreover, a paired t-test showed significantly higher scores for the Dutch BNT than for the Turkish BNT ($t(18)$ = 8.35, p < .001) (Table S10).

In all, the findings from the questionnaire, the language proficiency ratings, and the BNT reveal that the participants are dominant in their L2 (Dutch), like the participants in Experiment 1.

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Table 3. Accuracy rates for the items in the three stress conditions in Experiment 2 (Dutch lexical decision).

	Cognates			Non-cognates			Pseudo words		
	PEN-PEN	ULT-PEN	ULT-ULT	PEN-PEN	ULT-PEN	ULT-ULT	PEN-PEN	ULT-PEN	ULT-ULT
Incorrect responses	118	87	95	107	104	137	152	130	171
Missing values	3	3	4	3	1	4	9	11	9
Correct responses	479	510	501	490	495	459	1039	1059	1020
Total	600	600	600	600	600	600	1200	1200	1200
% accurate	79.83	85	83.5	81.67	82.5	76.5	86.58	88.25	85

Note: Missing values are reaction times below 500 ms and reaction times higher than 2000 ms.

Stimulus materials

The Dutch materials were again two-syllable items in three stress conditions, with the same properties as the earlier Turkish items. There were 30 cognates, 30 non-cognates, and 60 pseudo words per condition, for a total of 360 items (Tables S19 and S20). In addition, a practice set consisted of 4 cognates, 5 non-cognates, and 9 pseudo words. The cognates were selected based on word frequency, phonological similarity, and semantic similarity. The task did not include cognates with incongruent stress patterns in Dutch and English to avoid an English influence. Similar to in Experiment 1, 12 participants reported knowledge of English with a mean self-reported proficiency of 3.9 on a scale from 1 ('not good at all') to 5 ('very good').

The cognates and non-cognates in the different conditions were matched for word frequency. The SUBTLEX-NL database (Keuleers et al., 2010) was used to obtain word frequencies of the cognates and the Dutch non-cognates. Turkish word frequencies were calculated using Dave's (2012) corpus.

The duration and number of phonemes of the cognates, non-cognates, and pseudo words were also calculated. There were no significant differences for word frequency, based on independent t-tests. However, there were some differences for duration and the number of phonemes (Table S11). Therefore, duration was included as a factor in the regression model (see Results). Finally, all items in Experiment 2 were recorded by the same Turkish–Dutch bilingual who recorded the materials for Experiment 1.

Further assessment of the Dutch test items through ratings

To further assess various lexical properties of the Dutch test items, we performed an independent study, as for Experiment 1, in which we assessed the frequency, semantic similarity, and phonological similarity of the stimulus materials (Table S12). Independent t-tests showed no significant differences, indicating that the items were well matched on several relevant dimensions.

Procedure

The procedure in Experiment 2 was the same as in Experiment 1, except that the instructions were in Dutch and participants were instructed to determine if the presented sequence of sounds was an existing word in Dutch.

Results

First, RTs lower than 500 ms and higher than 2000 ms (3.92%) and incorrect responses (15.29%) were removed. The resulting accuracy rates per condition are given in Table 3 (see Tables S13 and S14 for our mixed-model analyses). Subsequently, two cognates in PEN-PEN and one Dutch non-cognate in ULT-ULT were discarded because they received few responses. Finally, RTs deviating more than 2.5 standard deviations from the mean were excluded. The subsequent RT analysis was based on 3,104 data points (see Table 4 for mean RTs and Standard Deviations). Overall, the RTs in Experiment 2 were somewhat shorter than in Experiment 1, indicating faster processing in Dutch, which is the participants' dominant language, than in Turkish.

Table 4. Reaction times (means and standard deviations, in milliseconds) for Experiment 2 (Dutch lexical decision).

	PEN-PEN	ULT-PEN	ULT-ULT
Cognates	918 (154)	856 (163)	889 (172)
Non-cognates	896 (176)	902 (172)	928 (178)
Difference	22	-46	-39

A mixed-effects analysis was done in which a new variable Cognate-r was created, from which variation in subjective frequency and duration was taken out. The new variable was highly correlated with the original variable Cognate Status ($r = .995$). We started out with a simple model with Cognate-r as fixed effect and Subject and Item as random effects. Other factors (Subjective Frequency, Duration, Stress Condition, and proficiency measures) and interactions were added one by one. By comparing different models, all involving as fixed factors at least residual Cognate Status and Stress Condition, with the *anova* function in R, we selected the best fitting model.

As fixed variables, the final model included Cognate-r (1 = 'yes', and 0 = 'no'), Stress Condition ('PEN-PEN', 'ULT-PEN', and 'ULT-ULT'), Subjective Frequency, Duration, and Turkish BNT score (Table S15). Subject and Item were included as random factors (Barr, Levy, Scheepers & Tily, 2013). Subjective Frequency and Duration were mean-centered and were included as variables potentially affecting cognate processing and stress conditions. The Turkish BNT score was added to assess the effect of language proficiency. Other related factors did not lead to an improved fit of the model.

Cognate-r had only a marginally significant main effect ($\beta = 33.26$, $SE = 18.30$, $t = 1.82$, $p = .071$), and ULT-PEN (with items with ultimate stress in Turkish and penultimate stress in Dutch) only differed marginally from PEN-PEN as the intercept ($\beta = -22.87$, $SE = 12.71$, $t = -1.80$, $p = .074$). However, there were significant interactions between Cognate-r and Stress Condition. Both ULT-PEN ($\beta = -63.59$, $SE = 25.59$, $t = -2.49$, $p = .014$) and

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ULT-ULT (β = -65.93, SE = 25.74, t = -2.56, p = .011) differed in their cognate effects from PEN-PEN. That is, the interaction between Cognate-r and Stress Condition was significant both in the comparison between ULT-PEN vs. PEN-PEN, and in the comparison between ULT-ULT vs. PEN-PEN. However, ULT-PEN and ULT-ULT did not differ. As shown in Table 4, responses to cognates were slower than to non-cognates in PEN-PEN, but somewhat faster in ULT-PEN and ULT-ULT. Finally, there were significant effects of Subjective Frequency (β = -27, SE = 4.07, t = -6.63, p < .001) and Duration (β = 0.65, SE = 0.07, t = 9.63, p < .001). Items with a lower subjective frequency and a longer duration were processed slower. The inclusion of the factor Turkish BNT scores improved the model: lower scores on the Turkish BNT were associated with longer RTs in Dutch. However, this factor did not have a significant effect.

We ran separate analyses for the three stress conditions (Table S16). In PEN-PEN, cognates were processed (non-significantly) slower than non-cognates, indicating inhibition. In ULT-PEN and ULT-ULT, however, cognates were processed faster than non-cognates, indicating cognate facilitation. In ULT-PEN (with penultimate stress in Dutch), this effect was only marginally significant (β = -29.70, SE = 15.91, t = -1.87, p = .068) and in ULT-ULT it was not significant. In all stress conditions, there were significant effects of Subjective Frequency and Duration, indicating that items with a lower subjective frequency and a longer duration were processed slower. In PEN-PEN, there was also a significant interaction between Cognate-r and Duration (β = -0.53, SE = 0.2, t = -2.66, p = .011), reflecting that in this condition, the cognates and non-cognates behave differently, depending on duration. For cognates with a longer duration, there was a reduced cognate effect. Future research should investigate whether these interactions could be attributed to phonological aspects of the cognates rather than orthographical aspects.

In all, we found a non-significant cognate facilitation effect for ULT-PEN and ULT-ULT, but not for PEN-PEN. In PEN-PEN, cognates were processed slower than non-cognates. This is striking because PEN-PEN has congruent stress across the two languages. The items in this condition have typical stress in Dutch but atypical stress in Turkish. The items in ULT-PEN also have penultimate stress in Dutch, yet the results are different from those of PEN-PEN. We will come back to this in the discussion. ULT-PEN and ULT-ULT, which have typical ultimate stress in Turkish, were more similar in RT.

Discussion Experiment 2 (Dutch lexical decision)

In Experiment 2, early Turkish–Dutch bilinguals performed a Dutch lexical decision task with cognates and matched non-cognates. We predicted that ULT-ULT and ULT-PEN would yield cognate facilitation effects in RTs, whereas PEN-PEN would show a reduced facilitation effect or even an inhibition effect. This was indeed what was observed. Numerically, cognates were processed slower than non-cognates when stress fell on the penultimate syllable in both Dutch and Turkish (PEN-PEN), but faster when it fell on the ultimate syllable in Turkish, irrespective of stress position in Dutch (ULT-PEN or ULT-ULT). The effect of cognate status was only marginally significant, but there were significant interactions: ULT-PEN and ULT-ULT differed significantly in cognate effects from PEN-PEN.

In sum, as in Experiment 1, the RT differences between cognates and non-cognates were mostly determined by the default stress position in Turkish. Dutch cognates with an atypical penultimate stress position in Turkish were processed more slowly than Dutch non-cognates, whereas Dutch cognates with a typical ultimate stress position in Turkish were facilitated. Also as in Experiment 1, the accuracy patterns were in line with those for RTs and in accordance with this interpretation. Thus, it can be concluded that (1) Turkish behaved as if it were the L1, and (2) Turkish stress position affected the cognate facilitation effect.

It is remarkable that the RT to the Dutch version of a cognate was affected by its stress position in Turkish, especially because in this Dutch task, the RTs were generally shorter than in the Turkish task. Such faster processing in Dutch than in Turkish indicates that Dutch is the participants' dominant language, as confirmed by the participants' self-ratings.

General discussion

This study examined the role of word stress position in bilingual auditory processing of Turkish–Dutch cognates, in Turkish and Dutch. It addressed the following questions. (1) Is there evidence for a processing difference between cognates and non-cognates in bilingual auditory word recognition? (2) What is the effect of stress position in the two languages on the bilingual processing of cognates? (3) Do similar effects occur during processing of the weaker L1 Turkish and the dominant L2 Dutch? We answer these questions in the following sections. Because the third question is related to the first two, we address question (3) while answering questions (1) and (2).

Is there evidence for a processing difference between cognates and non-cognates in bilingual auditory word recognition?

This is the first study to provide data in support of a difference in auditory cognate and non-cognate processing by Dutch heritage speakers of Turkish. The difference was observed mainly in Dutch, the dominant L2. For Dutch, RTs revealed non-significant cognate facilitation effects in ULT-PEN and ULT-ULT. The effect of cognate status was only marginally significant, but there were significant interactions between cognate status and stress condition, with faster responses to cognates than non-cognates in ULT-PEN and ULT-ULT and slower responses in PEN-PEN. For Turkish, the less frequently used L1, there were (non-significant) cognate inhibition effects in all stress conditions.

Our findings of L2 (Dutch) facilitation and L1 (Turkish) null-effects for cognates in unbalanced early bilinguals are similar to those in visual studies with unbalanced late bilinguals (Dijkstra et al., 2010; Peeters et al., 2013; Voga & Grainger, 2007).[1] As such, our data can be interpreted to a large extent in terms of the theoretical account proposed for visual bilingual cognate processing (Dijkstra & Van Heuven, 2002; Dijkstra et al., 2010; Voga & Grainger, 2007).

When a cognate from one language is visually presented, it activates cognate form representations in both languages, together with other word candidates that resemble the input. More segmental overlap between input and word candidate leads to more lexical activation, irrespective of language membership. Subsequently, the activated cognate form representations both spread activation to their shared semantic representation

[1]To our knowledge there are no comparable studies on auditory cognate processing, but our findings are in agreement with studies on visual cognate processing. Moreover, our study on visual cognate processing in Turkish and Dutch (Muntendam & Dijkstra, in preparation) revealed similar effects.

(Figure 1; see also Dijkstra et al., 2010), contrary to non-cognates, which have only one form representation. Next, the activated semantic representation sends top-down feedback to the orthographic (or phonological) level, leading to additional activation of the cognate forms in both languages. Finally, the lexical representation in the target language is selected for recognition when its activation surpasses a critical threshold. The language membership of an activated word candidate is available in the language nodes linked to the activated cognate forms in both languages.

Because in unbalanced late bilinguals the strong L1 cognate is activated before and to a larger extent than the weaker L2 cognate, the orthographic-semantic resonance results in a cognate facilitation effect for L2 targets. Generally, this results in a null-effect for L1 targets, because the L1 cognate target is recognized so early that its less activated L2 counterpart can contribute relatively little activation to linked representations (Dijkstra et al., 2010; Peeters et al., 2013; Voga & Grainger, 2007).

This account for unbalanced late bilinguals fits with the results we obtained. However, the account is based on a strong L1 and a weak L2, whereas in our study with early bilinguals, the L1 (Turkish) is used less frequently by the participants than the L2 (Dutch). We can interpret the results coherently by adding the assumption that language membership of a word is checked sequentially in the order L1-L2 when a representation is highly activated, and because this check takes time, it may slow down responding. This assumption is not new; Dupoux and Mehler (1992) proposed that, although co-activation of candidates in word recognition is a parallel process, subsequent selection and decision processes may be sequential.

In visual studies with unbalanced late bilinguals, the L1 cognate representation is relatively strong and its L2 counterpart relatively weak. In the case of Dutch–English late bilinguals, when the target language is L2 (English), a negative language check for the active L1 (Dutch) word is made, while activation in the word recognition system continues to spread to the L2. This results in the observed cognate facilitation effects for L2. However, when the target language in the task is L1, the response is given before sufficient L2 activation arises to make a language check for English necessary. This results in null-effects.

In our study with heritage speakers, there are two relatively active cognate representations. When the target language is L2 (Dutch), L1 (Turkish) is checked before L2 and the activated L1 representation is rejected, while activation spreads to L2. As before, this results in (a non-significant) cognate facilitation. When the target language is L1, however, the check of L1 is followed by a check of L2, because Dutch is highly activated, as it is the dominant language. Hence, this sequential checking process nullifies the effects of overlap and can even result in cognate inhibition effects (see Figure 2).

The double check and slower RTs for L1 Turkish might be a consequence of insecurity about the origin of the presented cognates. Some participants reported that sometimes they were not sure whether a Turkish cognate was a real word in Turkish or whether they used it because of Dutch. Further support for the important role of the L1 in our participants comes from the fact that the model fit of the Dutch RT pattern improved when the Turkish BNT scores were added.

In all, the combination of visual and auditory studies suggests that both language dominance and the status of the L1 (i.e., the language that was acquired first) play a primary role in bilingual word recognition. Thus, although the L2 Dutch was the dominant language in our participants, co-activation of L1 led to cognate facilitation in two of the stress conditions.

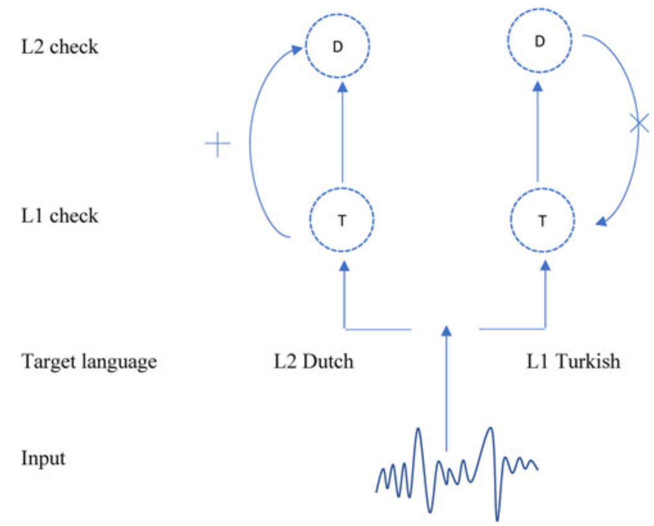

Fig. 2. Schematic representation of the bilingual processing of cognates in Dutch and Turkish, with two relatively active cognate representations. When the target language of the task is L2 (Dutch), L1 (Turkish, T) is checked before L2 (Dutch, D). The activated L1 (Turkish) representation is rejected, while activation spreads to L2 (Dutch). When the target language is L1 Turkish, the L1 (Turkish) check is followed by an L2 (Dutch) check, but the L2 does not have an effect on the L1.

What is the effect of stress position in the two languages on the bilingual processing of cognates?

The present study, to our knowledge, is the first one to report effects of word stress position on auditory cognate processing. In the Dutch task, there was a significant interaction between cognate status and stress condition, indicating that ULT-PEN (with penultimate stress in Dutch) and ULT-ULT differed from PEN-PEN. Specifically, the results indicated somewhat faster responses to cognates than non-cognates for ULT-PEN and ULT-ULT, but not for PEN-PEN, which implies more problems with PEN-PEN.

We suggest that the different RTs for cognates and non-cognates in the three stress conditions in the Dutch task stem from time-sensitive differences in lexical competition and segmental overlap. In Dutch PEN-PEN, the Turkish cognate became more and more co-activated over time, due to the overlap in both stress position and segmental information. This is in line with studies suggesting that words with typical stress are processed more easily than words with non-typical stress (Arciuli & Cupples, 2006; Colombo, 1991; Domahs et al., 2013). Penultimate stress in Turkish is non-typical and its processing may therefore require more time, prolonging competition with the Dutch cognate.

In contrast, for Dutch ULT-PEN, initially there was less competition, because the overlap in representations was smaller than for the congruent conditions. In addition, following Reinisch et al. (2010), we may assume that processing words with penultimate stress leads to the removal of competing candidates with ultimate stress as soon as the word stress on the first syllable is perceived. At the same time, the co-activated L1 Turkish equivalent facilitated the recognition of the Dutch target due to its convergence on a shared semantic representation.

Finally, in Dutch ULT-ULT there was more initial lexical competition, because candidates with penultimate stress were only cancelled out once stress on the second syllable was perceived. However, there was a strong activation of the shared semantic representation due to the large overlap between the Dutch and Turkish cognate. This facilitation was more enhanced because the co-activated Turkish equivalent had ultimate stress, which is typical stress in Turkish.

The findings for the Turkish task can be accounted for in the same way. First, the RTs in the PEN-PEN cognate condition were 43 ms slower than in its matched non-cognate condition, while the RTs in the other stress conditions were similar for cognates and non-cognates. Following the same argumentation as before, inhibition arose in Turkish PEN-PEN due to the strong co-activation of the Turkish and Dutch cognates. Due to its early onset, the lexical competition in this condition lasted longer and became considerable because Dutch was the dominant language. Note that penultimate stress is more typical for Dutch and non-typical for Turkish.

Finally, in Turkish ULT-PEN and ULT-ULT, typical Turkish ultimate stress was present in combination with cross-linguistic segmental overlap and lexical competition from the Dutch cognates. The absence of RT differences between cognates and non-cognates in these conditions suggests that these aspects almost cancelled each other out.

We note that our behavioral effects might have been affected by acoustic differences between stressed and unstressed syllables (e.g., longer duration, higher pitch, amplitude, full vowels) in the target language. Still, we observe facilitation effects in ULT-PEN and ULT-ULT, suggesting that the effects remain present despite these acoustic differences. However, future research is needed to further examine these issues.

Implications for theories on bilingual word processing

Our findings have important consequences for theories on bilingual word processing. First, we found that the visual and auditory modality are similar in terms of co-activation of the other language in bilingual cognate processing. Second, theories about bilingual processing should allocate an important function to the bilinguals' L1, even when it is not their dominant language. Third, our study has shown that the differences between penultimate and ultimate stress in bilingual auditory word recognition cannot be explained by a word initial stress bias, as proposed, e.g., by Van Heuven and Menert (1996). According to these studies, noncognates with initial stress are recognized earlier, because the presence of initial stress immediately reduces the competition of candidates with non-initial stress. In our study, by contrast, cognates with penultimate stress led to more processing difficulties than cognates with ultimate stress, which have predictable stress in Turkish. This indicates that cross-linguistic differences in stress position should also be considered to explain bilingual auditory word recognition.

Fourth, models about word recognition should incorporate the role of word stress. Examples are the Multilink model (Dijkstra, Wahl, Buytenhuis & van Halem, 2019), BIA+ (Dijkstra & Van Heuven, 2002; Dijkstra et al., 2010), BLINCS (Li, 2013), WEAVER (Roelofs, 1997), or the CDP++ model (Perry, Ziegler & Zorzi, 2010). These models could be adapted after empirically testing the role of word stress. A first attempt to include word stress in computer simulations is already being made (Kyparissiadis, Van Heuven, Pitchford & Ledgeway, 2017).

Conclusion

To conclude, we have demonstrated that L1 status, language dominance, and stress position all affect auditory cognate processing in Turkish and Dutch. First, cognates were processed marginally faster than non-cognates while processing in L2, due to co-activation of L1. In this respect, the Turkish heritage speakers resembled late bilinguals. The cognate facilitation effect for Dutch was only marginal. However, we found significant interactions between cognate status and stress position. Specifically, ULT-PEN and ULT-ULT differed in cognate effects from PEN-PEN. Cognates were processed slower than non-cognates in PEN-PEN, but faster in ULT-PEN and in ULT-ULT. That is, there was facilitation for words with ultimate stress, which is the typical stress pattern in Turkish. Note that this analysis is suggestive but not definitive, as the facilitation effect was marginal for ULT-PEN and not significant for ULT-ULT. Moreover, our study is based on relatively small sample sizes. Second, co-activation of the dominant L2 while processing in L1 led to cognate inhibition effects. Third, stress congruence may have led to initial competition between candidates, but our data suggest that word stress position determined whether this competition could be counteracted by cognate facilitation. Specifically, cognates with typical Turkish stress were processed faster than cognates with non-typical Turkish stress. Our study provides novel insights into the factors that influence auditory bilingual word recognition. We have demonstrated that auditory cognate processing resembles visual word recognition to a certain extent, but L1 status, language dominance, and stress position should be considered to improve existing models of bilingual word recognition.

Declarations of interest. None.

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