This paper describes preliminary work concerning phonetic simulations of unintuitive voicing behavior in Tswana. According to studies conducted by [3] and [13], languages from the Sotho-Tswana group of Bantu languages demonstrate unintuitive voicing behavior in devoicing of post-nasal voiced plosives (/mb/ → [mp]) – unintuitive in that greater articulatory effort is required to terminate voicing than to maintain it [16]. Nasals preceding stop consonants are said to have appeared in Bantu languages in order to facilitate production of voicing during the stop segment and were lost later during language evolutionary changes in languages like Swahili, Sotho or Duala [9]. Current studies on Tswana and Shekgalagari ([3]; [7]; [14]), however, demonstrate that nasal segments remained in those languages – surprisingly not only before voiced stops but also before voiceless ones.

The aim of this work is to apply exemplar-based phonetic simulations in order to investigate factors influencing post-nasal devoicing and its evolution over time. Exemplar Theory ([5]; [8]; [12]) assumes that language production and perception are tightly linked. Percepts of linguistic experiences are stored in the mental lexicon with their concrete forms, including for example phonetic detail. It is claimed that language use plays a crucial role in the formation of the sound system. In this sense, phonological rules stem from generalizations of representations of directly used forms [1]. Such a usage-based approach to language analysis presumes also categorical storage of exemplars, where frequency of occurrence and activation, determines successful storage of a phonological item and its role in speech production/perception and language acquisition [4]. The phenomenon of post-nasal behavior has been investigated from different perspectives. [6] implemented the computational model of [16] based on the previous work of [13] and tested the hypothesis that part or all of the stop closure after a nasal, is realized with vocal fold vibration. Their results demonstrate that post-nasal position of a stop facilitates its voicing (in case when no additional articulatory settings are undertaken). It confirms the hypothesis of [16] in that voicelessness requires additional articulatory cost, whereas voicing reflects a neutral state in post-nasal position. Furthermore, [3] pointed out that given the phonetic naturalness of post-nasal voicing and phonetic unnaturalness of post-nasal devoicing, phonetic grounding of phonology would assume no language could exist with the phonological rule of post-nasal devoicing. The authors describe acoustic measurements of Tswana post-nasal stops and report devoicing of these, arguing that one group of speakers applied aerodynamic and mechanical forces during the closure voicing, without employing any phonological rule (where voicing closure corresponded to maximally half of the total consonantal closure). On the other hand, another group of speakers tended to realize the whole closure duration with voicing. [3] claim that these speakers developed a rule of post-nasal voicing by phonologizing spontaneous partial voicing.

Computer simulation studies provide a means of investigating models and testing hypotheses. In particular, they can directly address empirically inaccessible phenomena. Moreover, only an implemented model (i.e. a simulation based on a model) can be tested and analyzed in all due detail. [2] for example, use computer simulations to investigate diachronic development of sibilant inventories. They successfully replicated the diachronic development of the Polish three sibilant system from a medieval state to its present-day configuration. [11] uses computer simulations to investigate language change under varying conditions of social interaction and acquisition biases within a population. [15] presents computer simulations of
category competition in an exemplar-theoretic framework. He argues that contrast is not “a property of forms” but that it can be described rather in an exemplar-theoretic framework as being implicitly driven by the statistical association of forms to categories.

In our work we adapt and combine the methods proposed by [11] and [15] by modeling competition between variants undergoing functional and social selection during language acquisition over many generations. We show that modelling voicing profiles [10], which can be extracted from labelled data bases, can be achieved by assigning functional and/or social biases to such processes as sonorant devoicing in obstruent context.

With our simulation experiments we investigate the influence of various parameters and compare the results against the reported “unintuitive” voicing behavior in Tswana and its diachronic development.

References