UNDERSTANDING REDUCED WORDS: THE RELEVANCE OF REDUCTION DEGREE AND FREQUENCY OF OCCURENCE

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ABSTRACT

In casual speech, words are often reduced. Previous research has shown that both native listeners and learners of a foreign language recognize reduced word pronunciation variants more quickly the more frequent they are and the less they deviate from the words' full variants (e.g. [1, 5]). We investigated the relevance of a variant's frequency of occurrence compared to its degree of reduction in word recognition. We tested native listeners and advanced learners of French on the processing of French words ending in obstruent-liquid-schwa clusters, with a cross-modal identity priming task.

The experiment showed that advanced learners suffer more from reduction than natives. Moreover, all participants recognized the highly frequent, strongly reduced variants more quickly than the low frequency, weakly reduced variants. This suggests that listeners' experience with a reduced variant plays a more important role in word recognition than its similarity to the word's full variant.

Keywords: spoken word recognition, speech reduction, frequency of occurrence, French

1. INTRODUCTION

In casual conversations, words are often produced with fewer segments than in formal speech (e.g. [7]). For instance, the English word *police* is often produced without its schwa (/pli:s/). This study contributes to the growing body of research addressing the question of how reduced word pronunciation variants are recognized by native listeners and advanced learners of a language.

Listeners may process reduced word pronunciation variants by reconstructing the full variants, based on subsegmental acoustic cues (e.g. [4, 15]) and violations of the language's phonotactic constraints (e.g. [14]). Reconstruction is facilitated by a smaller degree of reduction (e.g. [5]).

Listeners also recognize reduced words more easily if they expect the words given the meaning and syntax of the context (e.g. [15]). Moreover, several studies (e.g. [1, 12]) have shown that listeners process reduced word pronunciation variants more quickly the more frequent these are, and the more they thus can be expected.

This raises the question about the relevance of listeners' expectations based on the word pronunciation variants' frequencies compared to ease of reconstruction based on degree of reduction. We investigated this question by testing listeners' processing of French words ending in an obstruent-liquid-schwa cluster, such as *ministre* /ministrə/ 'minster' and *fenêtre* /fənɛtrə/ 'window'.

We showed in a corpus study [2] that, in casual French, the cluster occurs in seven variants. The most frequent variant does not contain schwa (35.7% of tokens), while in another frequent variant the cluster is completely absent (15.5%, e.g. /minis/ for /ministrə/, henceforth Ø variant). In contrast, the cluster is seldom produced with just the liquid (1%, e.g. /minisr/, henceforth L variant). That is, the most reduced variant (Ø variant) is more frequent than a less reduced variant (L variant). Comparison of the processing of the two variants can thus show whether processing is more hindered by a low frequency of occurrence or by more reduction.

We tested native listeners and advanced learners of French. Like natives [1, 5], foreign language learners recognize a reduced word pronunciation variant more easily the lower its degree of reduction [6] and the higher its frequency of occurrence [1], but, due to learners' limited experience with reduced variants (e.g. [9, 16]), the detrimental effect of reduction degree may be larger than for natives. This may explain why learners have difficulties understanding reduced variants of words (e.g. [6, 11, 17]). We tested learners to further document their difficulties with reduced variants and to see whether they process these variants differently from natives.

We tested our participants in a lexical decision experiment with cross-modal identity priming. The prime words were embedded in sentences.

2. EXPERIMENT

2.1. Participants

We tested 57 French native speakers from Paris (aged 17-35 years; mean age: 22.4 years; 13 males)

and 55 Dutch undergraduate students of French (aged 17-44 years; mean: 21.9 years; 5 males). The natives were born and raised in the north of France and their parents were also native speakers of French. The learners' proficiencies roughly corresponded to the C1-C2 level according to the Common European Framework of Reference for Languages [3]. All participants received financial compensation for taking part in the experiment.

2.2. Stimuli

Forty-eight French content words ending in an obstruent-liquid-schwa cluster (28 monosyllabic, 20 bisyllabic; 40 singular, 8 plural) were selected from vocabulary lists in teaching methods used at Dutch secondary schools, and served as experimental visual targets (e.g. *spectacle* 'show'). In order to have an equal number of required yes- and no-responses in the lexical decision task and to avoid words ending in obstruent-liquid-schwa clusters being the only words requiring yes responses, we added 139 filler words as visual targets, of which 42 were real words and 97 were pseudo words (63 monosyllabic, 76 bisyllabic; 119 singular, 20 plural). The pseudo words consisted of real French syllables and did not resemble real Dutch words.

The visual target words were combined with auditorily presented prime sentences, each containing a prime word. The prime word for an experimental target word was either: 1. an unreduced variant of that target word (e.g. /ministʁ(ə)/ for *ministre* 'minister'); 2. its low frequency L variant (e.g. /minisʁ/ for *ministre*); 3. its high frequency Ø variant (e.g. /minis/ for *ministre*); or 4. a semantically and phonetically unrelated word (e.g. *virage* 'turn' for *ministre*). The prime words for 60 pseudo word targets were phonetically related to these targets. We thus discouraged participants from associating phonetic overlap between the auditory prime word and the visually presented target word with a *yes* response in the lexical decision task. The prime words for the 42 real filler targets were phonetically unrelated to these targets.

The prime words were in sentence-medial position and did not carry sentence accent. For instance, the prime sentence for *cercle* 'circle' was *J'ai fait un cercle parfait sans compas* 'I made a perfect circle without compass', with accent on *parfait* 'perfect'. Each prime word was followed by a consonant initial word and minimally one more word. Participants could not predict the prime word based on the main verb in the sentence (e.g. *penser* 'to think', *faire* 'to do', *prendre* 'to take').

We recorded a 28-year-old French female speaker from the north of France pronouncing the prime sentences, using Adobe Audition 1.5 and a Sennheiser ME 64 microphone, and digitized the speech at a sampling rate of 44.1 kHz, a 16-bit quantization. We made four recordings of the sentences with prime words identical to the visual targets. For the first recording, we did not provide the speaker with detailed instructions. The resulting sentences had a mean rate of 5.6 syllables per second and contained few reductions: mostly schwa reduction in highly frequent words (e.g. /d/ instead of /də/ *de* 'of' and /dvnir/ instead of /dəvnir/ *devenir* 'to become'), and reduction of the final schwas of nine prime words. We then asked the speaker to pronounce each sentence three more times, realizing the prime words in an unreduced way, in the L variants, and in the Ø variants. We cross-spliced the prime words from these latter three recordings in the recordings we obtained without providing the speaker with detailed instructions.

We made two recordings of the prime sentences with prime words that were not identical to the targets. We cross-spliced the prime words from the first recordings into the second recordings. The mean speech rate was 5.9 syllables per second for the experimental sentences with non-identity prime words and 6.0 for the filler sentences. All sentences were scaled to the same average intensity level.

Figure 3.1 presents the durations of the four types of prime words for the experimental target words. The unreduced variants (mean: 351 ms) were significantly longer than the L variants (mean: 307 ms, p < .05) and the Ø variants (mean: 232 ms, p < .001) of the identity prime words. The latter two also differed significantly from each other in duration (p < .001). Word-final schwa was absent in 83.3% of the unreduced variants. It was maximally 30 ms.

Figure 1: Duration (in ms) of the four different experimental types of prime words.
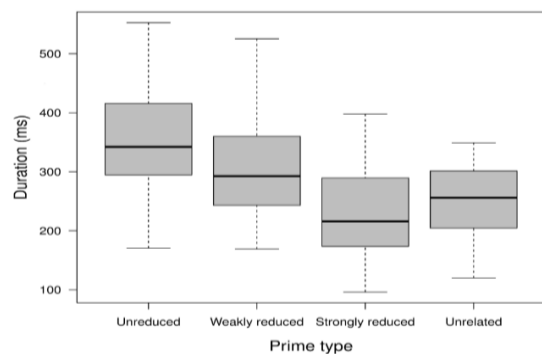
We created eight stimulus lists, each containing all filler and experimental target words with prime sentences. In each list, the prime words for 12 experimental targets were their unreduced variants, for 12 the L variants, for 12 the Ø variants, and for

12 the prime words were unrelated. The 48 experimental targets occurred equally often in the four priming conditions across the eight lists. The lists differed in their order of the targets. Each list was preceded by four practice trials (two with real target words of which one was preceded by an identity unreduced prime word).

2.3. Procedure

All participants were tested in sound-attenuated booths. The natives were tested in Paris, at the Laboratoire Charles Bruneau of the *Institut de Linguistique et Phonétique Générales et Appliquées*, while the Dutch were tested in the Netherlands, either at the Max Planck Institute for Psycholinguistics in Nijmegen, or at the Universities of Amsterdam, Groningen, Leiden, or Utrecht.

The experiment was presented in E-prime 2.0 [13] from a laptop. Each participant listened to the sentences from one stimulus list via Sennheiser HD 125 headphones. At the auditory prime word's offset, the target word was displayed in lower case (18-point Courier New), at the centre of the screen. The target word was presented at prime word offset as the prime word is likely to be recognized by then (e.g. [8]). The target word was visible for 3,000 ms.

Participants were asked to indicate for each visually presented stimulus whether it was a real French word or not as quickly and as accurately as possible. Right handed participants responded by pressing the key 'm' for 'yes', and the key 'z' for 'no', on the keyboard. For left-handed participants, the 'yes' and 'no' keys were reversed.

The next auditory stimulus was played 1000 ms after a key response or 4000 ms after prime word offset when the participant had not yet responded. Sentences were always played in their entirety. The 187 trials were divided in three equal blocks, separated by short breaks in the experiment.

The lexical decision task with cross-modal priming was followed by a dictation task (not reported here) and a background questionnaire. A complete session lasted approximately 30 minutes.

2.4. Results

Both the French natives and the Dutch advanced learners performed well on the visual lexical decision task. The mean accuracy score on the 48 target words was 96.7% for the French natives and 91.0% for the Dutch learners. The mean accuracy score on the pseudo words was 97.3% for the French natives and 78.9% for the Dutch learners.

We analyzed the RTs, measured from the onset of the presentation of the visual stimulus, for the trials in which the experimental target words had correctly been classified as real words (5062 trials). Since the accuracy (51% correct) and the RT (mean: 1274 ms) for the target word *chantre* 'cantor' were very different from the average accuracy (96% correct) and average RT (mean: 928 ms) for all other words, we excluded this word from our analyses. Furthermore, we excluded two extremely slow Dutch participants in order to obtain a normal distribution of the RTs. Finally, RTs deviating from the new mean (906 ms) by more than 2.5 times the standard deviation (1101 ms) were considered as outliers and were removed. This resulted in 4916 observations for analysis (91.1% of all data).

Figure 2: RTs in the four priming conditions, for the native listeners (left) and the learners (right).
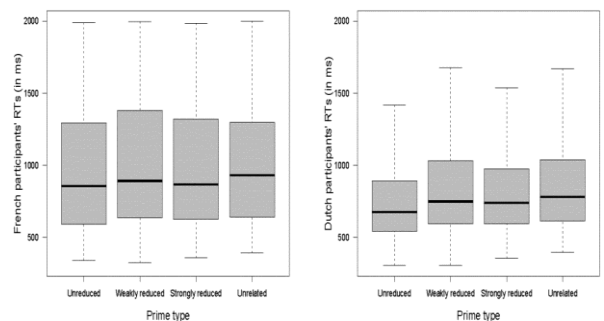

Figure 2 summarizes the RTs in the four priming conditions, both for the natives and the advanced learners. We analyzed the RTs by means of mixed-effects regression models, with target word and participant as crossed random effects and with prime word type (unreduced identity, L variant identity, Ø variant identity, unrelated) and participant group as the main fixed predictors. We also added several control predictors in order to reduce the variance in the data: prime word duration, trial number, previous RT, and the target word's log-transformed word frequency as listed in Lexique 3.80 for books [10]. Furthermore, we investigated whether distance (in ms) between prime word offset and sentence offset predicted response times. If so, listeners postponed their lexical decisions till sentence offset. Random slopes were tested for all fixed predictors. We only retained those predictors in the model that showed statistically significant simple effects or figured in statistically significant interactions.

The final model showed that the Dutch participants were faster than the French natives (β = -180.87, t = -4.33), although this difference was larger for some target words than for others, as indicated by a random slope of participant group by target word. The Dutch probably pre-activated fewer words during the processing of the primes than the natives. Moreover, the Dutch, but not the French,

responded faster to target words that occur more often in books (simple effect for the natives: β = 2.67, t = -0.35; interaction with participant group: β = -25.06, t = -2.20). A random slope of frequency by participant shows that this effect varied per participant. Furthermore, all participants were slower if they were also slow in the previous trial (β = 47.69, t = 7.59) and they all grew faster per trial (β = -41.16, t = -5.21). Random slopes show that these effects also differed per target word and participant.

More importantly, we found that participants responded faster to target words primed by unreduced identity prime words (intercept) than to those primed by unrelated words (β = 64.28, t = 4.45), by L variants of identity prime words (β = 56.38, t = 4.69), and, for the Dutch, by Ø variants of identity prime words (simple effect: β = 21.94, t = 1.83; interaction with group: β = 34.31, t = 2.10). This result suggests that the Dutch advanced learners benefited most from unreduced identity primes.

We then compared RTs obtained with priming from the L variants and the Ø variants of the identity prime words, by rerunning the model with the L variants on the intercept. We found that both natives and learners responded faster to target words primed by the Ø variants than by the L variants of the identity prime words (β = -34.43, t = -2.85, p < .01). This suggests that both participant groups were more hindered by a low frequency of the prime word variant than by a high degree of reduction.

We also found an effect of the duration of the sentence following the prime word. With the unreduced identity prime word on the intercept, we found a simple effect of this duration (β = 32.32, t = 2.84) and a significant interaction with the L variant (β = -33.97, t = -2.46). These results show that the longer the sentence is after the prime word, the more slowly the French participants responded, except when the target word was primed by an identity prime word in its L variant.

The Dutch learners showed a different pattern, as indicated by the interactions of participant group with remaining duration (β = -34.09, t = -2.10) and between these two variables and the Ø variant (β = 38.80, t = 1.97) and the L variant (β = 50.58, t = 2.61) of the identity prime word. The Dutch showed an effect of the remaining duration of the sentence if the prime word was presented in its Ø or L variant, that is, in any reduced variant.

3. DISCUSSION

The lexical decision task with cross-modal identity priming produced several insights on the processing of reduced word pronunciation variants by natives and advanced foreign language learners. First, both listener groups showed substantial priming from unreduced and highly reduced identity prime words. They thus recognized highly reduced variants sufficiently quickly to speed up the processing of directly following words.

Second, unlike the native listeners, the learners showed more priming from the unreduced than from the highly reduced identity prime words. Hence, although the Dutch learners showed priming from both variants, they had more difficulties processing the highly reduced variants. This result complements previous results reporting advanced learners' problems with identifying highly reduced word pronunciation variants (e.g. [6, 11, 17]).

Third, both listener groups showed more priming from identity prime words occurring in a common, highly reduced, variant than in an infrequent, weakly reduced, variant. This suggests that both groups suffered less from the high reduction degree than from the low frequency of a word pronunciation variant. Listeners' experience with a reduced variant appears to be more important for the recognition of this variant than ease of reconstruction based on reduction degree.

Finally, for both listener groups, there was an effect of the time interval between prime word offset and sentence offset. The natives showed this effect except when the target word was primed by the infrequent, weakly reduced identity prime word. They thus seem not to have taken the remainder of the sentence into account when the variant of the prime word was infrequent, and therefore difficult to process. The Dutch learners, in contrast, only showed an effect of the duration of the remainder of the sentence when the prime word was reduced (weakly or highly). They thus appear to have applied the opposite strategy from the natives: they took the remainder of the sentence into account when the prime word was difficult to process. The fact that the unreduced and the Ø variant of the identity prime word pattern together for the natives but not for the learners also suggests that the learners suffered more from the Ø variant than the natives did.

In conclusion, this study showed that advanced learners suffer more from reduction than native listeners. Moreover, a listener's experience with a reduced word pronunciation variant appears to play a more important role in the recognition of that variant than its similarity to the full variant, which may index ease of reconstruction of that full variant.

4. ACKNOWLEDGMENTS

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