ASSIMILATION OF PLACE IN JAPANESE AND DUTCH

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ABSTRACT

Assimilation of place of articulation across a nasal and a following stop consonant is obligatory in Japanese, but not in Dutch. In four experiments the processing of assimilated forms by speakers of Japanese and Dutch was compared, using a task in which listeners blended pseudo-word pairs such as *ranga-serupa.* An assimilated blend of this pair would be *rampa*, an unassimilated blend *rangpa.* Japanese listeners produced significantly more assimilated than unassimilated forms, both with pseudo-Japanese and pseudo-Dutch materials, while Dutch listeners produced significantly more unassimilated than assimilated forms in each materials set. This suggests that Japanese listeners, whose native-language phonology involves obligatory assimilation constraints, represent the assimilated nasals in nasal-stop sequences as unmarked for place of articulation, while Dutch listeners, who are accustomed to hearing unassimilated forms, represent the same nasal segments as marked for place of articulation.

1. INTRODUCTION

The human articulatory system apparently finds rapid alteration of manner of articulation preferable to rapid alteration of place of articulation. Across the languages of the world, it is far more common for two successive consonants with different manner of articulation to share place of articulation than to differ in place of articulation. Consider the case of nasal consonants preceding stop consonants. In English, such a sequence can occur within a syllable, in the coda position, and common place of articulation is obligatory if the syllable is morphologically simple: thus *lint*, *limp* and *link* all have different nasal consonants, and in each case the nasal has the same place of articulation as the stop consonant which follows it. By contrast, a mismatch in place of articulation produces an illegal sequence: *limt, linp, limk* etc.

In some languages this regressive assimilation of place for a nasal and a following stop consonant is obligatory even across syllable boundaries. Japanese is one such language. Indeed, intrasyllabic environments do not even occur in Japanese, because the phonology does not allow nasal-stop clusters (or any other kind of cluster in syllable coda position, for that matter). Thus for your Japanese lunch you may have some *tempura* in your *bento* box, but *tenpura* in your *bemto* box is not possible. In the kana orthographies of Japanese, there is only a single representation for any nasal consonant in syllabic coda position; the representation is unmarked for place, in other words, though it will differ in place as a function of the place of any following consonant. Consider, for example, the word *san*, 'three'. It occurs in many compound words, for example: *sangatsu* ('March', or 'third month'); *sanban* ('third'); *sanju* ('thirty'). In the first of these the final nasal of the first syllable is pronounced as a velar, in the second as a bilabial, in the third as a dental-alveolar; yet of course the first part of each compound is the same element, and is identically represented in both Japanese orthographic forms, kanji (Chinese characters) and kana (mora-based phonological representation).

In some other languages, however, regressive assimilation of place in nasal-stop sequences is not obligatory. English allows failure of assimilation across some syllable boundaries, for instance in compounds such as *songbird*, *sometimes* and *sunglasses*, and even within morphologically complex syllables such as *jammed* and *longed.* The situation in Dutch is even less constrained. Morphologically simple words with unassimilated codas exist - e.g. *hemd* ('shirt') or *vreemd* ('strange'), along with unassimilated morphologically complex syllables such as *zwemt* ('swims') or *zingt* ('sings'). Similarly unassimilated sequences can occur across syllable boundaries in morphologically simple words (*imker*, 'beekeeper'), derived or inflected words (*ruimte* 'space', *mengde* 'mixed') or compound words (*bloemkool* 'cauliflower', *renbaan* 'racecourse', *longtering* 'consumption').

Language users' perceptual responses indicate that this aspect of native-language phonology is taken account of in processing. Experimental studies involving phoneme detection or word recognition tasks have in recent years shown a highly consistent pattern of results: spoken-language processing is neither facilitated nor interfered with by optional regressive assimilations, but is inhibited by violations of obligatory regressive assimilation. Thus for speakers of English or Dutch, in which most assimilations are optional, speed of detection of a phoneme target is unaffected by whether or not an immediately preceding consonant is assimilated to the target (Koster, 1987; Gaskell and Marslen-Wilson, 1998; Otake, Yoneyama, Cutler and van der Lugt, 1996; Kuijpers and Donselaar, forthcoming). When, however, a target is preceded by a violation of assimilation - either by an unassimilated phoneme in Japanese, where assimilation is always obligatory, or by an "assimilated" phoneme in English or Dutch which does not match its following context - detection is significantly slowed (Gaskell and Marslen-Wilson, 1998; Otake et al., 1996; Kuijpers and Donselaar, forthcoming). Detection of a nasal phoneme in coda position in Japanese is equally fast irrespective of its place of articulation realisation (Otake et al., 1996). Recognition of spoken words is likewise unaffected by correctly applied optional assimilation, but impaired by violation of obligatory assimilation (Koster, 1987; Gaskell and Marslen-Wilson 1996; Marslen-Wilson, Nix and Gaskell, 1995).

In the present study we addressed the question of how assimilated phonemes are represented in perception by speakers of languages in which assimilation is respectively obligatory and optional. We used as a test case once again place of articulation in nasal-stop sequences, and we contrasted the obligatory assimilation of Japanese with the variable and often optional assimilation in Dutch. We predicted that obligatory assimilation would be associated with abstract representations, unmarked for place of articulation, while variable or optional assimilation would be associated with place of articulation marking in the perceptual representations. In other words, Japanese listeners should overlook place of articulation in nasals followed by stops, while Dutch listeners' representations should contain explicit marking of place.

Although this question principally involves perception, we addressed it via a speech production task. The task provided a reflection at least of what subjects thought they had perceived. Listeners were asked to make blends of two pseudo-words, taking the first part of one pseudo-word and adding it to the last part of another. In other words, they were essentially asked to repeat back parts of what they had heard; and whether these parts were repeated exactly as heard, or were assimilated to the altered context in which they were repeated, provided the dependent measure.

2. EXPERIMENT 1 - JAPANESE

2.1 Method

48 sets of two pseudo-names were constructed, all items being legal strings according to the phonology of Japanese, but none being existing words or names in the language (although they were composed of existing morphemes, since this is impossible to avoid in Japanese). All pseudo-names were trimoraic, with either CVNCV or CVCVCV structure (where N is a moraic nasal in syllabic coda position). In 24 of the sets, the first name contained an assimilated nasal-stop sequence, and the initial consonant of the last (CV) mora of the second name differed in place of articulation from the initial consonant of the last mora of the first name. Three places of articulation were used: bilabial (the stop consonants [b] and [p]), dental-alveolar (to be referred to henceforth as alveolar: [d] and [t]) and velar ([g], [k]). There were four pairs in each of six place of articulation conditions: bilabial to alveolar, bilabial to velar, alveolar to bilabial, alveolar to velar, velar to bilabial, velar to alveolar. For example *ranga-serupa* represents velar to bilabial, and *kumba-soroki* bilabial to velar. The 24 experimental pairs were: *pimba - kameta, zomba - barude, yambo - nafudo, tambo - kurato, kumba - soroki, gombe - misaku, zumbo - haruku, pimba - kushika, gonda - kasupe, bendo - neruba, nanto - tsuraba, rundo - makapa, bondo - pinega, senta - keruki, ronda - biraku, tanta - pasuko, tanga - barude, mongu - kibudo, kongu - kieta, banga - chimote, tonku - sakapa, ranga - serupa, tenke - tetobo, renku - chikapa.* The remaining 24 items were filler pairs which did not involve assimilation at the predicted division point of the blend.

26 native speakers of Japanese, students at Dokkyo University or at Ohio State University, participated in the study. They were given the following instructions (in Japanese): "Suppose you are the mayor of a certain town. Your town is to merge with a neighbouring town, which is smaller both in size and political power than yours. It is your task to make a new town name by combining a part of your town name (always the former part) and a part of the other town's name (always the latter part). The definition of former and latter is up to you. Be sure that the newly made town name should not be longer or shorter than your town name." The participants heard the taped items over headphones, each member of a pair being uttered twice; the first few pairs in the experiment were practice items. Participants repeated each of the pair members and then produced their candidate blend. Their responses were tape-recorded and transcribed.

Our prediction, again, was that the presence of obligatory assimilation in native-language phonology would lead language users to perceive the assimilated nasals as unmarked for place of articulation; thus we expected them to re-assimilate to a different place of articulation in the blended form where required. We thus predicted that most blends would change place of articulation (*ranga-serupa* blended as *rampa, kumba-soroki* as *kungki*), rather than preserve it (*ranga-serupa* as *rangpa, kumba-soroki* as *kumki*).

2.2 Results

The transcribed responses were scored as to whether the blend contained an assimilated nasal (*rampa, kungki*), an unassimilated nasal (*rangpa, kumki*), or fell into an third category we termed "unscorable". Responses marked as "unscorable" were errors, containing no nasal or no environment for testing our assimilation hypothesis, e.g. *ranga-serupa* blended as *rangapa, rarupa* or *seruga.* Responses which also were actually errors, but which involved a nasal in the appropriate position, were included in the scoring (e.g. *ranga-serupa* blended as *rumpa*); such errors accounted for 3.8% of all responses. Table 1 shows the responses falling into the three scoring categories for each of the six place conditions. In all, 85.3% of these Japanese subjects' blends contained assimilated nasals, 0.4% contained unassimilated nasals, and 14.3% were unscorable. Sign tests on the absolute numbers of scorable responses revealed that significantly more assimilated than unassimilated forms were produced both overall ($z = 22.83$, $p < .001$) and in all place conditions: (bilabial to alveolar; bilabial to velar; alveolar to bilabial; etc.).

Table 1: Mean proportion (across subjects) of assimilated, unassimilated and unscorable responses as a function of place of articulation, Experiment 1 (Japanese listeners, Japanese stimuli).

	assimilated	unassimilated	unscorable
bilabial to alveolar	86.5	1.0	12.5
bilabial to velar	87.5	1.0	11.5
alveolar to bilabial	79.8	0.0	20.2
alveolar to velar	84.6	0.0	15.4
velar to bilabial	84.6	1.0	14.4
velar to alveolar	88.5	0.0	11.5

The results were thus just as predicted: Japanese listeners, whose native-language phonology exhibits obligatory assimilation, assimilated nasals to a different place of articulation in blended forms, consistent with the interpretation that they had perceived the nasals in the stimulus items as unmarked for place of articulation.

3. EXPERIMENT 2 - DUTCH

3.1 Method

48 sets of two pseudo-names were constructed, patterned on the Japanese materials of Experiment 1. All were legal strings according to the phonology of Dutch, and none were existing words or names in the language (although again they were largely composed of existing morphemes). All pseudo-names were bisyllabic, with varying structures. In 24 of the sets, the first name contained an assimilated nasal-stop sequence, and the initial consonant of the second syllable of the second name differed in place of articulation from the initial consonant of the second syllable of the first name. The same three places of articulation were used (although note that in Dutch the [t]/[d] place of articulation is simple alveolar, and the phoneme [g] does not exist so that all velar stops were [k]). For example *mengkerk-trabeek* represents velar to bilabial, and *stambest-sliekoop* bilabial to velar. These 24 pairs were: *lempost - duidel, zoombos - meitaal, krimbeek - prudonk, riempoort - steedrop, bloempark - blakem, veemblik - heikaap, kombult - mukant, stambest - sliekoop, wandijk - koebos, mindaal - drieborn, zondorp - veepaal, loenturf - nabroek, heenten - treekamp, kerndam - veekamp, turndonk - stakerk, boonterp - tweekerk, jongkapel - spebaan, mengkerk - trabeek, lienkum - slapool, langkoop - stropoort, renkulo - prodam, boenkel - reetak, tingkerk - wiedijk, spongkamp - kludorp*. The remaining 24 filler pairs again did not involve assimilation at the predicted division point of the blend.

26 undergraduates at Nijmegen University, all native speakers of Dutch, participated in the study. Instructions were as in Experiment 1, but in Dutch; the procedure was as in Experiment 1.

The absence of obligatory constraints in Dutch phonology should lead, we predicted, to the perception of nasals in nasal-stop sequences as marked for place of articulation, so that Dutch subjects should produce blends in which place was preserved (*mengkerk-trabeek* as *mengbeek*; *stambest-sliekoop* as *stamkoop*) rather than assimilated (*mengkerk-trabeek* as *membeek*; *stambest-sliekoop* as *stangkoop*).

3.2 Results

The responses were scored as for Experiment 1; 9.3% of scorable responses contained some error. Table 2 presents the response rates in each scoring category for each of the six place conditions. In all, Dutch subjects produced 82.7% responses with UNassimilated nasals (against 11.3% assimilated and 6.1% unscorable); sign tests showed that significantly more unassimilated than assimilated forms were produced overall ($z = 18.38$, $p < .001$) and in five of the six conditions. The exception was velar to alveolar, as in *tingkerk-wiedijk* becoming *tindijk*.

The results were thus again as predicted: Dutch subjects preserved place of articulation in blended forms, consistent with the hypothesis that they perceived nasals in nasal-stop sequences as marked for place of articulation.These first two experiments having supported our hypothesis regarding perception of native-language materials, our next experiments addressed the issue of perception of assimilated forms in foreign-language input.

Table 2: Mean proportion (across subjects) of assimilated, unassimilated and unscorable responses as a function of place of articulation, Experiment 2 (Dutch listeners, Dutch stimuli).

	assimilated	unassimilated	unscorable
bilabial to alveolar	1.9	93.3	4.8
bilabial to velar	1.0	88.5	10.6
alveolar to bilabial	2.9	93.3	3.8
alveolar to velar	4.8	89.4	5.8
velar to bilabial	8.7	86.5	4.8
velar to alveolar	48.1	45.2	6.7

4. EXPERIMENTS 3 AND 4 - CROSS-LINGUISTIC

4.1 Method

The materials were those of Experiments 1 and 2; subjects were 26 members of each of the Dokkyo and Nijmegen subject populations, none of whom had taken part in the preceding experiments. The Japanese materials of Experiment 1 were presented to Dutch listeners, and the Dutch materials of Experiment 2 were presented to Japanese listeners. None of the subjects knew the non-native language. The procedure was as in Experiments 1 and 2 except that listeners were instructed that the materials were in a foreign language, were given repeated practice if they needed it, and were allowed to listen more than once to stimulus pairs which they had trouble perceiving. (Both subject groups made use of this option, the Japanese subjects however to a greater extent than the Dutch.)

4.2 Results

The crosslinguistic task proved very difficult. Simply the task of repeating accurately the two members of a stimulus pair was one that subjects found extremely frustrating. (Three additional Dutch subjects who produced essentially no scorable responses were dropped from the analysis.) The number of unscorable responses for Dutch listeners with the Japanese stimuli was 31.2%, and scorable responses containing some error 17.8%; for Japanese listeners with the Dutch stimuli there were 12.3% unscorable responses and 3.4% scorable responses containing error. (The Japanese listeners' higher proportion of scorable responses is presumably due to the fact that they took more advantage of the repeated-listening option.)

Nevertheless, Japanese listeners again produced significantly more assimilated than unassimilated forms (77.2% assimilated against 10.5% unassimilated) and Dutch listeners significantly more unassimilated than assimilated forms (42.8% unassimilated against 26% assimilated). Table 3 presents the detailed responses for each condition. Sign tests again showed the overall preference of each group was significant (Japanese listeners $z = 17.79$, $p < .001$; Dutch listeners $z = 5.02$, $p < .001$).

A combined statistical analysis compared (across all four experiments) the proportion of assimilated versus unassimilated responses from the Japanese versus Dutch subject populations on the Japanese versus Dutch materials sets. The difference between

the two subject groups (Japanese subjects producing more assimilations) was separately significant, across subjects and across items for every place of articulation condition of each materials set.

Table 3: Mean proportion (across subjects) of assimilated, unassimilated and unscorable responses as a function of place of articulation, Experiments 3 (Dutch listeners, Japanese stimuli) and 4 (Japanese listeners, Dutch stimuli).

	assimilated	unassimilated	unscorable
Experiment 3			
bilabial to alveolar	18.3	46.2	35.6
bilabial to velar	9.6	58.7	31.7
alveolar to bilabial	32.7	34.6	32.7
alveolar to velar	31.7	37.5	30.8
velar to bilabial	36.5	40.4	23.1
velar to alveolar	26.9	39.4	33.7
Experiment 4			
bilabial to alveolar	92.3	2.9	4.8
bilabial to velar	68.3	19.2	12.5
alveolar to bilabial	84.6	6.7	8.7
alveolar to velar	75.0	16.3	8.7
velar to bilabial	63.5	13.5	23.1
velar to alveolar	79.8	3.8	16.3

5. CONCLUSIONS

The results of these four studies strongly support our claim that obligatory versus optional constraints in native-language phonology lead to different representations of spoken-language input, whether the input is in the native or a foreign language. Obligatory place of articulation assimilation in Japanese nasal-stop sequences leads Japanese listeners to represent nasals as unmarked for place of articulation, and thus to assimilate them to a different place of articulation when producing a blended form. Dutch listeners, who are accustomed to hearing unassimilated forms, more often preserve the original place of articulation in blended forms, suggesting that they have explicitly represented this information in the input.

Note that no violations were ever present in the stimuli; in both materials sets, all input nasal-stop sequences were assimilated. With the foreign input at least, this symmetry might perhaps have encouraged subjects to adopt a strategy of assimilating. In fact, both subject groups showed a somewhat less asymmetric pattern of response with the non-native input than they did with their native language; but although in both cases the difference was less strong, it was in the same direction as with native input, and again statistically significant.

Only one exception to the overall pattern appeared. Dutch listeners, required to blend an assimilated velar nasal with an alveolar context, as in *tingkerk-wiedijk*, produced assimilated forms (*tindijk*) as often as unassimilated forms (*tingdijk*). The Dutch listeners' paradoxical openness to assimilation in this one case may, we suggest, reflect a role for orthography in guiding the representations they formed of the nonword stimuli. A velar nasal before a velar stop is not necessarily encoded as such in Dutch orthography. Velar/alveolar contrasts are encoded where there is no following stop (thus *ban* 'ban' contrasts with *bang* 'afraid'), but with a following stop there will be no contrast, as there are no unassimilated alveolar-velar sequences within syllables - thus *bank* 'bank' must have a velar nasal. Further, bisyllabic plural forms of words such as *bank* (i.e. *banken*) have a syllable boundary between the nasal and stop but will have the velar nasal as in the monosyllabic singular. Although unassimilated alveolar-velar sequences do appear across syllable boundaries in Dutch (*steenkoud* 'stone cold'; *aanklacht* 'accusation'), there are many words like *banken* with a velar nasal before the boundary unmarked in the written form - *denken* 'think', *winkel* 'shop', *donker* 'dark', etc. Thus it is possible that the Dutch listeners sometimes interpreted the velar nasal in items such as *tingkerk* as an orthographic n - *tinkerk*, producing apparent assimilated alteration of the place of articulation in the blended form. Note that they did not however produce as many assimilated forms of the velar to bilabial blends (*mengkerk-trabeek*), so that again their ability to form truly unmarked representations, even in this orthographically encouraging case, seems very limited compared with that of the Japanese.

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