It is well-known that vowel quality intrinsically affects fundamental frequency (F0), with low vowels having a lower F0 than high vowels (e.g. Lea 1973, Hombert 1978). As for the reverse relation, that is, the effect of F0 on vowel quality, various studies have reported that, in singing, F0 rises are accompanied by rises in the first formant (F1) (Rossing 1990, Sundberg & Skoog 1997). As far as I know, it remains unclear whether the same phenomenon occurs in normal speech, and, also, whether this intrinsic influence can become extrinsic or phonologized in the language system. In this paper, I present evidence supporting these hypotheses. In the Matbat language, a lowering vowel change is partially conditioned by a rising tone.

Matbat is an Austronesian language with around 600 speakers on Misool, off the west coast of New Guinea. Its immediate ancestor had a five-vowel system with /i,e,a,o,u/ (Blust 1978). I recently found that Matbat has developed a seven-vowel system – /i,e,E,a,o,ç,u/ – that is, with an additional level of vowel height. The seven-vowel phonological contrast is evident from lexical minimal pairs and a phonetic investigation based on data from eight speakers. This diachronic change in the vowel system is conditioned by two factors – a phonotactic one and a prosodic one. As for the former, the mid vowels */e,o/ of the original system have lowered when followed by a non-semivowel consonant. For example, /tE21l/ ‘testicles’ has developed from Malay /telur/ ‘egg’. We hypothesize that this sound change has started in words that have the coda /l/. Laterals are known to give rise to significant perturbations of the formants of adjacent vowels (Ladefoged & Maddieson 1996). The hypothesis that post-vocalic /l/ started the change is also supported by the fact /l/ conditions lowering among the high vowels as well.

The second factor involved in the vowel change is lexical tone. Matbat has six tonemes (Remijsen 2001). Using a convention in which the speaker’s tonal range is represented by the range from 1 (bottom) to 4 (top), these tonemes can be transcribed as follows: /41, 3, 12, 121, 21, 1/. It was mentioned above that the vowel shift only took place in syllables with a non-semivowel coda. A consistent exception to this rule are syllables that have the low-rising toneme (/12/). Words with this toneme that originally had */e,o/ invariably show the shift to /E,ç/, respectively, irrespective of the presence or nature of a coda. The rise in F0 at the end of this toneme implies a corresponding rise in the higher harmonics. I hypothesize that this toneme induced an increase in F1 as the speakers tuned F1 upwards so as to follow the nearest rising harmonic. This kind of interaction between F0 and F1 (‘formant tuning’) is well-known from professional singers (Rossing 1990:353, Sundberg & Skoog 1997). A perception study by Carlsson & Sundberg (1992) revealed that formant tuning is not appreciated by expert listeners. This suggests that formant tuning benefits the speaker rather than the hearer, and is therefore likely to be a mechanical, intrinsic characteristic of producing an F0 rise. From the perspective of the Matbat vowel change process, the rise of F1 as a result of formant tuning gives open syllables the same kind of transition as induced by a following /l/ in closed syllables. In an inferential test with only two Matbat minimally contrastive word sets, the difference in F1 at vowel offset between /12/ and the other tonemes tended towards significance (p = .105). We expect that a controlled comparison with a greater dataset will yield significance. Pending such quantitative confirmation, we can already conclude that there is phonological evidence – in the form of this
prosodically conditioned vowel change – that in normal speech, just as in singing, a rise in F₀ may be accompanied by a rise in F₁.

References