THE PROCESSING OF SCHWA REDUCED COGNATES AND NON-COGNATES IN NON-NATIVE LISTENERS OF ENGLISH

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ABSTRACT

In speech, words are often reduced rather than fully pronounced (e.g., (/ˈsʌmri/ for /ˈsʌməri/, *summary*). Non-native listeners may have problems in processing these reduced forms, because they have encountered them less often. This paper addresses the question whether this also holds for highly proficient non-natives and for words with similar forms and meanings in the non-natives' mother tongue (i.e., cognates).

In an English auditory lexical decision task, natives and highly proficient Dutch non-natives of English listened to cognates and non-cognates that were presented in full or without their post-stress schwa. The data show that highly proficient learners are affected by reduction as much as native speakers. Nevertheless, the two listener groups appear to process reduced forms differently, because non-natives produce more errors on reduced cognates than on non-cognates. While listening to reduced forms, non-natives appear to be hindered by the co-activated lexical representations of cognate forms in their native language.

Keywords: bilingual processing, speech comprehension, cognates, schwa reduction, English.

1. INTRODUCTION

In spontaneous speech, words are often pronounced in a reduced form, with fewer segments or even fewer syllables than they have in careful speech (e.g., [7]). For instance, the word *yesterday* /jɛstədeɪ/ may sound something like *yeshay* /jɛʃeɪ/. Native speakers understand reduced forms effortlessly, and are most of the time not even aware of the presence of reduced forms in speech. Non-native listeners of a language, in contrast, can have serious problems understanding reduced forms. In this paper, we investigate whether also highly proficient non-native listeners suffer more from reduction than natives do, and whether they are equally hindered by reduction when processing words that are very similar to the words in their own language (i.e. cognates) as when processing words that are not (i.e. non-cognates).

Research on spoken word comprehension (e.g., [13]) suggests that at least some reduced forms are stored in the native speakers' mental lexicons. In contrast, non-native learners of a language may have at best weakened representations for these reduced forms, because they have not encountered these forms as frequently as non-natives (cf. [3]). If the lexical representations for reduced forms are not well accessible, non-natives may still processes the forms via these representations but this will take more time. Alternatively, they may process reduced forms via the corresponding full form by means of a reconstruction of the full form. This route probably also implies more processing costs than the direct route for natives.

The processing of a reduced form may be modulated by the cognate status of the word. Cognates are translation equivalents that overlap largely in form (spelling or pronunciation). Examples of cognates are English *cat* /kæt/ and Dutch *kat* /kɑt/. Behavioural studies generally have observed faster and more accurate responses to cognates than to non-cognates in visual or auditory lexical decision tasks [for an overview, see 4]. This is commonly taken as evidence that upon hearing or seeing a cognate, both language representations of this cognate are activated. The semantic and form overlap between the activated representations strengthens the activation of the input word, which leads to faster recognition.

Due to co-activation, the processing problems that arise as a result of reduction may be partly overcome: Non-native listeners may co-activate the lexical representation of the corresponding word in their native language (for instance, directly via the lexical representation of the reduced form, or via the reconstructed full form). As a result of this co-activation, the activation of the non-native word is strengthened (only its full form or also its reduced form), which will speed up the recognition of this reduced form. However, if reduction largely diminishes the overlap between the representations of the word in the two languages, the word in the listeners' native language may be activated less, and, as a consequence, co-activation may be weaker and cognate status may hardly modulate the processing of reduced forms. The present paper investigates whether the cognate status of a word affects the processing of reduced forms in highly proficient non-natives.

In an English auditory lexical decision task, native and highly proficient Dutch non-native listeners of English were presented with English-Dutch cognates and non-cognates with stress on the first syllable and schwa in the second syllable. These words were either presented in their full form (e.g., /ˈɪnstrəmənt/ *instrument* and /ˈsʌməri/ *summary*) or with missing post-stress schwa (e.g., /ˈɪnstrmənt/ and /ˈsʌmri/). In English, schwa is often completely absent in post-stress position [12], whereas this is seldom the case in Dutch [9]. As a consequence, the full forms were very similar to the corresponding Dutch forms, whereas this was not the case for the reduced forms.

2. METHOD

2.1. Participants

The non-native group consisted of 31 students (mean age = 22.1 years, SD = 2.3) of Radboud University. All were native speakers of Dutch and master students of English-taught degrees. They were highly proficient in English as evidenced by their scores on the LexTALE proficiency task (mean = .76, SD = .11; [10]). The native group consisted of 38 students (mean age = 21.5 years, SD = 3.2) of the University of Cambridge who had no knowledge of Dutch. None of the participants had any hearing disabilities, and all were paid for their participation.

2.2. Stimulus materials

The stimuli consisted of 196 real mono-morphemic English words and 200 pseudo words. Of the real English words, 92 were target items, and 104 were filler items. The target items were 46 Dutch-English cognate items and 46 English non-cognate items. An item was considered a cognate if it had the same meaning in English and Dutch and the Levenshtein distance [11] (not considering word stress) between the Dutch and the English pronunciations was 5 or less (mean 3.3). The cognates and non-cognates had similar log subtitle word frequencies (*SUBTLWF*, [2]; mean frequency for cognates and non-cognates: 2.18 and 2.41, respectively; t-test: $t = -1.68$, $p = 0.1$). They were all trisyllabic and had a schwa in the second syllable. Main stress was on the first syllable, whereas it was on the final syllable in the cognates' Dutch equivalents (e.g., English /ˈɪmpətənt/ versus Dutch /ɪmpoˈtɛnt/ *impotent*).

The filler items were 44 disyllabic and 60 trisyllabic real words with the position of word stress varying between words. These items were matched to the experimental set on number of syllables and frequency of occurrence (mean frequency target: 2.29, mean frequency fillers: 2.41; t-test: $t = -1.26$, $p > 0.1$).

The pseudo words were generated by means of *Wuggy* [8] on the basis of the target and filler words. The pseudo words were phonotactically legal in English and were matched to the real word stimuli on number of syllables.

The stimuli were recorded by a male native speaker of British English. Each target word was recorded twice: once in its full form and once without the schwa in the second syllable. The mean intensities of all words were scaled to 70 Hz. The duration of the schwa was manually transcribed per item with the speech analysis software package *Praat* [1]. Schwa was absent in all reduced forms and had an average duration of 66 ms in the full forms. The full and reduced forms had average durations of 665 ms and 500 ms, respectively.

Fifteen experimental lists were created on the basis of these materials, with different word orders. In each order, no more than three real words or three pseudo words occurred in a sequence and half of the target words were full and the other half reduced. The lists were then mirrored in the reduction status of the target items, resulting in a total of 30 lists. Therefore, each list contained a different combination of 23 reduced cognates, 23 full form cognates, 23 reduced non-cognates, and 23 full form non-cognates. Each list was split into two blocks, with a break in between.

2.3. Procedure

Participants performed an English auditory lexical decision task. They were asked to decide as quickly and accurately as possible whether or not the aurally presented stimulus was a real English word by pressing a button on the computer keyboard corresponding to either the answer 'yes' or 'no'. Participants pressed the 'yes' button with their dominant hand. Participants first read the English instructions which informed them about the procedure of the task, followed by a practice session containing 6 practice items (one reduced non-cognate, one full cognate, one full non-cognate, and three pseudo words). The task was developed and conducted in *E-prime* version 2.0.10 [5].

Each trial started with the presentation of a black fixation point '+' in the middle of a white screen for 400 ms. Then the target stimulus was played. The next trial started after the participant had pressed a response button or after a time-out of 5000 ms measured from stimulus onset.

After completing the lexical decision task, participants performed the LexTALE task [10]. This task provides a general indication of a participant's proficiency in English in terms of vocabulary knowledge.

2.4. Results

One native participant was discarded due to technical failure. Three non-native participants were excluded from analysis because of their high error rates (above 30%). The mean error rate was 5.1% for full target words and 15.4% for reduced ones. Six words (*eloquent*, *legacy*, *suffocate*, *predator*, *pinnacle* and *sycamore*) were discarded because the reduced forms elicited extremely high error rates (over 60%). Time outs and all reaction times (from now on referred to as RTs) that fell below or above two and a half standard deviations from the grand mean were removed from the data set. This resulted in a dataset of 5418 trials for the accuracy analysis. For the analysis of the RTs (measured from word offset), the incorrect responses were removed, and the final dataset contained 5003 trials.

The accuracy and RT data were analysed with (logistic) linear mixed effect models with subject and item as cross-random effects. In both the accuracy and RT analyses, the following factorial predictors were considered: *Reduction* (reduced or full), *Cognate* (cognate or non-cognate), and *Group* (native or non-native). Further, we considered the following continuous predictors: *Word frequency* (log-transformed), *Word duration* (in ms), *Trial* (the rank of the item in the stimulus list), and *Previous RT* (the response latency at the previous trial).

To obtain the best fitting model, we performed a stepwise variable selection procedure in which one predictor was added at a time. For each significant predictor or interaction, it was evaluated whether inclusion of this predictor or interaction resulted in a better model (i.e., had a lower AIC compared to when this predictor was not part of the model). Next, for the RT analyses, any remaining harmful outliers (defined as data points with standardized residuals exceeding 2.5 standard deviation units) were removed from the data set. A new model with the same predictors was fitted to this trimmed data set.

2.4.1. Accuracy

Figure 1 shows that, as expected, in both groups, reduced forms were responded to less accurately than full forms, and that natives were more accurate than non-natives on all item types. Moreover, the figure shows that, as expected, only non-natives were sensitive to the cognate status of a word. More importantly for our research question, non-natives responded more accurately to cognates than to non-cognates but only when the cognate was presented in its full form. These patterns are statistically significant, as revealed by the final model summarized in Table 1.

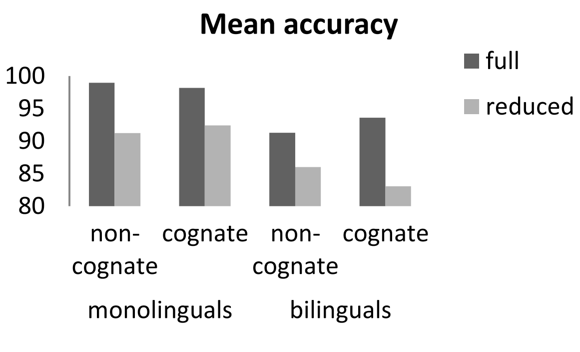
The model also revealed a significant interaction of *Frequency* with *Reduction* showing that the effect of reduction on accuracy scores was smaller for very low frequent words. Finally, the effect of *Word Duration* shows that longer words elicited higher accuracy rates.

Table 1: Summary of the model predicting accuracy. On the reference level of the intercept are native speakers, non-cognates and unreduced forms.

	β	std.err	*z(p)*
Intercept	-1.01	1.35	-0.75
Word frequency	1.78	0.34	5.25***
Group*non*	-2.69	0.46	-5.85***
Cognate*cog*	0.14	0.61	0.22
Reduction*red*	-0.02	1.10	-0.02
Word duration	0.01	0.01	2.79***
Group*non*:Reduction*red*	2.09	0.47	4.47***
Group*non*:Cognate*cog*	1.03	0.55	1.87*
Reduction*red:*Cognate*cog*	0.37	0.70	0.53
Frequency: Reduction*red*	-0.95	0.41	-2.32**
Group*non*:Reduction*red:* Cognate*cog*	-1.55	0.62	-2.52**
Random effects	var	sd	
Subject (Intercept)	0.43	0.66	
Item (Intercept)	1.45	1.21	

Note. non = non-native, *cog* = cognate, *red* = reduced; *** $p < 0.001$; ** $p < 0.01$; * $p = 0.06$.

Figure 1: Accuracy scores in percentages.



2.4.2. RTs

Table 2 summarizes the final model predicting RTs. The model contains a significant interaction between *Group* and *Cognate*. Together with the simple effects, this interaction shows that natives reacted more quickly than non-natives, but the difference was smaller for the cognates than for the non-cognates. Contrary to our expectations, *Reduction* only showed a simple effect and thus equally delayed the two listener groups, and for both groups affected the processing of cognates as much as of non-cognates.

The significant effects of *Frequency* and *Word Duration* showed that more frequent words were responded to faster, while longer words elicited longer RTs. Finally, the random effects reveal that there was some variability in items and participants with respect to the effect of *Reduction* or of both *Reduction* and *Frequency*, respectively.

Table 2: Summary of the model predicting RT. On the reference level of the intercept are native speakers, non-cognates and unreduced forms.

Predictor	β	std. err	*t*
Intercept	594.66	45.87	12.97
Trial	-14.90	1.99	-7.46
PreviousRT	0.06	0.01	9.51
Frequency	-36.13	7.98	-4.53
Group*non*	103.73	18.45	5.62
Cognate*cog*	-1.25	10.63	-0.12
Reduction*red*	54.05	13.47	4.01
Word duration	0.52	0.06	9.30
Cognate*cog*:Group*non*	-18.92	7.80	-2.43
Random effects	var	sd.	
Subject (Intercept)	4155.00	64.46	
Subject (Reduction*red*)	11.61	3.41	
Subject.1 (Intercept)	0.00	0.00	
Subject.1 (Frequency)	211.98	14.90	
Item (Intercept)	3046.36	55.19	
Item (Reduction*red*)	10346.04	101.72	
Residual	17289.97	131.49	

Note. *non* = non-native, *cog* = cognate, *red* = reduced; $t > 1.96$ or < -1.96 is significant.

3. DISCUSSION

This study addressed two research questions. First, it investigated whether also highly proficient non-natives have more difficulties in processing reduced forms than natives. Secondly, it examined whether the cognate status of a word modulates the processing of reduced forms in these non-natives. We addressed these questions by means of an auditory lexical decision experiment with highly proficient Dutch non-natives of English and with English natives judging words presented in their full forms or with their post-stress schwas missing.

Overall, the accuracy and RT analyses showed that reduced forms were responded to less quickly and less accurately than full forms by both natives and non-natives. These findings are in line with earlier studies showing a processing advantage for full forms in isolation (e.g., [6]). Importantly, reduction affected natives and non-natives equally. This shows that highly proficient non-native listeners are affected as much as natives by single segment reduction.

The RT and accuracy data also revealed that the natives were insensitive to the cognate status of a word. This is not surprising as they had no knowledge of Dutch, and therefore could not distinguish between cognates and non-cognates.

The picture is different for the highly proficient non-natives. Cognates and non-cognates differed in how reduction affected their accuracy scores: reduction only affected those for cognates. This shows that cognate status did not facilitate the processing of reduced forms. Apparently, the reduced form of an English cognate was not sufficiently similar to the Dutch equivalent (full or reduced) to benefit during processing from the word's cognate status. A reduced English cognate did not substantially co-activate its Dutch equivalent.

On the contrary, the processing of a reduced English cognate was hindered by its cognate status. One possible explanation is that the link between the Dutch and English representations of a cognate word hinders the development of lexical representations for the reduced form variants of cognates during language acquisition. The Dutch lexical representations strengthen the English full forms, which may stimulate non-native listeners to process cognates above all via these full forms, rather than to develop lexical representations for the reduced forms. Reduced forms of cognates would then have weaker lexical representations (if any) than the reduced forms of non-cognates, which would explain why reduction leads to more errors for the reduced variants of cognates.

This interaction between listening group, cognate status and reduction was not visible in the RT data. Possibly, this is a statistical power issue. In addition, the RT analyses are only based on items that were correctly classified as real words, and therefore on items (full and reduced) that listeners could easily identify. This decreases the likelihood that the analyses reveal effects of variables that hinder word identification, including cognate status for reduced forms.

In conclusion, our data suggest that highly proficient learners are affected by reduction as much as native speakers. Nevertheless, the two listener groups appear to process reduced forms differently, because non-natives produce more errors for reduced forms of cognates than of non-cognates. While listening to reduced forms, non-natives appear to be hindered by the co-activated lexical representations of the cognate forms in their native language.

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