The consonantal realisation of the mora nasal in Osaka Japanese

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Introduction

The description of the pronunciation of the mora nasal in Standard Japanese varies considerably in the literature. The mora nasal is the syllable final nasal in Japanese (e.g. '*n*' in *Honda*). Along with other elements, it came into the Japanese language with early loan-words from Chinese and extended the originally simpler phonotactics, which consisted of (C)V-syllables only. The variation in the descriptions of the mora nasal can be found not only between different researchers but also depending on the phonetic context, in which it is placed. In some studies the mora nasal is described as having an underlying phonetic place and modus of pronunciation, close to a velar nasal, and which is modified according to phonetic context and speaking style, but often leaves a trace of the original pronunciation. Others assume more context dependent realisations, not giving any information about some original pronunciation.

In the following, a more detailed outline of the various descriptions of the pronunciation of the mora nasal in specific context will be given to illustrate the motivation of the present investigation, which is to show the existence of a consonantal realisation of the mora nasal in intervocalic context in Osaka Japanese, however favoured by particular circumstances and contexts.

The utterance and word final mora nasal

In the case of its utterance final occurrence – as in /hoN/[1] meaning 'book' or 'origin' – some agreement exists that the mora nasal should be produced with an unreleased oral closure. The description of the place of articulation varies from a velar nasal (Sakuma 1929) to a uvular nasal (Hattori 1930). Nakano 1969 presents us with two kinds of velar nasals in the phonetic description of the mora nasal, according to the immediate context. He gives an account of

[1]The capital letter *N* symbolizes the mora nasal.

the occurrence of a velar nasal in the case of a word final or intervocalic mora nasal, which is related in articulation to the utterance used to support the interlocutor to continue the performance. He shows an X-ray picture to demonstrate the articulatory settling of this nasal, which is a simultaneous closure at the rear part of the velum and the uvula. Nakano expresses the possibility for this nasal to be produced simultaneously with lip-closure in that specific dialogue situation, which does not change the auditory impression due to the extensive closure at velum and uvula.

Hattori 1930 and Arisaka 1940 describe the uvular closure as being weak, or lax. Contrasting results were shown in the following investigations: Aoki 1976 showed that oral airflow could be found during the production of the mora nasal when kymograph recordings were made, whereas Sakuma 1929 (1963) did not find any oral airflow with a much less elaborated experimental method. Bloch's description (1950) of the phonetic realisation of the mora nasal at the end of an utterance diverges from the descriptions above in that he claims the existence of a "voiced frictionless nasal ... spirant", which probably results – as Vance 1986 remarks quite convincingly – in an approximant articulation, in agreement with Catford 1977.

The mora nasal in pre-consonantal position

Before obstruents (as in /hoNda/) and sonorants (as in /hoNma/, both examples being Japanese family names), the mora nasal is expected to be assimilated in place of articulation to that of that consonant (Vance 1986, Nakano 1969).

Kawakami 1977 claims three realisations of the mora nasal in such a position, depending on the speaking style and speech tempo. In the case of careful pronunciation, the greater part of the mora nasal is realised as a nasal consonant having the same place of articulation as the supportive particle in conversation, which has been mentioned above. However, towards the end of the mora nasal, the articulation changes due to the place of articulation of the following consonant. Regressive assimilation takes place, but affects only a small portion of the mora nasal ([saN^{m}po] 'stroll'). In more casual speech this assimilation is much stronger, meaning that the portion of the original pronunciation of the mora nasal which is the same as in the supportive particle occurs only within a short time span of the whole nasal ([sa^{N}mpo]). In fast speech, the assimilation affects the whole time span of the mora nasal, and therefore the place of articulation for the whole nasal is homorganic with the following consonant ([sampo]).

Where there is a following fricative (as in /hoNSu:/, the name of the main island of Japan), the mora nasal tends to be a nasalised vowel which corresponds in quality to the place of articulation of the following fricative in the front-back dimension and is therefore a front or back vowel (Hattori 1930).

Before a vowel or a glide

Vowels and glides are also described as being preceded by the mora nasal (as in /seNeki/ 'battle' or /saNyo/ 'participation'), realised as a nasal vowel (Vance 1986, Arisaka 1940). These two authors agree that there can never be a complete oral closure, which would result in a nasal consonant. Arisaka 1940 points out, that in the case of a complete oral closure, a release would have to follow, in order to pronounce the following vowel. Such a release would give a different auditory impression than it does when produced correctly. Nakano 1969 admits the occurrence of an oral closure of the supportive type in dialogue in the case of careful pronunciation. However, in moving towards a more colloquial speech style, the mora nasal is assimilated to its adjacent vowels and transforms into a vowel itself, spreading nasality onto the adjacent vowels at the same time.

The present study

These descriptions of the realisation of the mora nasal represent the Tokyo and Standard variety of Japanese.

Having been exposed to Osaka Japanese for some time, the author felt the need to complement the illustrations above with the observation that complete oral closure in the realisation of the mora nasal can be found in the variety of Osaka Japanese in the case of intervocalic occurrence. However, the consonantal version of the mora nasal, i.e. articulated with complete oral closure, is not the only manner of pronunciation, as a nasal vowel realisation can be found as well. The usage of either version varies according to the speaker's membership of a certain age group or generation. In addition, speech tempo is investigated as a factor on the choice of the variant of the mora nasal. Further observations suggest that the type of adjacent vowels in a *VNV*-sequence influences the realisation type of the imbedded mora nasal as being either vocalic or consonantal. The phonological status of the mora nasal in Osaka Japanese differs from Tokyo Japanese in that it can bear accent (see e.g. Nagano-Madsen 1992). However, informal observations suggest that the distance from the accented mora to the mora nasal or a

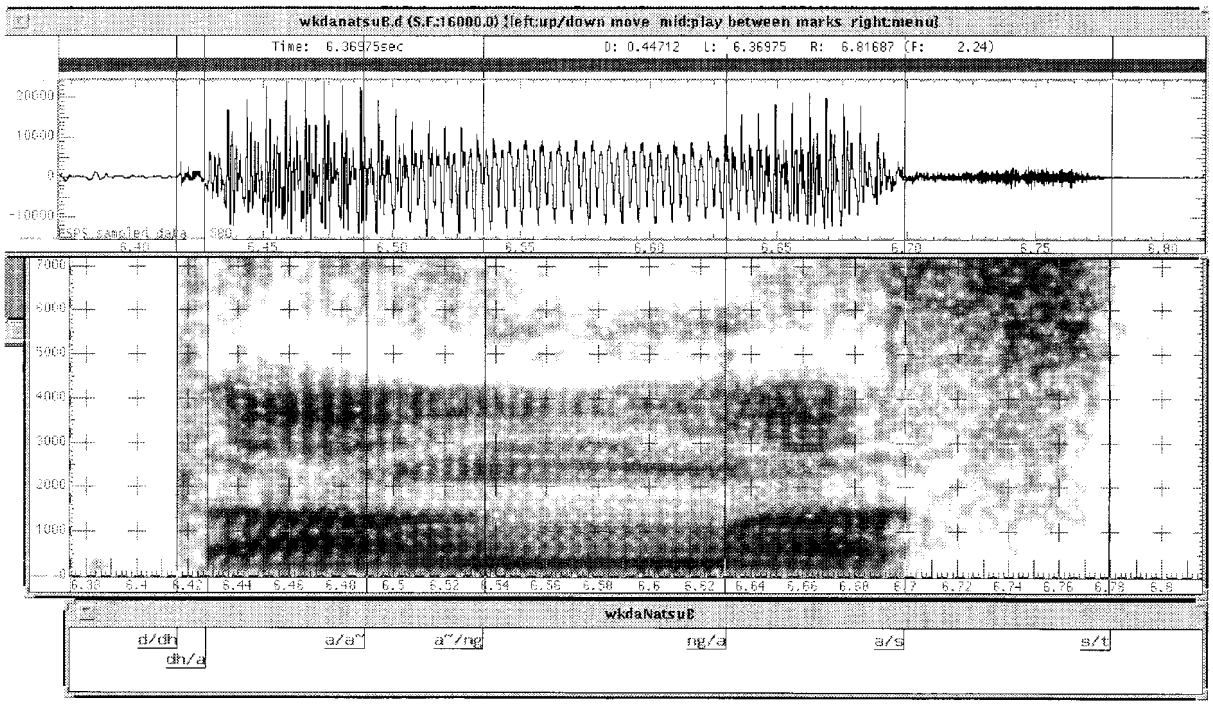

Figure 1. Waveform and spectrogram of the word /daNatsu/, where the mora nasal is realised with oral closure.

possible overlap of the accented mora with the mora nasal has no influence on the realisation type and is not pursued any further in this study.

The factor of speaker age

Speaking styles tend to vary between generations. The use of the consonantal version of the mora nasal seems to underlie such influence, too. Informal observation suggests that this realisation is less likely to occur in adolescent speech.

Material, subjects and recording

The material for this investigation consists of read speech. It contains a list of 65 sentences of the type: *A yori wa, B to iu hoo ga ii* ‘in comparison to *A*, *B* is better’, where *A* is a compound word, enclosing a mora nasal (*N*) at a morpheme boundary in intervocalic position (V*N*V). The rest of the phrase was designed not to contain any kind of phonological nasal, including the meaningful word *B*, which stands in semantic relation with *A*. The text was presented in Japanese characters, where the words *A* and *B* were often presented in kanji plus furigana. However, for some more familiar cases, kanji only was presented. Due to the requirement that the target word *A* should contain a mora nasal in intervocalic context, and all 5·5 possible contexts should be presented, it was not easy to find well-known words, that could be understood by all the subjects when presented in kanji only.

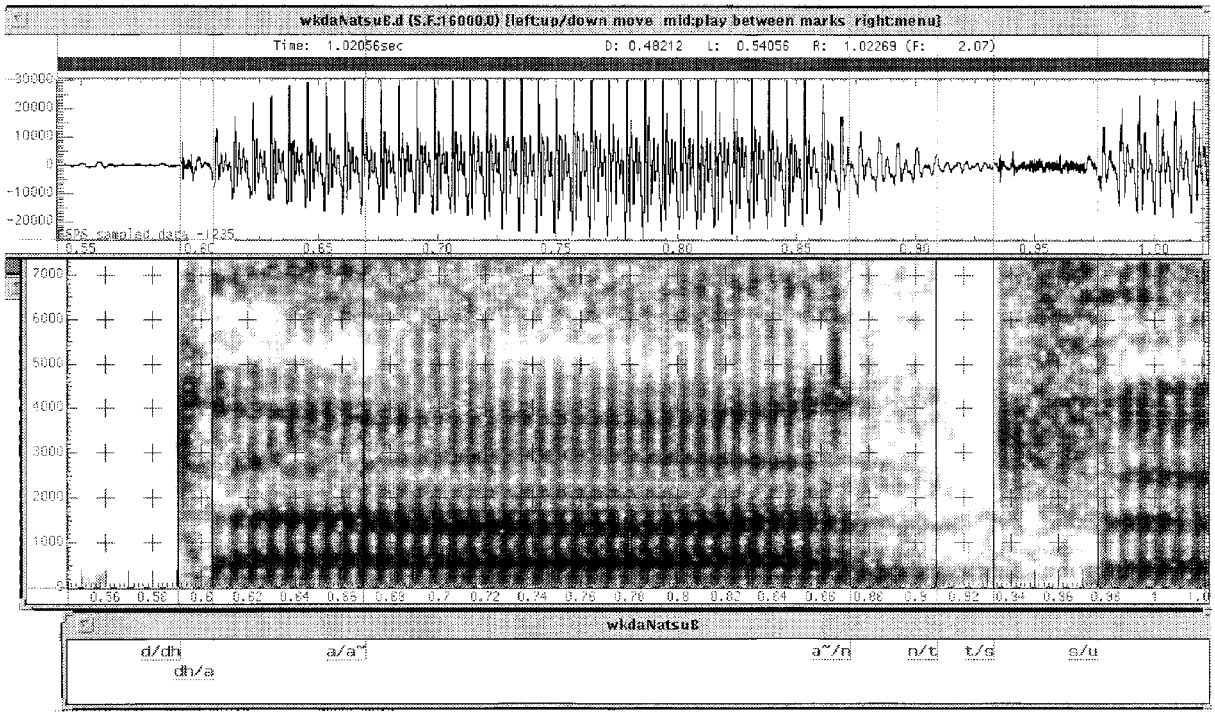

Figure 2. Waveform and spectrogram of the word /daNatsu/, where the mora nasal is realised without oral closure.

However, it was not possible to find suitable words in all 25 vowel contexts. There is a distinct lack of target words containing the combinations /uNu/, /oNu/, /iNo/ in the material. The subjects were asked to read the sentences fluently, avoiding any kind of pausing.

The group of subjects consists of eight native speakers of the Kansai variety of Japanese. They have all lived in the city of Osaka all their lives and their parents are natives of the city or the Kansai area as well. Four of the subjects belong to a younger generation, aged between 15 and 20 years (genA), the other four subjects belong to an age group between 40 and 45 years of age (genB). For each generation, two of the subjects are female and two of them are male. They have completed high-school or – for the younger subjects – are high-school students. The two male subjects of the older generation have completed undergraduate studies at college. The two female subjects of the younger generation have very good comprehension of English.

The recordings were made mostly in the subjects' homes. A portable two-channel DAT-recorder was used for that purpose. In addition to the oral signal, a nasal signal was recorded with the help of an accelerator microphone attached to the nose as described in Tronnier 1995.

Analysis

The recorded data were analysed in the ESPS/Waves+ environment. With the help of spectrograms, the waveform and the possibility of auditory output of fractions of the speech signal, traditional labelling was undertaken (Figure 1 and Figure 2). The information in the nasal signal obtained with the accelerometer was merely used for support and orientation to detect the beginning and the end of the velar opening in the vowels adjacent to the mora nasal.

In the case of age group behaviour, the number of consonantal realisations of the mora nasal out of the whole number of appropriate realisations per subject was calculated in percentage. In some cases, kanji-compounds in Japanese can be read in two different ways. Appropriate realisations were therefore target words read in the expected way – i.e. including a mora nasal – and realisations without misreading. The data is grouped for the different age groups (genA for the younger generation and genB for the older generation) and an unpaired t-test, assuming equal variance was applied to compare the two groups statistically.

Results

The number of realisations of the consonantal version of the mora nasal varied not only between the age groups, but also between the speakers. As can be seen in Table 1 and Figure 3, no speaker had a higher realisation rate of the consonantal version than 33%, when reading the sentence list containing the target words. The lowest occurrence rate, however, is 0% for two subjects. These two subjects are both members of the younger generation (genA). One further subject of the younger generation shows a very low occurrence of the consonantal realisation with only 3.2%.

Of the four subjects in the older generation (genB), three show a rather similar occurrence rate of the consonantal version, which varies from 25% to 33%. The really surprising results are obtained from subject *Mitsuyo* in genA and from subject *Tonomura* in genB, where non-conformity with the rest of the subjects in the respective age group can be observed: subject *Mitsuyo* shows an untypically high number of consonantal realisations for her age group (genA) with 21.7%. Subject *Tonomura* on the other hand shows an untypically low number of consonantal realisations for her age group (genB, 8.7%). Due to the non-conforming behaviour of these two subjects, the difference between the two generations is not highly significant ($t=2.399284$, $df=6$, $p<0.1$). However, if we assume some personality characteristics of the two subjects with non-conforming results, which could be the ability to adapt

to another age group in speaking style and therefore exclude these subjects,

genA		genB	
Mitsuyo	21.7%	*Fuji*	25.0%
Shoichi	3.2%	*Tooru*	33.0%
Jun	0%	*Noriko*	31.0%
Saburoo	0%	*Tonomura*	8.7%

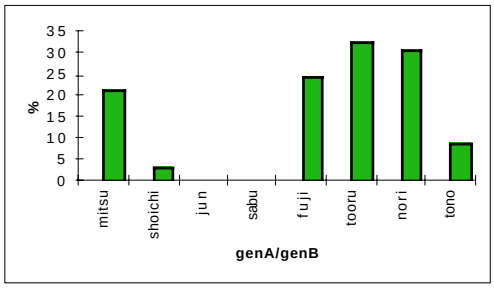

Table 1 and Figure 3. Occurrence rate of the consonantal realisation for each subject of the two generations in percentage.

the differences between the two age groups would be highly significant ($t=10.87558$, $df=4$, $p<0.001$). The motivation for these two subjects to adapt to another age group could lie in the fact that the investigator the subjects were presented with belonged to neither of the age groups, but is older than the members of genA and younger than the age group genB.

The spontaneous reaction to subject *Jun's* utterances by a native Japanese of some variety of the Kansai dialect was, that she spoke in an extremely casual manner. However, that impression did not evolve in the case of subject *Saburoo,* who equally did not produce any consonantal realisation of the mora nasal in this investigation. In summary, not all the speakers made use of the consonantal variant of the mora nasal, and those who have it in their repertoire still use the vocalic version more often. When looking at the distribution of the subjects who make a more frequent use of the consonantal version, it is obvious that three out of four subjects belong to an older generation group than those subjects who hardly or never use the consonantal version. However, the reverse is also the case: of four subjects, the three who rarely or never make use of the consonantal version of the mora nasal belong to a younger generation, an adolescent generation.

Speech tempo

As Kawakami 1977 observes from fast speech that the underlying quality of the mora nasal is reduced and even deleted in consonantal context, this study will enquire such deletion in vocalic context. The assumption is therefore, that the consonantal version of the mora nasal is more likely to be chosen in the case of slower speech tempo.

Material, recording, subjects and analysis

For this part of the study, the same material and the same recordings as described for the preceding part were used. The recordings of the four speakers more frequently using the consonantal variant of the mora nasal in their repertoire were analysed here. For estimating the speech tempo of the utterances, the length of the portion *yori wa* of the carrier sentence *A yori wa, B to iu hoo ga ii* was measured. This procedure was chosen prior to measuring the length of the VNV-sequence to avoid the problem of a preceding vowel representing a whole mora in contrast to just one part of a mora (*eNo* vs. *seNoo*), or a following vowel-occurrence counting as one mora in one case and two morae in other cases, where either the quality is the same (*eNo* vs. *seNoo*), or where due to diphtongization two vowels are difficult to separate (*jiNai*). Only non-interrupted realisations up to the end of the particle *wa* were included in the data. Excluded realisations contained pauses, hesitations and audible tempo change (such as acceleration) within that phrase. One more reason for the exclusion of an utterance was in the case of a transposition of the two phonemes /yo/ of *yori wa*, which resulted in the realisation of the sequence [oi]. Such transpositions occurred in some realisations for VNV-sequences ending in /o/. The evaluation of the suitability of an utterance was undertaken by the author in co-operation with a phonetically trained native speaker of Japanese in a rather informal way. Since the subjects were asked to read without interruption, making use of the *yori wa*-portion seemed to be sensible, because it is consistently present in the material.

For the investigation of the influence of speech tempo, the data was grouped for each of the four subjects as to whether the mora nasal in the VNV-sequence was realised as a consonant or a nasal vowel. For each subject an unpaired t-test, assuming equal variance was applied to compare the speech tempo of the two realisation types.

Results

Varied speech tempo is observable for all subjects when reading the list of sentences. Such variation occurs not only between the categories of the different realisation types – i.e. the consonantal and the vocalic realisation –, but also within each category. As can be seen in Table 2 and Figure 4, for all but one subject (*Mitsuyo*) there is a tendency for the reference segment *yori wa* to be spoken slower on average in a phrase where a consonantal version of the mora nasal in the target word was realised. However, due to the extreme variation within each category, this tendency is not significant for any of the subjects. The only significant difference between the two

categories is present for the subject *Mitsuyo*, who shows the reverse effect, where the reference segment *yori wa* was spoken slower on average in a

	consonant	vowel
Mitsuyo	0.397	0.437
Shoichi	0.385	0.367
Jun	----	0.356
Saburoo	----	0.372
Fuji	0.393	0.365
Tooru	0.428	0.407
Noriko	0.402	0.401
Tonomura	0.449	0.391

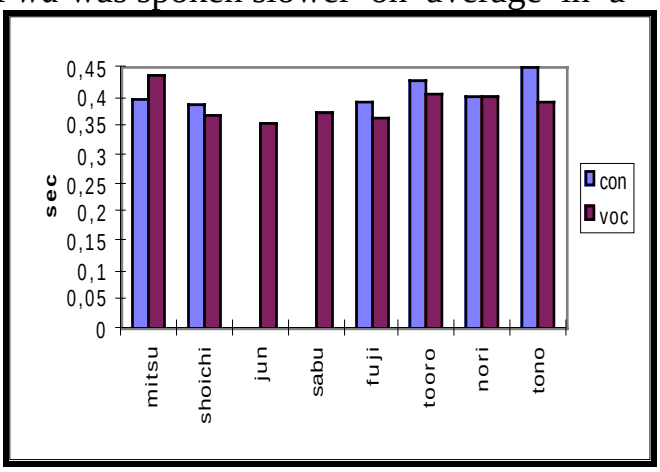

Table 2 and Figure 4. Average duration of the reference segment *yori wa* in seconds for each subject, grouped by the realisation type of the mora nasal in the target word of that phrase.

phrase with a vocalic version of the mora nasal in the target word ($t=2.59$, $df=44$, $p<0.05$).

The two subjects, who did not produce any consonantal version of the mora nasal, however, show fairly fast realisation of the reference segment *yori wa* on average, when compared with the other subjects. For a more general comparison, their measurements were added to Figure 4 and Table 2.

In summary, speech tempo seems to be a parameter that can be dismissed as an important factor for the production of the mora nasal with complete oral closure. The variation in speech tempo for each subject making use of the consonantal version at all is too large for both categories – i.e. the consonantal vs. the vocalic realisation –, so that no significant influence is present. However, one speaker, who was informally rated as having very casual pronunciation and who did not demonstrate any consonantal realisation, showed on average the fastest speech tempo.

Quality of the adjacent vowels

Observations suggest that the type of adjacent vowels in a *VNV*-sequence influences the realisation type of the imbedded mora nasal as being either vocalic or consonantal. In addition, the combination of the two adjacent vowels seems to play a major role in the choice of the variant.

The Japanese language contains the five vowels /a, i, u, e, o/, where /u/ is an un-rounded vowel. Within Jones' cardinal vowel system, arranged

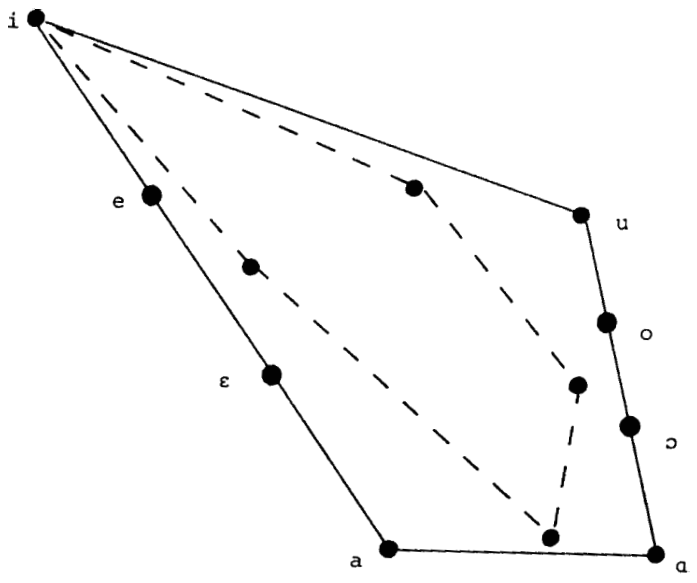

Figure 5. The placement of the five Japanese vowels within the cardinal vowel system according to tongue position (adopted from Vance 1986).

according to an articulatory analysis, i.e. tongue position (Abercrombie 1967), they are found to be placed as shown in Figure 5 (Nihon Onsei Gakkai 1976). Such placement again refers to the standard variety of Japanese. However, with regard to vowel quality, the Osaka dialect – in contrast to more northern Japanese dialects – is not known to differ considerably from standard Japanese.

In the following, a detailed analysis of the influence of the type of vowel preceding the mora nasal and following the mora nasal will be described. In addition, the combination of the adjacent vowels, i.e. their relationship according to (a) their degree of openness and (b) distance in terms of lying next to each other or how many steps apart within the Japanese vowel system as is shown in Figure 5 will be investigated.

Material, recording, subjects and analysis

The material for this part of the investigation consists of the same material as in the above presented parts. In addition to the 65 sentences of the type *A yori wa, B hoo ga ii*, a second set of 65 sentences was recorded, which had the target word and the semantically related word in interchanged position (*B yori wa, A hoo ga ii*). Therefore, two realisations of the target word *A* could be obtained. The group of subjects were selected from the group recorded for the previous investigations and consists of four native speakers of the Kansai variety of Japanese, all having the consonantal variant of the mora nasal in their repertoire.

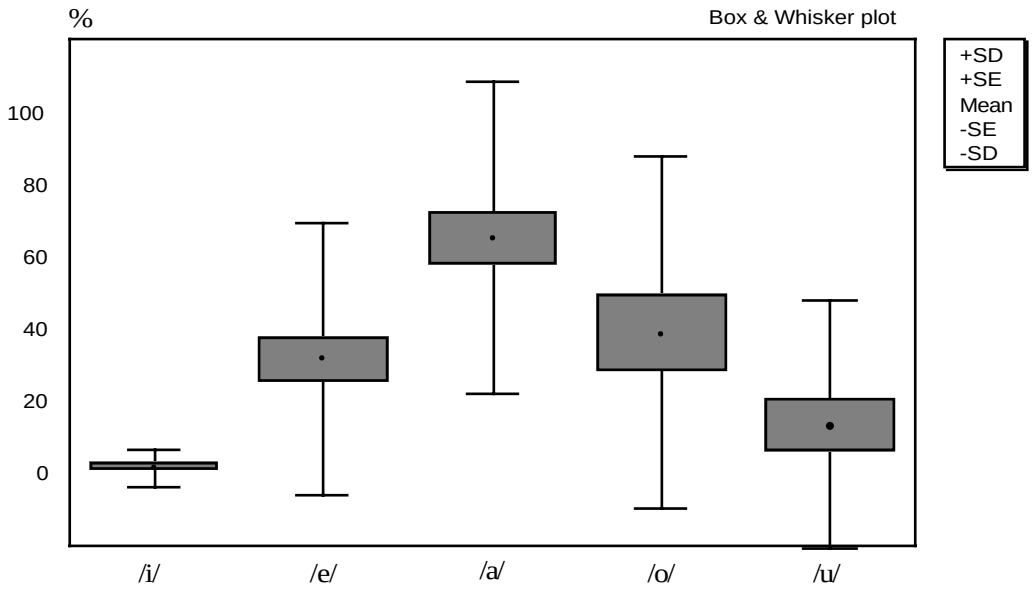

Figure 6. The five Japanese vowels in post-nasal position show a different degree of influence (in %) on the number of the consonantal realisation of the preceding mora nasal.

The recording and analysis procedure was the same as is described in the previous sections.

For the statistical analysis, the STATISTICA-package was used. The number of consonantal realisations of the mora nasal in the target word *A* for each combination of the adjacent vowels in each sentence position was calculated in percent. For the different aspects, one and two-factor ANOVAs with repeated measures for the different sentence positions were applied.

Results

First of all, no significant difference was observable in the type of realisation of the mora nasal between the two repetitions of the same target words in different sentence positions ($p>0.05$). In addition, no significantly deviating behaviour of any of the four subjects could be observed ($p>0.05$).

The figures in the appendix show the distribution of the occurrence of the consonantal realisation of the mora nasal for all vowel combinations.

The vowel preceding the mora nasal does not seem to play an important role in determining the realisation type of the mora nasal ($p>0.05$).

However, the type of vowel following the mora nasal seems to be of great importance ($p<0.001$). As can be seen in Figure 6, the number of realisations of the consonantal version of the mora nasal covaries with the degree of openness of the five Japanese vowels in post-nasal position: the more open

the post-nasal vowel, the higher the number of consonantal realisations of the mora nasal.

The strong influence of the most open vowel /a/ on the realisation of a consonantal version of the mora nasal (x@=65%, sd=43.21) is highly significant in comparison to the vowels /i/ (x@=1.44%, sd=5.31) and /u/ (x@=13.64%, sd=35.13) ($p<0.001$) and significant in comparison to the vowels /e/ (x @=31.54%, sd=37.91) and /o/ (x @=36.96%, sd=48.19) ($p<0.05$). However, the vowel /o/ does not differ significantly from the vowels /e/ and /u/. Even /e/ and /u/ do not differ significantly from each other in respect to their influence on the realisation type of the preceding mora nasal. The same is the case for the two closed vowels /i/ and /u/. The degree of openness of the post-nasal vowel seems to be proportionally influential in the number of consonantal realisations of the mora nasal.

One further observation is, that where the post-nasal vowel is more open than the pre-nasal vowel, a significant preference for the consonantal variant of the mora nasal is observed ($p<0.005$). The three directional factors are distributed in the combinations such as (1) pre-nasal more open vowel and post-nasal more closed vowel, (2) pre-nasal and post-nasal vowel with the same degree of openness and (3) pre-nasal more closed vowel and post-nasal more open vowel. The relative degree of openness of the vowels according to Figure 5 serves as a basis for this classification, so that all five vowels have a different degree of openness. In more detail, a significant difference can be found between the combinations (1) and (2) ($p<0.05$), in that where the two vowels adjacent to the mora nasal have the same degree of openness, the occurrence of the consonantal version is much more frequent (x@=39.66%, sd=44.31) than where the pre-nasal vowel is more open than the post-nasal vowel (x@=13.15%, sd=32.08). An even higher significance can be detected between the combinations (1) and (3) ($p<0.001$). Here again, the case of the pre-nasal vowel being more open than the post-nasal vowel (i.e. (1)) favours the occurrence of the consonantal version of the mora nasal to a lesser extent. In comparison, in the reverse combination (3), where the pre-nasal vowel is more closed and the post-nasal vowel is more open, the consonantal variant is favoured more often (x @=45.09%, sd=44.95). There is no significant difference between combination (3) and combination (2) ($p>0.5$), where both vowels adjacent to the mora nasal have the same degree of openness. For each of the three combinations a significantly varied number of consonantal realisations of the mora nasal can be observed in combination with the type of the various post-nasal vowels, that is for (1) open-close direction $p<0.05$, (2) same degree of openness for both adjacent vowels $p<0.001$ and (3) close-

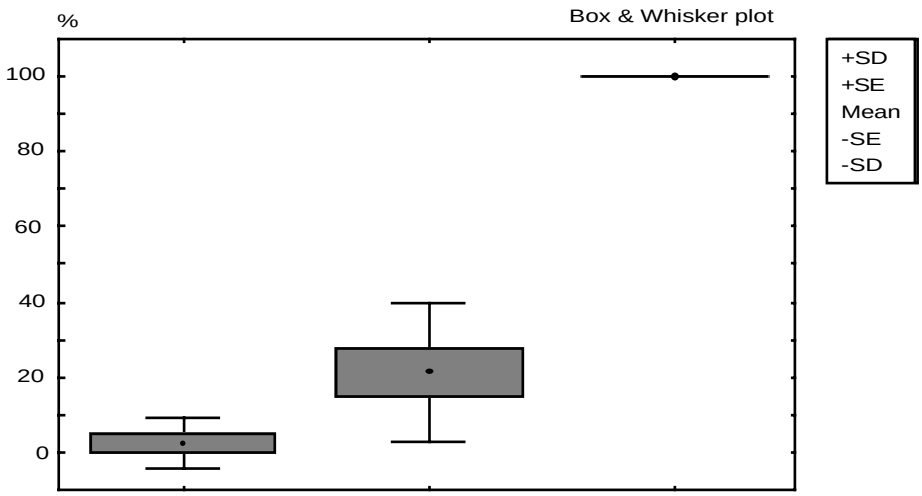

Figure 7. If both adjacent vowels have the same degree of openness (i.e. *aNa*, *eNe*, *iNi*), the open vowel /a/ triggers a consonantal realisation of the mora nasal much more frequently (in %).

open direction p<0.05. If we compare the cases, where the preceding and the following vowels have the same degree of openness, a similar distribution as for the case of the post-nasal vowels can be observed (Figure 7).

The highest rate of consonantal realisations is found in the case of pre- and post-nasal /a/ (x@=100%, sd=0). Hardly any consonantal realisations appear where the pre- and post-nasal vowel is /i/ (x@=2.5%, sd=7.07). Inbetween cases with significant differences from the combination with the vowel /a/ (p< 0.001) and in tendency but not significantly higher occurrence of the consonantal variety than /i/ (p=0.3) and with an intermediate number of consonantal realisations /e/ (x@=21.45%, sd=18.37) in pre- and post-nasal position can be observed. Here again, the openness of the post-nasal vowel rather than the combination of the two adjacent vowels seems to be relevant and additionally contributes to the significant difference between (1) and (2) and the similarity in the number of consonantal realisations for (2) and (3). Thus, the factor of degree of openness of the post-nasal vowel already incorporates the factor of combination of vowels adjacent to the mora nasal according to their degree of openness.

The effect of distance between the vowels within the five Japanese vowels accommodated in the cardinal vowel system as presented in Figure 5 seems to play a marginal role (p<0.05). If the two vowels adjacent to the mora nasal are not neighbours in the Japanese vowel system, but if they have the same quality or lie further apart than one step only, a slight tendency for the

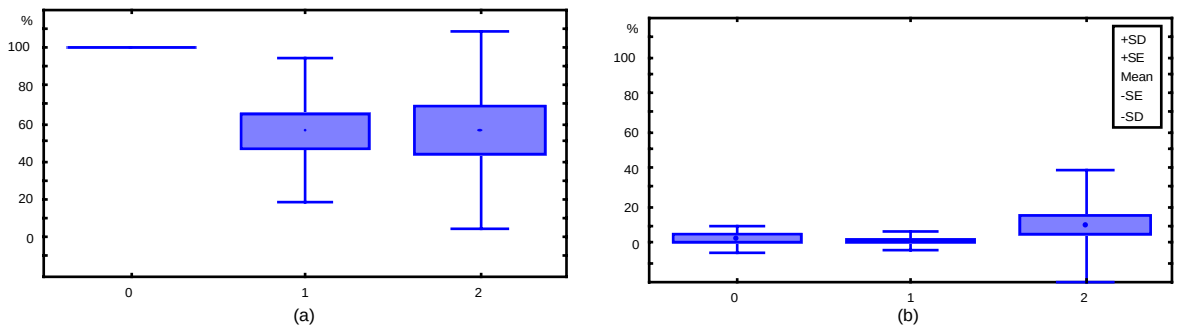

Figure 8. The occurrence of the consonantal realisation for differrent degrees of distance (0, 1, or 2 steps) in %, between the vowels, adjacent to the mora nasal, where (a) the postnasal vowel is of an open category (/a/) and (b) the postnasal vowel is closed (/i/ and /u/).

preference for the consonantal realisation of the mora nasal is seen. However, when analysing the individual vowel combinations in more detail, again, the strong influence of the degree of openness of the post-nasal vowel rather than the effect of distance on the choice of the consonantal variant becomes evident (Figure 8).

In summary, the degree of openness of the vowel following the mora nasal seems to be the most relevant factor in choosing the variant of the mora nasal. The consonantal pronunciation of the mora nasal is more likely to be chosen the higher the degree of openness of the postnasal vowel. The influence of the relationship of the two vowels adjacent to the mora nasal is already incorporated in this factor.

Discussion and conclusions

The present investigation shows that a consonantal realisation of the mora nasal is present in the Osaka variety of the Kansai dialect not only in consonantal context but even in purely vocalic context. This finding is complementary to earlier studies on that topic for the Standard and Tokyo variety of Japanese, where a consonantal realisation was accepted and assumed in specific consonantal context. With one exception (Nakano 1969), a vocalic realisation was assumed in intervocalic position. However, Nakano 1969 claims, that the consonantal version only occurs in careful pronunciation.

The data presented here showed that not all the speakers made use of the consonantal variety of the mora nasal, and those who have it in their repertoire still use the vocalic version more often. When looking at the

distribution of the subjects who have a more frequent use of the consonantal version, it is obvious that three out of four subjects belong to an older generation group than those subjects who hardly, or never, use the consonantal version. However, the reverse is also the case: of four subjects, the three, who rarely or never make use of the consonantal version of the mora nasal belong to a younger generation, an adolescent generation. These results could be interpreted as showing either (a) that in a time course of adaptation to an adult society's demands, such speech behaviour of the younger generation will change, or (b) that in the course of language change the consonantal version of the mora nasal in intervocalic position will disappear from the Osaka dialect.

Speech tempo seems to be a parameter that can be dismissed as an important factor for the production of mora nasal with complete oral closure. The variation in speech tempo for each subject making use of the consonantal version at all is too large for both categories – i.e. the consonantal vs. the vocalic realisation – so that no significant influence is present. However, one speaker who was informally rated as having very casual pronunciation did not demonstrate any consonantal realisation and showed on average the fastest speech tempo. In contrast to Kawakami 1977, who observes the loss of the consonantal pronunciation of the mora nasal due to a faster speech tempo in the case of a following consonantal context, as is described in more detail in the introductory section above, it seems sensible to follow Nakano 1969 when accounting for the existence of a consonantal version of the mora nasal with complete oral closure in Osaka Japanese. Nakano distinguishes between careful pronunciation on one end of the scale including a consonantal realisation of the mora nasal and a colloquial variant at the other end, where no consonantal realisation of the mora nasal can be observed, rather than regarding speech tempo as a differentiating factor.

In the section concerned with the influence of the vowels adjacent to the mora nasal, it has been shown that the degree of openness of the following vowel is most important in the choice of the type of mora nasal, that is: towards a more open degree of the post-nasal vowel a higher probability of occurrence of the consonantal variant is found. Other effects favouring the consonantal version over the vocalic one, such as combinations of the pre-nasal and the post-nasal vowels with respect to varying degree of openness and absence of adjacency in the vowel system are also based on the degree of openness of the post-nasal vowel.

Bell-Berti et al. 1979 showed in an experiment on coarticulatory effects of vowel quality on the function of the velum that, for English, the open vowel

/a/ evokes a relatively lowered velar position in comparison to the vowel /i/ in general, not only in the case of an adjacent nasal. This might have led to the perceived need of some speakers of the Osaka variety of Japanese to dissociate and mark the transition between two vowels for some cases, where the mora nasal is imbedded. Such dissociation with the help of a complete oral closure would occur in the case of a preceding closed/high vowel and a following open/low vowel, because the natural velar opening towards the open vowel would confuse the percept for whether a mora nasal occurs in this place or not. Furthermore, it would be reasonable to assume this kind of dissociation in the case of both adjacent vowels of an open quality. Both assumptions are supported in the data presented here.

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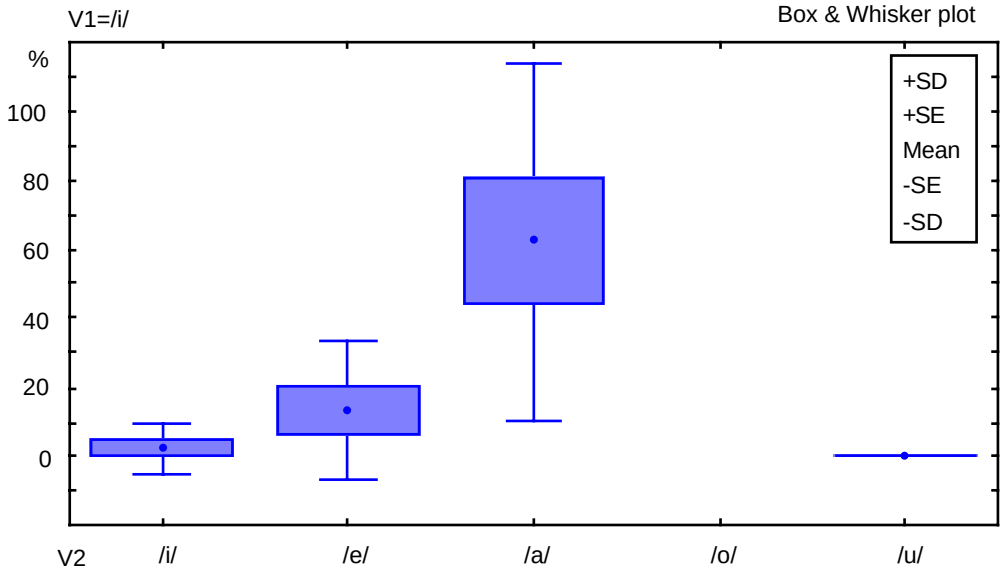
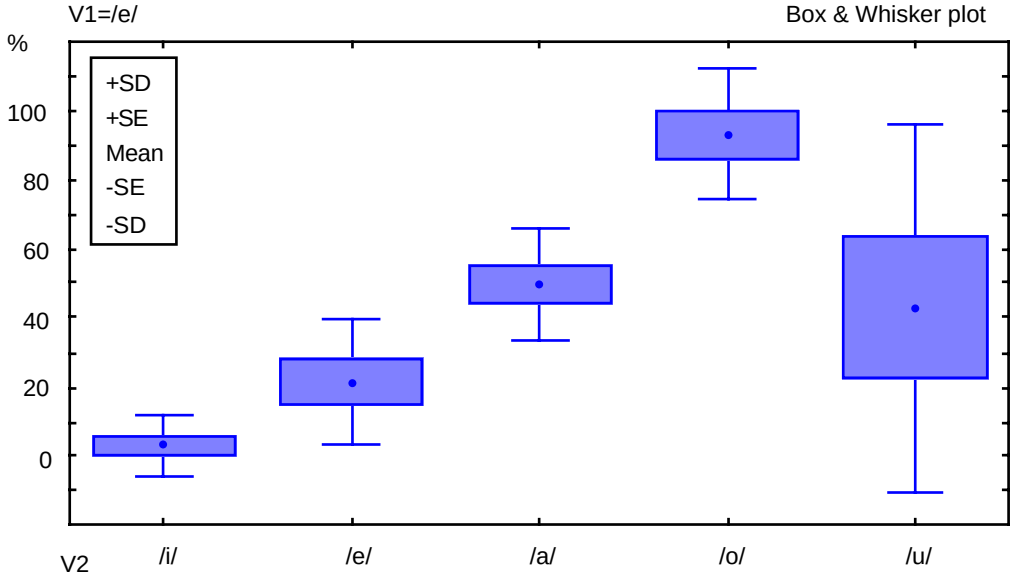
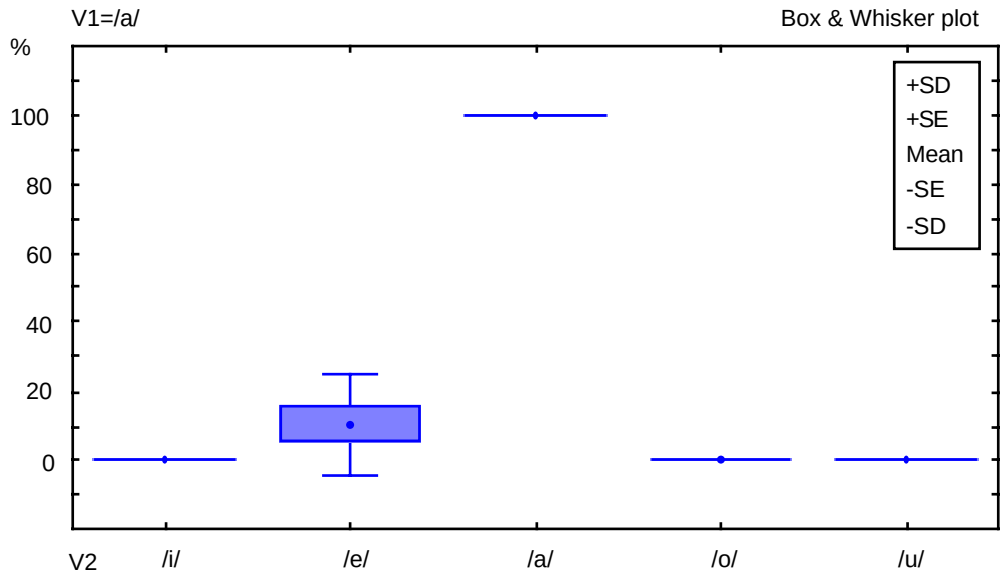
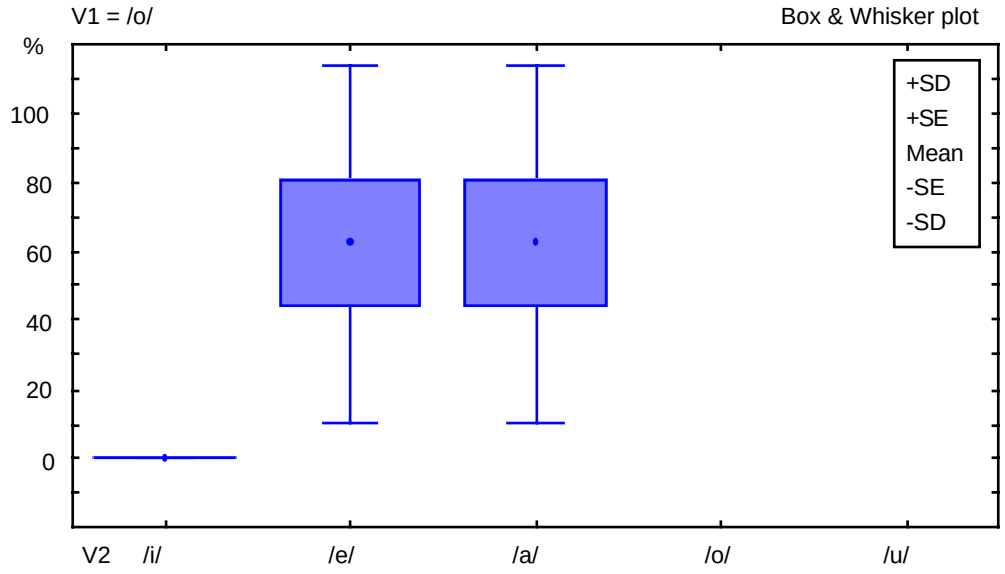
Appendix

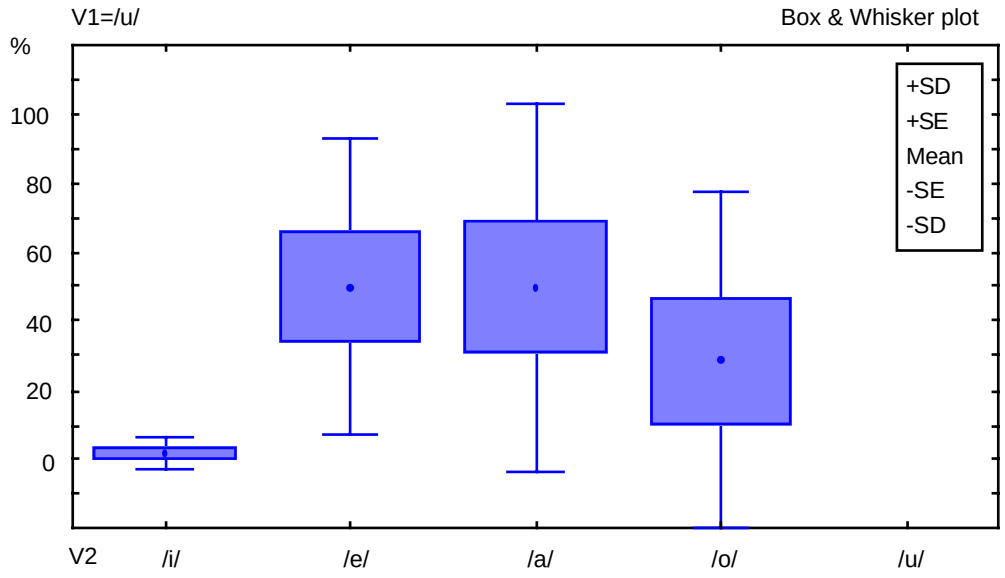
The occurrence of the consonantal realisation of the mora nasal for all vowel combinations (in %) across all subjects, where V1 denotes the vowel preceding the mora nasal and V2 stands for the postnasal vowel.






V1=/a/
Box & Whisker plot
%
100
80
60
40
20
0
+SD
+SE
Mean
-SE
-SD
V2
/i/
/e/
/a/
/o/
/u/


V1 = /o/
Box & Whisker plot
%
100
80
60
40
20
0
+SD
+SE
Mean
-SE
-SD
V2
/i/
/e/
/a/
/o/
/u/


V1=/u/
Box & Whisker plot
%
100
80
60
40
20
0
+SD
+SE
Mean
-SE
-SD
V2
/i/
/e/
/a/
/o/
/u/